Journal of Business Venturing 34 (2019) 141–177

Contents lists available at ScienceDirect

Journal of Business Venturing

journal homepage: www.elsevier.com/locate/jbusvent

Signaling in science-based IPOs: The combined effect of affiliation with prestigious universities, underwriters, and venture capitalists☆

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ARTICLE INFO

Keywords:
IPO
Signaling
Valuation
Underwriter
Venture capitalist
Academic entrepreneurship
Spinoff

ABSTRACT

This paper studies the combined effect of affiliation with prestigious universities, underwriters, and venture capitalists on the valuation of biotech ventures at IPO and their post-IPO performance. We argue that affiliation to a prestigious university provides the affiliated firm with a quality signal in the scientific domain. The pure quality signaling effect of the affiliation is isolated from the substantive benefits it provides by performing a difference-in-difference approach based on the scientific reputation of scientists in firms' upper echelons. The signal is stronger the weaker is the scientific reputation of scientists of the focal IPO-firm and is additive to those provided by prestigious venture capitalists and underwriters. Results for a sample of 254 European biotech ventures that went through an IPO between 1990 and 2009 confirm our predictions.

Executive summary

The information gap between the founders of biotech ventures and external investors is likely to be extraordinarily large. Consequently, these firms face significant challenges gaining the attention of potential investors. The matter is conveying the right signals to potential financiers on the quality of the firm. Such signaling challenge reaches its peak with the decision to go public, which assures financial means, but involves the convincement of the investment community that the firm has a long-term potential.

An extensive literature has examined the role of internal signals of firm quality, such as corporate governance characteristics (Certo, 2003) or the composition of the top management team (Higgins and Gulati, 2006; Pollock and Gulati, 2007). Following the sociological evidence that ties to reputable actors enhance prestige, third-party endorsements have also been studied as signals certifying firm quality to uninformed external investors. The underline conjecture is that prestigious (repeated) players value their reputation highly and will guard carefully against tarnishing it. In the IPO context, being backed by prestigious venture capitalists or hiring top investment banks as underwriters creates a perception in the market that the IPO firm must be of good quality, as top-tier financial intermediaries are expected to sign on to those deals they see as most likely to reinforce their reputation (Beatty and Ritter, 1986; Carter and Manaster, 1990; Carter et al., 1998; Megginson and Weiss, 1991).

Biotechnology is generally considered the most intensively science-based industry and one in which the role of public research

☆ We would like to thank Fabio Pammolli, Don Siegel, Paula Stephan, Frank Rothaermel, and participants at the 2016 ENTFIN conference at EMLyon, at seminars at Lancaster Business School and at Politecnico di Milano for helpful comments.

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https://doi.org/10.1016/j.jbusvent.2018.04.009
Received 23 June 2016; Received in revised form 30 March 2018; Accepted 23 April 2018
Available online 01 May 2018
0883-9026/

organizations is particularly relevant, given the great difficulties faced by entrepreneurs in starting a business without this liaison. Coherently, in the context of biotech ventures, the alliances with prominent third-party organizations, such as universities, have been shown to positively affect their performance (Baum et al., 2000; Baum and Silverman, 2004; Bonardo et al., 2011; Gulati and Higgins, 2003; Khoury et al., 2013; Pollock and Gulati, 2007; Pollock et al., 2010; Stuart et al., 1999). There are substantial benefits that biotech firms derive from the affiliation with a prestigious university. For instance, they enjoy access to scientific knowledge and resources (e.g., labs) of a higher quality. More interestingly, the effect of the affiliation with a prestigious university on investors can be investigated in terms of a “pure” signaling effect (Spence, 1973), in that the affiliation is per se a signal of quality. How to isolate the signaling value from the substantive benefits provided by affiliation with prestigious universities is the first research question that we address in this paper. We do so by using a difference-in-difference approach, where we consider the different scientific reputations of scientists in firms' upper echelons. Specifically, we argue that information asymmetries about the scientific quality of firms are smaller if firms' upper echelon includes prestigious scientists, as in this latter case investors can rely on a concurrent indicator of firms' scientific quality.

Using the population of 254 biotech firms that went public in Europe between 1990 and 2009, we find that the signal provided by the affiliation with prestigious universities is stronger and leads to higher IPO valuations, the weaker is the scientific reputation of scientists in the upper echelon of the focal IPO-firm. Moreover, this signaling effect is found to be additive to those sent by the affiliation with prestigious venture capitalists and underwriters. We argue that the signal generated by affiliations with prestigious universities, and those sent by prestigious venture capitalists and underwriters, pertain to different domains, namely the science domain and the business and finance domain, respectively. Accordingly, the signal provided by the affiliation with prestigious universities is recognized as beneficial by investors, independently of other actors.

Last, our results hold in the long-term. Indeed, our analysis of the long-run price and operating performance of IPO firms confirms the signaling value of the affiliation with prestigious universities. This is important as it provides evidence of a separating equilibrium, given that a necessary equilibrium condition is satisfied, in that investors are willing to pay extra for affiliated firms at the IPO insofar as these firms outperform other firms in the long-run. Again, this effect is found to be stronger the weaker the scientific reputation of firms' upper echelon members.

The implication of our study to IPO investors is that it is worth paying more to take an equity position in firms affiliated with prestigious universities at the IPO. In addition, managers of technology transfer offices and entrepreneurial scientists should be aware that valuations at the IPO closely depend on the prestige of the universities to which academic spin-offs are affiliated. Last, we conclude with a policy implication by highlighting that, as far as academic spin-offs from non-prestigious universities do not outperform unaffiliated firms, policy schemes that indiscriminately stimulate the creation of academic spin-offs will hardly see long-term success in the financial markets.

1. Introduction

When valuing initial public offerings (IPOs), prospective investors rely on signals to reduce the uncertainty generated by incomplete and asymmetrically distributed information. Coherently, the signaling theory (Spence, 1973) is the dominant approach to investigating IPO valuation, and endorsements by third-parties have received considerable attention as signals certifying firm quality to uninformed IPO investors. The underlying idea is that prestigious players highly value their reputation and will carefully avoid tarnishing it by being connected with low-quality IPO firms.[1] In particular, the affiliation with a prestigious underwriter (UW) or a venture capitalist (VC) has been shown to be associated with better firm performance (Beatty and Ritter, 1986; Carter and Manaster, 1990; Carter et al., 1998; Megginson and Weiss, 1991).[2]

In this work, we are interested in science-based IPOs, of which biotech IPOs are a prominent example. The biotech industry originates from the recombinant DNA (rDNA) scientific breakthrough; commercial applications have a direct link with basic research (Kolympiris et al., 2014) and firms' competitive advantage largely depends on the specialized scientific and technical knowledge embedded in the human capital of their scientists (Zucker et al., 1998). Accordingly, in biotech IPOs, uncertainty about firm quality has two dimensions. Investors need not only assess the market potential of firms' product pipeline but also firms' scientific quality, as the latter strongly influences their ability to develop innovative products. IPO investors are unlikely to possess the requisite scientific knowledge to independently assess the innovativeness of the products and technologies biotech firms are developing (Junkunc, 2007; Junkunc and Eckhardt, 2009). In addition, biotech firms are reluctant to diffuse information about their research because of the risk of expropriation of their proprietary knowledge (Deeds et al., 1997; Janney and Folta, 2003). In such settings, the literature has considered specific signals, such as the affiliations of firms' upper echelons with prominent companies (Chen et al., 2008; Gulati and Higgins, 2003) or their scientific standing (Deeds et al., 1997, 2004; Hess and Rothaermel, 2011; Higgins et al., 2011), and the establishment of alliances with prominent third-party organizations (Baum et al., 2000; Baum and Silverman, 2004; Gulati and Higgins, 2003; Pollock and Gulati, 2007; Pollock et al., 2010; Stuart et al., 1999). A few studies have focused attention on the role of the links created by upstream alliances with universities and other research organizations (Khoury et al., 2013) and other links with universities (Bonardo et al., 2011).

[1] An extensive literature has also examined the role of internal signals of firm quality, such as corporate governance characteristics (Certo, 2003) or the composition of the top management team (Higgins and Gulati, 2006; Pollock and Gulati, 2007), as well as offer (Leland and Pyle, 1977) and ownership structure (Brav and Gompers, 1997; Fischer and Pollock, 2004). In this paper, we control for internal signals and focus our attention on the interaction between external signals.

[2] The IPO literature has also considered other financial intermediaries involved in the going public process, such as top-quality auditors (Beatty, 1989) and rating agencies (Khurshed et al., 2014), finding that they are less effective signals.

Despite the achievements of this literature, important issues have not been explored yet. First, as far as we know, only Deeds et al. (2004) consider affiliation of biotech IPO firms with *prestigious* universities. The authors define a firm as affiliated with a focal university if it was founded based on academic research carried on at the university. They provide (statistically weak) evidence that biotech firms affiliated with the top ten U.S. medical schools or biochemistry graduate programs raise more capital at IPOs. This result is interesting and deserves a closer examination, as one would expect that only prestigious endorsers convey valuable signals to investors. Even more interestingly, no previous study has managed to disentangle the "pure" signaling value of the affiliation with a prestigious university from the substantive benefits provided to affiliated firms. To distinguish the signaling value from the substantive benefit associated with the signal, the literature has relied on the view that the signaling effect is stronger when less information is available about firm quality. Accordingly, younger firms (e.g., Stuart et al., 1999) or firms in early funding rounds (Hoenen et al., 2014; Hsu and Ziedonis, 2013) benefit more from a signal than mature firms or firms in subsequent financing rounds. Alternatively, Pollock et al. (2010) distinguish the signaling value from the substantive value according to the type of signal sender. In line with the argument that prestigious executives and directors mostly deliver substantive benefits, the benefits they generate for the focal firm resulting in higher IPO valuations accumulate in a linear manner. On the contrary, prestigious UWs and VCs are assumed to primarily serve a certification function, hence the benefits generated by the prestige of the VCs and UWs accumulate in a curvilinear manner leading to higher IPO valuations at a declining rate. How to isolate the signaling value from the substantive benefits provided by affiliation with prestigious universities still is an open question.

Second, to alleviate information asymmetry problems, firms may simultaneously send *multiple* signals to potential investors. Since the degree of uncertainty that endorsers can reduce is finite (Pollock and Rindova, 2003), these signals yield declining marginal benefits if different endorsers base their decisions on overlapping sets of information, and thus the signals are to some extent replicative. However, as we mentioned earlier, firm quality in biotech IPOs is a multi-dimensional construct, as investors are interested in both the scientific potential of the technologies and products under development and their market potential. The positive effects of multiple signals on affiliated firms may thus be *additive* if they certify quality in *different* domains (in the case of biotech IPOs, the science domain, and the business and finance domain). How receivers aggregate concurrent signals has received limited scholarly attention (Connelly et al., 2011), with only a few exceptions (e.g., Pollock et al., 2010; Khoury et al., 2013).

Third, Spence (1973) claims that beliefs about the relationship between a given signal and firm performance must, in equilibrium, be confirmed by the post-signal experience (i.e., by superior post-signal performance of signaling firms). As remarked by Bergh et al. (2014), this is rarely tested in previous signaling studies.

To address these gaps, we study the population of 254 biotech firms that went public in Europe between 1990 and 2009. We first distinguish firms depending on whether they are affiliated with a university. As in Deeds et al. (2004), a firm is defined as affiliated with a university if it is funded to exploit commercial research carried on at the focal university, with affiliation creating a link that can take different forms.[3] Then, we measure the prestige of universities in different ways, including bibliometric indicators. We find that firms affiliated with prestigious universities have higher valuations than either non-affiliated firms or firms affiliated with other universities. More interestingly, we disentangle the quality signaling effect of firms' affiliation with prestigious universities from the substantive benefits it provides to affiliated firms by resorting to a difference-in-difference approach. We consider the different scientific reputations of scientists in firms' upper echelons. We argue that information asymmetries about the scientific quality of firms are smaller if firms' upper echelon includes prestigious scientists, as in this latter case investors can rely on a concurrent indicator of firms' scientific quality. We find that the weaker the scientific reputation of scientists in the upper echelon of the focal IPO-firm, the stronger the signal provided by the affiliation with a prestigious university. We thus deliver an original approach to isolate the signaling value of a scientific endorsement from its substantive value.

Second, we claim that in biotech IPOs, the study of the interaction between multiple signals needs to take duly into account that signals differ based on their information content, are incomplete, and reduce uncertainty about firm quality along specific dimensions. Signals generated by affiliations with prestigious universities and prestigious VCs or UWs pertain to the science domain and the business and finance domain, respectively. Hence, their positive effects on firms' IPO valuation are *additive* (i.e., the two types of signals do not substitute for each other). The results of our estimates on the interaction between signals confirm that the signal provided by the affiliation with a prestigious university is recognized as beneficial by investors, independently of that from prestigious VCs and UWs. Moreover, the value of these latter signals is not influenced by the scientific reputation of firms' upper echelon members, contrary to what happens with the signal generated by affiliation with a prestigious university. As a natural experiment, we also show that the signaling value of the affiliation with a prestigious university is not influenced by regulatory changes in financial markets, which instead reduce the value of the affiliation with prestigious VCs or prestigious UWs. From this perspective, our paper is particularly related to the study by Khoury et al. (2013), who similarly contend that it is important to consider IPO investors' evaluation of multiple simultaneous signals. They argue in favor of signal substitutability, with the quality signals conveyed to IPO investors by alliance-based social capital and affiliation with prestigious UWs offsetting one another's effects. We diverge from Khoury et al. (2013) in that we discriminate firms depending on whether they are affiliated with prestigious universities, while they consider the number of all upstream alliances established by IPO-firms. Their theory is indeed grounded in social capital arguments, whereby "obtaining more alliances is a reliable, sought-after quality signal" (Khoury et al., 2013, p. 573). As explained above, our contention is instead that firms signal their scientific quality by leveraging the prestige of the universities to which they are affiliated.

[3] As we will explain later in greater detail, the nature and strength of the link may differ, thus influencing the strength of the associated signal. The university may own a share of the equity capital of the firm, the firm may have established one or more alliances (e.g., licenses, research contracts) with the university, or may have been founded by (current or former) faculty members or other research personnel.

Third, we show that our results also hold in the long-term, providing a separating equilibrium in which firms affiliated with prestigious universities outperform both firms without affiliation and those affiliated with less prestigious universities, and this effect is stronger the weaker the scientific reputation of firms' upper echelon members is. We consider different indicators of firms' long-run performance. In line with existing studies on the long-run performance of IPOs, we measure the stock price performance of firms in terms of buy-and-hold returns. We also consider post-IPO operating performance, measured by return-on-assets, and the probability that in the post-IPO period, firms become the target of an acquisition. This evidence further confirms the long-term relevance of the signal originated by the affiliation with a prestigious university. We thus provide empirical evidence relating to signal confirmation.

The rest of this paper proceeds as follows. Section 2 illustrates the research hypotheses. Section 3 discusses the data, variables, and methodology used in the study. Section 4 reports on the econometric results. Finally, Section 5 concludes the paper and discusses its implications.

2. Theory and hypotheses

2.1. Affiliation with prestigious universities and valuation of science-based IPOs

We argue that in science-based IPOs, affiliation with a *prestigious* university has a *signaling value* for potential investors, making them confident about the scientific quality of the technologies and products the focal IPO firm is developing.

Science-based IPOs pose specific challenges to investors. On the one hand, it is extremely important for investors to be confident in the scientific quality of firms because there is a close link between basic R&D and the novelty of products, which in turn is a prerequisite of their commercial success (Zucker et al., 1998; Kolympiris et al., 2014). On the other hand, investors generally do not possess the scientific knowledge necessary to assess the scientific potential of IPO firms (Junkunc, 2007; Junkunc and Eckhardt, 2009). The fact that firms are reluctant to divulge information relating to technologies and products that are in an early development stage, because of appropriability concerns, makes things worse (Deeds et al., 1997; Janney and Folta, 2003).

In this situation, affiliation with a prestigious university conveys a signal of the scientific quality of firms, thus resulting in greater IPO valuation. Investors are reassured by the endorsement of prestigious universities for two reasons. First, prestigious universities enjoy a solid reputation generated by their previous scientific achievements, which they widely advertise with the aim of attracting both students and research contracts. Investors expect these universities to have superior abilities to evaluate the scientific rigor of studies and experiments, and thus are inclined to consider the technology and products of affiliated firms as scientifically legitimate (Deeds et al., 2004). For example, if academics at the University of Cambridge and at a lesser known university deliver a similar technology, the Cambridge academics' claim about the scientific potential of the technology will be perceived by investors as more reliable due to Cambridge's prestige. Second, as scientific reputation is a fundamental asset for prestigious universities, they do their best to avoid tarnishing it. Hence, they hire professors and other research personnel with the expectation that they will further contribute to university's scientific achievements and selectively screen their research projects. The substantial penalty cost that prestigious universities would incur from a loss of reputation makes investors confident about the value of the scientific knowledge on which affiliated firms rely in their R&D activity. It is also important to stress that affiliation with other (i.e., non-prestigious) universities does not have a similar signaling effect of firms' scientific potential. IPO firms would not be able to leverage the reputation of the universities with which they are affiliated, and in the absence of the penalty costs from false signaling, affiliation does not have any quality signaling effect.

However, in addition to delivering a signal of scientific quality, the affiliation with a prestigious university also provides substantive benefits to affiliated firms. Indeed, previous studies have shown that biotech firms generally maintain close links with universities (Audretsch and Stephan, 1996; Liebeskind et al., 1996). Affiliation with a prestigious university places the affiliated firm in an ideal position to leverage the state-of-the-art scientific knowledge produced by the university, because of the social links of its upper echelons. In turn, biotech firms that in-license advanced scientific knowledge from universities are more likely to craft revenue-generating commercial alliances with pharmaceutical firms (Stuart et al., 2007). Affiliated firms also have easier access to the state-of-the-art laboratories of the university and can benefit from the effective administrative and legal support it provides to affiliated firms. Therefore, one could argue that the positive effect on IPO valuation generated by affiliation with a prestigious university can be traced to these substantive benefits rather than to a signal of scientific quality.

Disentangling the signaling effect of affiliation with a prestigious university from the associated substantive benefits is a challenging task. Here, we take inspiration from previous works that have emphasized that the signaling effect of affiliations with prestigious parties is weaker when more information about firm quality is available (Stuart et al., 1999). Considering the key role of prestigious scientists for the birth and development of biotech firms (Audretsch and Stephan, 1996; Zucker et al., 1998), we argue that the uncertainty perceived by IPO investors about the scientific potential of the technologies and products biotech firms are developing is lower when firms' upper echelon includes prestigious scientists. Consistently, Higgins et al. (2011) find that biotech firms that have a Nobel prize winner in their upper echelon enjoy better valuation at IPO. We therefore expect the signaling effect of the affiliation with a prestigious university to be weaker if firms' upper echelon includes prestigious scientists. Below, we explain our argument in greater detail.

High-quality teams and ideas are likely to stem from prestigious universities. Biotech firms can also derive substantive benefits from their affiliation with prestigious universities, and the more prestigious the universities, the larger these benefits. Independently of whether biotech firms are affiliated with prestigious universities or not, they may have in their upper echelons prestigious scientists. If they do, the uncertainty perceived by IPO investors about the scientific quality of the focal firm will be limited, while it will be higher if firms' upper echelons are non-prestigious (i.e., not yet recognizably accomplished) scientists. We expect the signaling effect of affiliation with a prestigious university to be stronger and have a stronger effect on firms' IPO valuation the lower the prestige of scientists in firms' upper echelons, because larger uncertainty surrounds the scientific quality of these latter firms. On the contrary, the substantive benefits generated by this affiliation are likely to be largely independent of the scientific prestige of individual scientists in firms' upper echelons. From the above arguments, we derive Hypotheses 1 and 2.

Hypothesis 1. The affiliation of a firm with a prestigious university is positively related to IPO valuation.

Hypothesis 2. The positive effect of the affiliation of a firm with a prestigious university on IPO valuation is higher when the prestige of scientists in its upper echelon is lower.

2.2. Multiple signals of biotech IPOs: the combined effect on IPO valuation of affiliations with prestigious universities, underwriters, and venture capitalists

Firms going public do so with an investment bank that underwrites their shares. The finance and entrepreneurship literature has established that the endorsement of prestigious UWs has a positive effect on the success of IPOs (Beatty and Ritter, 1986; Carter and Manaster, 1990; Carter et al., 1998). Endorsement by prestigious UWs, as does any type of endorsement, has a signaling value. The above discussed matching mechanisms between prestigious universities and their affiliated firms also apply to the underwriting markets, with prestigious UWs less likely to undertake speculative issues. Prestigious UWs prefer lower-risk IPOs due to the legal liabilities and potential loss of reputational capital associated with unsuccessful IPOs (Beatty and Ritter, 1986). Dealing with more solid firms also increases investment banks' hopes that such relationships will lead to involvement in subsequent larger deals. Indeed, IPO-firms tend not to switch to a different investment bank when performing seasoned equity offerings in the post-IPO period (Krigman et al., 2001), which would explain why prestigious UWs are associated with better performing firms. Another explanation of this association is that top-tier investment banks have better access to the most promising start-ups and/or are better at “picking winners.”

The signal delivered to affiliated firms by prestigious VCs works similarly to that delivered by prestigious UWs, in that it creates a perception in the market that the IPO firm must be of good quality. Prestigious VCs generally conduct extensive due diligence and implement effective contracting (e.g., Kaplan and Stromberg, 2001). IPO investors will therefore be willing to pay more for taking an equity position in a firm whose quality is certified by the affiliation with a prestigious VC. Accordingly, empirical studies find that VC-backed IPO firms outperform their non-VC-backed counterparts (Brav and Gompers, 1997; Ritter, 2015) and the prestige of the backing VCs is associated with higher IPO valuations (Chemmanur et al., 2011; Nahata, 2008).

Insofar as the signals conveyed to IPO investors by different affiliations relate to different domains, they are likely to generate additive effects on IPO valuations. We expect that this situation applies to affiliations with prestigious UWs or VCs and prestigious universities. The certification delivered by affiliation with prestigious universities lies in the realm of science and relates to the scientific quality of affiliated firms. Conversely, the affiliation with prestigious UWs or VCs plays a certification role in the business and finance domain. Thus, the associated signals to IPO investors do not overlap.[4] The above arguments lead to our third and fourth hypotheses.

Hypothesis 3. The affiliations of a firm with a prestigious university and a prestigious underwriter are related to IPO valuation in a positive, additive manner.

Hypothesis 4. The affiliations of a firm with a prestigious university and a prestigious venture capitalist are related to IPO valuation in a positive, additive manner.

2.3. Effects on long-run performance

Beliefs about the relationship between a signal and productivity must, in equilibrium, be confirmed by subsequent experience (Spence, 2002). In Spence's (1973, p. 360) words (applied to the job market), “an equilibrium can be thought of as a set of employer beliefs that generate offered wage schedules, applicant signaling decisions, hiring, and ultimately new market data over time that are consistent with the initial beliefs.” In the context of biotech IPOs, this means that if the affiliation with a prestigious university serves as a quality signal, the signaling value becomes confirmed if the affiliated firms subsequently outperform their peers who lacked this affiliation.

Accordingly, recent management papers (Bergh et al., 2014; Connelly et al., 2011) maintain that applying signaling theory requires testing for the presence of a separating equilibrium. This, in turn, requires going beyond the receiver's reaction to a signal (in our case, the valuation at the IPO) to study whether the expectation associated with the presence of the signal is confirmed by post-signal findings (in our case, better long-run performance). Our arguments imply that prestigious universities create a separating equilibrium because investors believe that they will not be associated with low-quality firms. Therefore, a necessary equilibrium

[4] Since the domains of activity of UWs and VCs, though different, are both related to finance and business, there is at least a partial overlap in the domains of their signals. Additionally, prestigious VCs are frequent players in IPO markets and provide a continuous deal flow to the investment banks they work with (Bradley et al., 2015). Thus, prestigious VCs and UWs are often found together with declining marginal effects on firms' IPO valuations (Bradley et al., 2015; Liu and Ritter, 2011; Pollock et al., 2010). In other words, there is signal substitutability between the two, rather than signal complementarity.

condition is that investors are willing to pay extra for affiliated firms at the IPO insofar as these firms outperform other firms in the long-run.

Starting with the seminal study by Ritter (1991), a vast literature has found that IPOs underperform in the long-run relative to benchmarks of matched seasoned firms. Several economic and behavioral explanations have been brought forward to explain this anomaly. For instance, the windows-of-opportunities theory predicts that, when investors are overly optimistic about the potential of certain industries, firms may take advantage of this window of opportunity by timing their IPO and benefitting from very high valuations (Loughran and Ritter, 1995). This inevitably results in poor performance in the long-run, as market enthusiasm starts to fade, stock prices are progressively adjusted, and temporary inefficiencies are corrected. Upwardly biased valuations will therefore result in a downward adjustment of the issuer's stock price over time. The necessary condition for this to happen is the primary market's inability to detect overvaluation.

These market-efficiency arguments (Fama, 1970) apply to our research setting. If the signal sent by third-party endorsement is actually *not* related to firm's quality, firm's higher initial valuation will mean-revert in the long-run. As long as investors are not able to notice it immediately, overvalued IPO shares will be placed on the market (which would not be possible in an efficient market), with a subsequently stronger underperformance.[5] If, instead, the affiliation with a prestigious university *does* signal quality, affiliated firms will outperform other firms in the long-run. Based on the same arguments leading to Hypothesis 2, we expect the effect of the affiliation with a prestigious university on firms' long-run performance to be stronger when the prestige of firms' scientists is lower. We thus propose the following hypotheses.

Hypothesis 5. The affiliation of a firm with a prestigious university is positively related to post-IPO performance.

Hypothesis 6. The positive effect of the affiliation of a firm with a prestigious university on the post-IPO performance is higher when the prestige of scientists in its upper echelon is lower.

The results reported by Carter et al. (1998) document that IPOs with a prestigious UW have higher long-run abnormal returns. Similarly, Brav and Gompers (1997) find that VC-backed IPOs have higher returns, while Nahata (2008) shows that the reputation of VCs is positively related to the performance of their portfolio companies. For the same reasons reported in the previous section relating to the additionality of the signals conveyed by affiliations with prestigious universities, UWs, and VCs, we expect that the positive effects of affiliation with prestigious universities on firms' long-run performance are additive to those generated by affiliations with prestigious UWs and VCs. We thus propose the following hypotheses.

Hypothesis 7. The affiliations of a firm with a prestigious university and a prestigious underwriter are related to post-IPO performance in a positive, additive manner.

Hypothesis 8. The affiliations of a firm with a prestigious university and a prestigious venture capitalist are related to post-IPO performance in a positive, additive manner.

3. Research design

3.1. Data and sample

The main challenge of an IPO is convincing a wide variety of stakeholders that the firm has long-term potential. The company's primary tool for communicating information to prospective investors is the offering prospectus. Since owners and managers are legally accountable for the information disclosed in the prospectus, this document is considered reliable in finance and entrepreneurship research (Shrader and Siegel, 2007). This study therefore relies on information in the offering prospectus to determine a firm's affiliation. In particular, companies going public are required to describe their history and report the *curriculum vitae* of their upper echelon members (Higgins and Gulati, 2006). We refer to these sections to identify university-affiliated firms, namely companies that were either founded by faculty members based on their own research or created specifically to capitalize on academic research (Deeds et al., 2004; Bonardo et al., 2011). Information on UWs and VCs is reported on the front page of the prospectus and in the ownership structure section, respectively.[6]

We analyze the 254 biotech firms[7] that went public in Europe between 1990 and 2009. Information on European IPOs is obtained from the EURIPO database, which has been used in previous IPO studies (e.g., Chambers and Dimson, 2009; Judge et al., 2015). The

[5] If, instead, the signal is false (i.e., if affiliated firms are not better than non-affiliated ones) and the market is efficient, there is a second pure strategy equilibrium in which the investors refuse to believe the signal. For firms affiliated with prestigious universities, this would imply that there will be few references to their affiliation in IPO prospectuses.

[6] In order to be effective, signals need to be costly and *observable*. The fact that we rely on information published in IPO prospectuses assures the observability condition, as potential investors carefully scrutinize these documents to assess the prospects of an equity position. In general, the affiliation with a prestigious university is made very explicit in various sections—not only those reporting the curricula of the founders but also those dedicated to the history of the firm or its R&D strategies. Typical sections that report such information are "History and background," "Management," "Directors," and "Research and Development Programmes" in the UK; "*Historique du Groupe*," "*Recherche et développement,*" and "*Ressources humaines*" in France; "*Gründung,*" "*Organe der Gesellschaft,*" and "*Forschung und Entwicklung*" in Germany; "*Storia ed. evoluzione dell'attività*," "*Politica di ricerca e sviluppo,*" "*Attività svolte dai componenti del Consiglio di Amministrazione*," and "*Struttura organizzativa*" in Italy.

[7] We identify biotech firms using code 4573 of the Industry Classification Benchmark (ICB), which comprises Healthcare (45), Pharmaceuticals & Biotechnology (7), and Biotechnology (3). The ICB is the official industry classification adopted by European stock exchanges.

Table 1
Sample by type of affiliation.
Distribution of our sample of 254 biotech IPO firms by country, age at IPO and IPO year. The last two columns refer to firms affiliated with prestigious universities, namely with a value of *PRESTIGE-UNI* (see Table 2) greater than or equal to the median value, calculated in the group of university-affiliated firms.

Total		Firms affiliated with universities		Firms affiliated with prestigious universities	
		No.	%	No.	%
Panel A. Country					
UK	110	38	58.5	22	66.7
France	45	5	7.7	1	3.0
Germany	39	13	20.0	5	15.1
Italy	10	1	1.5	0	0.0
Other	50	8	12.3	5	15.1
Panel B. Age at IPO (years)					
Age 1	18	5	7.7	2	6.1
$1 < \text{Age} \leq 5$	74	22	33.8	18	54.5
$5 < \text{Age} \leq 10$	99	29	44.6	12	36.3
$\text{Age} > 10$	63	9	13.8	1	3.0
Panel C. Year of IPO					
1990–2000	57	12	18.5	5	15.1
2001–2003	62	18	27.7	11	33.3
2004–2006	58	15	23.1	8	24.2
2007–2009	77	20	30.8	9	27.3
Total	254	65	100.0	33	100.0

biotech firms in our sample operate in different industry segments. Following Stuart et al. (1999), we include four categorical variables to indicate whether the focal venture operated in any of these four segments: Immunology, Diagnostic, Genetics, and Protein Engineering and Investigation New Drug. Moreover, we added two categories: Instruments and Services.

The sample of firms and the subsamples of firms affiliated with universities and prestigious universities (namely, universities with a value of *PRESTIGE-UNI*, as defined in Section 3.2.2, above the median value, calculated in the group of firms affiliated with a university) and disaggregated by country, age, and IPO year, are described in Table 1. In total, 65 IPO firms are affiliated with a university, meaning that one out of every four biotech companies going public in Europe is university-based. Predictably, the UK dominates the subsample of university-affiliated IPO firms, with 38 firms (58.5%), as well as the subsample of IPOs affiliated with prestigious universities (66%). The UK has the most highly developed stock exchange in Europe; it also has a flourishing biotech industry, and its university system is probably Europe's most prestigious and entrepreneurial. Firms affiliated with prestigious universities went public earlier than other firms: 61% of them were five years old or younger at the time of the IPO, while the same figure for the entire sample of firms is 36%.

3.2. Variables

3.2.1. Dependent variables

Our empirical analysis investigates the determinants of the market's initial valuation of biotech ventures. For this purpose, we rely on Tobin's Q, a robust indicator of the perceived future value of a firm, i.e., the ratio of the market value of assets, calculated as the sum of the book value of assets and the market value of common stock (calculated at offer prices) less the book value of common stock, over the book value of assets. Indeed, economic theory assumes that the difference between market value and book value is the present value of a company's future abnormal earnings.

To test the long-run effects of affiliation with a prestigious university, we use three different measures. First, financial performance is measured using three-year Buy-and-Hold Abnormal Returns (BHARs). These are calculated, as in Loughran and Ritter (1995), using monthly returns from the beginning of the holding period until the minimum of the end of the holding period or the delisting date, as follows:

$$BHAR_i = \left[\prod_{t=1}^{\min(T,delist)} (1 + R_{i.t})\right] - \left[\prod_{t=1}^{\min(T,delist)} 1 + R_{m,t}\right]$$

where $R_{i,t}$ is the return on stock i at time t, T is the time period in which the BHAR is to be determined, and $R_{M,t}$ is the raw return of the FTSE Euromid index, excluding dividends. As in Vismara et al. (2012), the holding period starts from the twenty-second day of trading, as UWs are sometimes stabilizing prices during the first 21 days. Since $R_{i,t}$ includes dividends and $R_{M,t}$ does not, the expected $BHAR_i$ may be positive rather than 0 in an efficient market.

Second, we measure operating performance by the three-year average return-on-assets (ROA), calculated by using the ratio between EBIT (Earnings Before Interest and Taxation) and total assets, in the three years following the IPO.

Third, following the IPO, acquisitions by incumbent firms are mechanisms to finalize the technology transfer process started in a research lab (Meoli et al., 2013). Hence, we also investigate the probability that a focal firm is the target of an acquisition as a measure of post-IPO success. For this purpose, we use survival models, i.e., Cox proportional hazard regressions, analyzing the hazard rate of an acquisition occurring at time t after the IPO, given that it did not occur up to t. The sources of information on acquisitions are the databases Thomson One Banker Deals and Zephyr by Bureau Van Dijk.

3.2.2. University affiliation and university prestige

The *University affiliation* dummy is equal to 1 for firms affiliated with a university and 0 otherwise. University-affiliated firms are identified as companies that were either founded by faculty members based on their own research or created specifically to capitalize on academic research. An example of text identifying university affiliation is: "The Company was formed in 1996 at Brunel University Science Park, Uxbridge, to research and develop a number of technologies…and to make use of Dr. [name omitted]'s experience." It is important to emphasize that firms affiliated with a university may have different links with the focal university. The university may own a share of the equity capital of the affiliated firm, members of firm's upper echelon may be (or have been) members of the faculty or the research staff of the university, the firm may have licensed technology from the university or may have given it a research contract. We assume that affiliation with a prestigious university conveys to investors a signal of the scientific quality of the firm, independently of the specific link. However, we acknowledge that the strength of the signal may vary depending on the link. We address this issue in Section 4.5.

The prestige of universities (*PRESTIGE-UNI*) is measured by resorting to a bibliometric indicator, namely the total number of citations (in thousands) received up to the year before the IPO by all papers ("articles") published by the parent university in the twenty years before the IPO year in the following biotech-related fields: medicine; biochemistry and genetics; nursing; dentistry; chemistry; pharmacology, toxicology and pharmaceutics; agriculture and biological sciences; neuroscience; immunology and microbiology; veterinary; health professions; chemical engineering. Following Gittelman and Kogut (2003), in regression analysis, raw citations are normalized by the mean and standard deviation of citations received by all articles that were published in a given year in the fields under consideration. Normalizing raw citations by year allows citations to be summed across years for each university. The source of information for citation is Scopus, Elsevier's database of peer-reviewed literature. Even if we believe that citations are a good measure of scientific quality and most university rankings, such as QS, Times Higher Education, and US News are indeed determined also based on citations, we also use alternative prestige measures as robustness checks (see Table A6 in the Appendix).

Table A1 in the Appendix reports the list of the 20 top European universities included in our sample (i.e., with at least one IPO firm affiliation) according to our main prestige indicator, measured at the time of each IPO. The universities of Cambridge and Oxford are at the top of this league, in the first and third position, respectively. They back four and seven IPOs, respectively. In between, in the second position, we have the Swedish Karolinska Institute, backing only one IPO in our sample.

3.2.3. Scientist prestige

As in several previous studies on biotech firms (e.g., Audretsch and Stephan, 1996; Zucker et al., 1998), the prestige of scientists involved in the upper echelon of each IPO firm (*PRESTIGE-SC*) is measured by resorting to a bibliometric indicator based on citations. The fact that in biotech, scientists' patents and publications have been shown by previous studies to be complements rather than substitutes (Stephan et al., 2007; Azoulay et al., 2009) corroborates our choice. In particular, we calculate the total number of citations (in thousands) received up the year before the IPO by all papers ("articles") published by members of the upper echelon of a focal IPO firm in the twenty years before the IPO year in the biotech-related disciplines, as defined for university prestige. Raw citations are normalized as illustrated above. The source of information for citation is Scopus. We again use alternative measures of scientists' prestige as robustness checks (see Table A6 in the Appendix).[8]

3.2.4. Venture capital affiliation and prestige

The *VC backing* dummy is equal to 1 for firms backed by VCs at the time of the IPO and 0 otherwise. VCs are identified as in Vismara et al. (2012) among firms with institutional shareholders focusing on start-up financing. This information comes from a detailed examination of the directors' associations and "Other significant shareholders" section of the IPO prospectuses. It mandatorily covers at least the three years prior to the IPO.[9] To identify VC firms, several sources were used, including the lists of members of national associations such as the European Private Equity and Venture Capital Association (EVCA), the British Venture Capital Association (BVCA), the *Association Francaise des Investisseurs en Capital* (AFIC), the *Bundesverband Deutscher Kapitalbeteiligungsgesellschaften* (BVK), the *Associazione italiana del private equity e venture capital* (AIFI), and the National Venture Capital Association in the U.S. (NVCA). We also used directories such as Pratt's Guide to Venture Capital Sources and the Venture Capital Resource Directory. Finally, we also included Venture Capital Trusts (VCTs) managed by established VC firms.

The operationalization of VC prestige is not well-defined in the literature, and no commonly recognized measure exists. In the context of IPOs, research had not differentiated among VCs by reputation until recently (see Loughran and Ritter, 2004). VC reputation has been considered through different measures, such as the reputational rank of the lead UWs (i.e., the Carter and Manaster (1990) rankings associated with a VC in prior IPOs Baker and Gompers, (2003)); the number of investments the VC had made in a start-up's industrial segments (Hsu, 2004); past VC fund returns (Kaplan and Schoar, 2005); past rounds of VC investment (Sorensen, 2007); and the degree of industry specialization by individual venture capitalists at a VC firm, as measured by the

[8] Higgins et al. (2011) argue that the presence of a Nobel laureate affiliated with a firm going through an IPO reduces information asymmetries relating to the scientific quality of the focal firm. Here we are not able to use this indicator of scientific prestige as we do not have enough observations of firms with Nobel prize laureates in their upper echelon.

[9] The IPO regulation requires firms to disclose the share ownership structures for at least the preceding three years. We further checked using the Zephyr dataset and did not find any pre-IPO investment by VCs in our subsample of non-VC-backed IPO-firms. We believe that it is unlikely that (1) a VC exited the firms many years before its IPO, and (2) in such eventuality, the management decide not to disclose the previous investment of a VC. We acknowledge such possibility anyway.

Herfindahl–Hirschman Index, based on all previous investments in each industry (Gompers et al., 2009). Only recently have studies examined the impact of VC reputation on IPO success and post-IPO firm performance. Nahata (2008) uses a cumulative IPO market share measure in prior years based on firms' capitalization. Lee et al. (2011) introduce the LPJ VC reputation index, a multi-item, time-varying index of several indicators of VC reputation, calculated annually for the period 1990–2010.[10]

In our study, the prestige of VCs (*PRESTIGE-VC*) supporting a focal IPO firm is measured, similarly to Nahata (2008), as the cumulative market capitalization of IPOs backed by the same VC over the cumulative market capitalization of all IPO firms in our sample that went public before the focal firm. We also use alternative prestige measures as robustness checks (see Table A6 in the Appendix).

Table A2 in the Appendix reports the list of the 20 top VCs included in our sample (i.e., with at least one VC-backed biotech IPO). The UK-based 3i is by far the most prestigious VC in Europe's biotech sector.

3.2.5. Underwriter affiliation and prestige

The prestige of the UW (*PRESTIGE-UW*) taking public a focal IPO firm is measured as the capital raised by the UW taking public all the firms in the sample that went public before the focal firm, divided by the capital raised by all the firms in the sample going public before the focal firm. Only lead and co-lead UWs are considered. When more than one UW underwrites an issue, the proceeds (and number of IPOs) are split equally among all lead banks, as in Aggarwal et al. (2002); this is rare in Europe (Migliorati and Vismara, 2014). UWs that have been acquired during the sampling period are treated as part of the new parent.

Table A3 in the Appendix reports the list of the 20 top UWs included in our sample (i.e., with at least one European biotech IPO underwritten between 1990 and 2009). Morgan Stanley, Commerzbank, and Goldman Sachs are at the top of this league. While Morgan Stanley and Goldman Sachs are international top-tiers, Commerzbank operates almost entirely in a single country, Germany. For this and other national champions (e.g., Mediobanca in Italy), their reputations are supposedly high in domestic IPO markets but lower abroad. Existing measures of UW reputation are tailored to the U.S. market, where the same established investment banks typically handle IPOs on both the NYSE and NASDAQ. The widely used Carter–Manaster rankings do not grade the reputations of the UWs involved in 67.5% of the IPOs in Europe. The European IPO market is indeed fragmented into several domestic markets, and most UWs operate almost exclusively in a single country. For this reason, we perform a number of robustness checks with alternative measures of UW prestige (see Table A6 in the Appendix).

3.2.6. Signal matching and sequentiality

University-affiliated firms are especially attractive to VCs (Wright et al., 2006), and one can expect that firms spawned from prestigious universities find it easier to obtain financing from prestigious VCs and backing from prestigious UWs. Thus, the VC and UW variables are constructed, following Pollock et al. (2010), in order to take into account potential matching between the signals conveyed by affiliation with prestigious universities, VCs and UWs. In our research setting, signals are sequential, as the affiliation to a university is determined at the establishment of the firm, while the VC comes in before the IPO, and the UW intervenes at the IPO. Given this sequentiality, *PRESTIGE-VC* is measured as the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, and country and year dummy variables (we do the same for *VC backing*). *PRESTIGE-UW* is measured as the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, and country and year dummy variables. The auxiliary regressions employed for the estimations of residuals are reported in Table A11 in the Appendix.

3.2.7. General control variables

In all our regressions, we include firm and market indicators as control variables, in line with previous studies on the valuation and long-run performance of IPOs (Ritter, 1991). Specifically, we include in all our specifications a set of controls for (1) the general characteristics of the firm and its offer, (2) firms' upper echelons, and (3) inter-firm relationships. Details on all variable definitions and data sources are reported in Table 2. Variables are defined following previous papers (see, for instance, Bonardo et al., 2011).

The first set includes characteristics of the firm and the IPO that may influence our dependent variables. *Firm size* is measured as (the log of) the inflation-adjusted sales in the year prior to the IPO in 2008 Euros (millions), using purchasing power parities (EU27 = 1). For continental European firms, most accounting information has been reported in Euros since 1999. For earlier years, we use yearly average exchange rates between the ECU and national currencies to obtain a Euro equivalent. The exchange rate used for companies based in non-Euro countries is the average of the year of the IPO. *Age* at the time of the IPO is measured in years since incorporation. Natural logarithms of (*Age* + 1) are used in the regressions. *Profitability* and *Leverage* are measured as return on assets and the ratio of debt to total assets in the year prior to the IPO, respectively. The *Dilution ratio* is the number of shares offered at listing over the number of shares outstanding before the IPO. The *Participation ratio* is the percentage of the offering made of shares sold by existing shareholders. We also include, as a measure of innovation activity,[11] the variable *Patents*, measured as the number of registered patents as reported by the U.S. and the European Patent Office issued to the focal firm up to the date of the IPO (sources are EURIPO, EPO, and USPTO). Natural logarithms of (*Patents* + 1) are used in the regressions.

[10] The variables included in the LPJ VC reputation index are the following: average of the total dollar amount of funds under management over the prior five years; average of the number of investment funds under management in the prior five years; number of start-ups invested in over the prior five years; total dollar amount of funds invested in start-ups over the prior five years; number of companies taken public in the prior five years; and VC firm age.

[11] Approximately half of the firms in our sample report R&D investments in their balance sheets. We tested whether the ratio between R&D investments and assets could influence our results on this subsample, but we could not identify a significant change in our results. The variable has therefore been dropped from the analysis.

Table 2
Variable definitions.

Panel A. Dependent variables	
Tobin's Q	Ratio of market value of assets, calculated as the sum of the book value of assets and the market value of common stock less (calculated at offer prices) the book value of common stock, over book value of assets. *Source*: EURIPO.
3-year BHAR	3-year Buy-and-Hold Abnormal Returns calculated as in Loughran and Ritter (1995). *Source*: EURIPO and Datastream.
3-year ROA	3-year-average Return on assets (ROA), calculated as the ratio between EBIT (earnings before interests and taxes) and total assets, in the three years following the IPO. *Source*: EURIPO.
Time to first acquisition	Months from IPO to acquisition (target), calculated as in Meoli et al. (2013). Only deals up the 5 years after the IPO are considered. *Source:* ORBIS from Bureau Van Dijk.
Panel B. Explanatory variables	
University Affiliation	Dummy variable equal to 1 for firms affiliated with universities, 0 otherwise. University-affiliated firms are identified as companies that were either developed by faculty members based on their own research or created specifically to capitalize on academic research. This information comes from IPO prospectuses. An example of text identifying university affiliation follows. "The Company was formed in 1996 at Brunel University Science Park, Uxbridge, to research and develop a number of technologies […] and to make use of Dr. [name omitted]'s experience"
VC Backing	Dummy variable equal to 1 for firms backed by VCs at the time of the IPO, 0 otherwise. VCs are identified as in Vismara et al. (2012) among firms with institutional shareholders that focus on start-up financing. This information comes from a detailed examination of the directors' associations and 'Other significant shareholders' section of the IPO prospectuses. Such information is provided for at least three years prior to the IPO. In order to identify VC firms, several sources were used: the national associations such as the European Private Equity and Venture Capital Association (EVCA), the British Venture Capital Association (BVCA), the Association Francaise des Investisseurs en Capital (AFIC), the Bundesverband Deutscher Kapitalbeteiligungsgesellschaften (BVK), the Associazione italiana del private equity e venture capital (AIFI), and the National Venture Capital Association (NVCA). We also used other directories, including Pratt's Guide to VC Sources and the VC Resource Directory. Finally, we also included VC Trusts managed by established VC firms.
PRESTIGE-UNI	The prestige of universities is measured as the total number of citations (in thousands) received by all papers ("articles") published by the parent university in the twenty years before the IPO year in the following disciplines: Medicine; Biochemistry and Genetics; Nursing; Dentistry; Chemistry; Pharmacology, Toxicology and Pharmaceutics; Agriculture and Biological Sciences; Neuroscience; Immunology and Microbiology; Veterinary; Health professions; Chemical engineering. Double citations have been cleaned out. Following Gittelman and Kogut (2003), in regression analysis, raw citations are normalized by the mean and standard deviation of citations received by all sampled articles that were published in a given year. *Source:* Scopus.
PRESTIGE-SC	The scientific prestige is measured as the total number of citations (in thousands) received by all papers ("articles") published by members of the upper echelon of a certain IPO-firm in the twenty years before the IPO in the same disciplines as for *PRESTIGE-UNI*. Double citations have been cleaned out. Following Gittelman and Kogut (2003), in regression analysis, raw citations are normalized by the mean and standard deviation of citations received by all sampled articles that were published in a given year. *Source:* Scopus.
PRESTIGE-VC	For each VC-backed IPO *i*, the prestige of the VC is measured, similarly to Nahata (2008), as the cumulative market capitalization of all IPOs in the sample backed by the same VC before the IPO of firm *i*.
PRESTIGE-UW	For each backed IPO *i*, the prestige of the UW is measured as the capital raised by the UW taking public companies in the sample before *i* went public, divided by the capital raised by all the IPOs in the sample, previous to the IPO of firm *i*. Only lead and co-lead underwriters are considered. When more than one underwriter underwrites an issue, the proceeds (and number of IPOs) are equally split among all lead banks, as in Aggarwal et al. (2002). Underwriters that have been acquired during the sampling period are treated as part of the new parent.
Panel C. Controls	
Firm size (€m)	Inflation-adjusted sales in the year prior to the IPO, measured in 2008 millions of Euros using Purchasing Power Parities (EU27 = 1). Yearly average exchange rates are used before 2009 between the ECU and national currencies to obtain a euro-equivalent and for companies based in non-euro countries. *Source*: EURIPO, Eurostat and Datastream. Natural logarithms are used in the regressions.
Age (years)	Years since incorporation at the time of the IPO. *Source*: EURIPO. Natural logarithms of (Age + 1) are used in the regressions.
Profitability (%)	Return on assets, in the year prior to the IPO. *Source*: EURIPO and Amadeus.
Leverage (%)	Ratio of debt to total assets, in the year prior to the IPO. *Source*: EURIPO and Amadeus.
Dilution ratio	Shares offered at listing over number of shares outstanding before the IPO. *Source*: EURIPO and Dealogic.
Participation ratio	Percentage of the offer made of shares sold by existing shareholders. *Source*: EURIPO and Dealogic.
Prone to IPO (IMR)	Inverse Mills Ratio, calculated as in Heckman (1979), correcting for the selection of firms that go public rather than remaining private, as described in the methodological section. *Source*: Amadeus, for all variables related to the matching sample of private firms.
Patents	Number of patents registered at the U.S. and European Patent Offices issued to the firm up to the date of the IPO. Natural logarithms are used in the regressions. *Source*: EURIPO, EPO and USPTO.
UE size (No.)	Number of board members and top managers (upper echelons). Natural logarithms are used in the regressions. *Source*: EURIPO.
UE with PhD	Proportion of upper echelons that hold a PhD degree. *Source*: EURIPO.
UE with MBA	Proportion of upper echelons with an MBA degree. *Source*: EURIPO.
UE business experience	Proportion of upper echelons who had prior experience managing biotechnological or pharmaceutical companies. *Source*: EURIPO.
Non executives (%)	Fraction of non-executive board directors. *Source*: EURIPO.
Corporate spinoff	Dummy variable equal to 1 for firms that are concentrated around activities that were originally developed in a parent firm (Clarysse et al., 2011). *Source*: EURIPO and IPO prospectuses.
Alliances	Number of alliances, joint ventures, licensing, R&D, marketing/distribution, manufacturing and supply agreements (Guo et al., 2005). Natural logarithms are used in the regressions. *Source*: EURIPO and IPO prospectuses.
Country dummies	Set of dummy variables controlling for companies listed in France, Germany, Italy, and the U.K. Companies listed in other countries are the reference case.

(*continued on next page*)

Table 2 (*continued*)

Panel A. Dependent variables	
Industry dummies	Set of dummy variables controlling for the following sub-industries in the biotech sector: immunology, diagnostics, investigation new drug, protein engineering, instruments and services. Reference case is services. See Meoli et al. (2013) for details. *Source*: IPO prospectuses.
Panel D. Additional control for the analysis of long-run performances	
Biotech return	[included in 3Y-BHAR models only]: Percentage change of the NASDAQ biotechnology index in the 3-year period starting from the day of the focal IPO. *Source*: Thomson Reuters Datastream.
Biotech ROA	[included in the 3Y-ROA models only]: Average ROA of the biotech industry (NACE-Rev 2 industry: 72.11 Research and experimental development on biotechnology) in the same country of the focal-firm in the 3 years following the year of the IPO. *Source*: ORBIS from Bureau Van Dijk.
Biotech M&As	[included in the acquisition target models only]: Number of acquisitions of European biotech firms, measured as a regressor which varies over time (monthly) after the IPO of the focal firm. Survival time is censored five years after the IPO. Source: Thomson One Banker Deals and Zephyr by Bureau Van Dijk.
Biotech Cluster Size	[included in all models for long-run performances]: Number of biotech IPOs in the 24-month period preceding the IPO of the focal venture.
Biotech Tobin's Q	[included in all models for long-run performances]: Average market-to-book ratio for biotech firms, measured in the 24-month period preceding the IPO of the focal firm.
Biotech Underpricing	Average first day return of biotech IPOs in the 24-month period preceding the IPO of the focal venture.
CEO turnover	Dummy variable equal to 1 for firms experiencing a CEO turnover in the 3-year period starting from the day of the IPO. CEO turnover is defined as a change in the identity of the CEO. In the acquisition model, only turnovers until the acquisition are considered. *Source:* ORBIS from Bureau Van Dijk.
Scientists departures	Dummy variable equal to 1 for firms experiencing at least one departure in the scientific team in the 3-year period starting from the day of the IPO. Departures are identified by searching each member of the upper echelon with at least one scientific publication (*Source:* Scopus) for a different firm in the 3-year period starting from the day of the IPO. In the acquisition model, only departures until the acquisition are considered. *Source:* EURIPO and Espacenet.

The second group of control variables comprises upper echelon (UE) measures. *UE size* is (the log of) the number of board members and top managers. *UE with PhD* is the proportion of upper echelons comprising professors and PhDs. *UE with MBA* is the proportion of upper echelons with an MBA. *UE with business experience* is the proportion of upper echelons with experience managing biotech or pharmaceutical firms. *Non-executive directors* is the proportion of non-executive directors on the board.

The third group of control variables is related to inter-firm relationships. First, we control for IPO-firms spun out from large established firms. *Corporate spinoff* is a dummy variable equal to 1 for firms that are concentrated around activities originally developed in a larger parent firm (Clarysse et al., 2011) according to their IPO prospectus. Second, we include the number of alliances reported in the IPO prospectus (Baum et al., 2000; Baum and Silverman, 2004; Khoury et al., 2013). *Alliances* include strategic alliances, joint ventures, licensing, R&D, marketing/distribution, and manufacturing and supply agreements, as in Guo et al. (2005). Natural logarithms of (*Alliances* + 1) are used in the regressions.

Our models also include country dummies (a set of dummy variables controlling for companies located in the UK, Germany, France, and Italy, where the reference case is "company from other countries") and industry dummies (a set of dummy variables controlling for industry segments in the biotech sector—immunology, diagnostics, investigation new drug, protein engineering, instruments, and services—where the reference case is "services"). As timing matters in the valuation of IPOs, we also include year dummies.

3.2.8. *Specific controls for long-run performances*

The analysis of firms' long-run performance raises peculiar challenges, due to the occurrence of events in the post-IPO period that may affect long-run performance, thus possibly biasing our results. Controlling for such post-IPO effects is not easy, as one needs to identify exogenous events that are not related to the quality of the focal firm as revealed by signals conveyed to IPO investors. In our analysis of long-run performances, we tackle these issues through three complementary strategies.

First, if unanticipated changes in firm performance are driven by industry-wide exogenous shocks, they should similarly affect all firms independently of their affiliation. In turn, this should be reflected in the long-run performance of all biotech firms observed in a given period. To take duly into account the effect of these shocks, we have inserted in each long-run performance model an exogenous control at the industry level. The long-run models have three different dependent variables (i.e., stock price performance, operating performance, and acquisition target). Accordingly, we have included three different controls in the three models, as follows: 1) In the 3Y-BHAR model, we have considered the increase of the NASDAQ biotechnology index in the three-year period starting from the day of the focal IPO (source: Thomson Reuters Datastream); 2) in the 3Y-ROA model, we have included the average ROA of the biotech industry in Europe (source: ORBIS from Bureau Van Dijk, NACE-Rev 2 industry: 72.11 Research and experimental development on biotechnology) in the three years following the year of the focal IPO; 3) in the acquisition target model, we have included the number of acquisitions of European biotech firms, a time-varying regressor which varies over time (monthly) after the focal IPO.

Second, we acknowledge that there may be shocks at firm level that may influence our results. While we are aware that determining whether these shocks are exogenous (e.g., the abrupt death of a firm's star scientist) or not is not trivial, we considered two additional sources of (allegedly negative) post-IPO firm-specific (allegedly) exogenous shocks, relating to the composition of firms' upper echelon, that may influence the long-run performance of firms: i) CEO turnover; ii) departures of one or more scientists who were members of the upper echelon of the focal firm. These two firm-specific dummy variables have been included in all models of long-run performance.

Third, leveraging previous studies of the post-IPO long-run performance of firms, we have inserted additional controls. We have taken inspiration from Jain and Kini (2006) and have inserted in the model specification the number of biotech IPOs in the 24-month period preceding the IPO of the focal firm (*Biotech cluster size*). The intuition is as follows. If a biotech firm goes through an IPO in a "crowded" period, there will be "too many firms within an industry raising capital to chase the same investment opportunities leading to overcapacity" (Jain and Kini, 2006, p. 2), and possibly lower long-run performance. Following a similar logic, we have inserted additional controls, namely: the average market-to-book of equity value and the average first day return of the biotech IPOs in the 24-month period preceding the focal IPO. These variables are proxies of investors' sentiment at the time of the IPO. Gulati and Higgins (2003) suggest that the information value of signals varies depending on whether the market is "hot" or "cold". Hence, the hotness of the market may influence the quality of the signal conveyed by affiliation with a prestigious university.

3.2.9. Selection bias and the Prone to IPO variable

Because not all firms go public, studying only IPO firms may introduce a "success" bias that could influence our results. We use the Heckman correction model to correct for this potential sample selection bias (Heckman, 1979). Following Pollock et al. (2010), we therefore introduce in our models a first-stage regression to estimate the probability to be included in our sample for each IPO firm, with a specification in accordance to prior research on IPOs (Higgins and Gulati, 2003; Stuart et al., 1999). First, we collected from Bureau van Dijk's Amadeus database data on a random sample of 254 private biotech firms that did not go public between 1990 and 2009 but were similar to the companies in our sample according to nearest-neighbor propensity scores based on country dummies, industry dummies (see Section 3.2.7), size (total assets) and age.[12] All these firms were "at risk" of going public during the period covered by our study. Once the matching sample was selected, we obtained information about each private firm's age (natural logarithms of *Age* + 1 are used in the regression), total assets (natural logarithms of inflation-adjusted values are used in the regression), and number of employees (natural logarithms are used in the regression). We combined these data with similar data on our IPO firms and then used a probit regression to predict whether a firm went public during the 1990 to 2009 period. The results of this regression are reported in Table A11, Model 1, in the Appendix. Each of the predictor variables was strongly associated with the likelihood of going public (namely, total assets and number of employees are positively related, while age is negatively related). Given that only age at the IPO is a control variable in our analysis (see Section 3.2.7), total assets and number of employees grant the identification condition in our model (Puhani, 2000). The first stage regression was then used to calculate the Inverse Mills Ratio (i.e., the *Prone to IPO* variable) that we include in our second-stage regression models as an additional control.

3.3. Sample description

Table 3 reports the descriptive statistics for the variables employed in the empirical analysis, while the correlation matrix is reported in Table A4 in the Appendix. The average firm in our sample received a valuation at the IPO (in terms of Tobin's Q) of 3.94, experienced a −30% BHAR and a −24% average ROA over the next three years. Almost 60% of the sample was the target of an acquisition in the five years following the IPO. > 25% of firms in the sample were university-affiliated, while 42% were backed by a VC. All measures of prestige are right-skewed, with a mean value greater than the median value.

4. Results

4.1. Disentangling the signaling effect of affiliation with prestigious universities through a difference-in-difference approach

One of the main aims of our paper is to isolate the signaling effect of the affiliation with a prestigious university from the substantive benefits it provides to affiliated firms. Building on the claim made by previous studies that the relevance of signals depends on the uncertainty surrounding firms' activities, we argue that the greater the uncertainty about firms' scientific quality is, the stronger the signaling effect of the affiliation with a prestigious university should be. In turn, this type of uncertainty is reduced if firms' upper echelon includes prestigious scientists.

In this section, we resort to a difference-in-difference approach, where the "treatment" is provided by the affiliation with a prestigious university (with the prestige of the university measured by *PRESTIGE-UNI*), and firms differ depending on the scientific prestige of scientists in their upper echelons (measured by *PRESTIGE-SC*). In particular, we consider as "treated" only the firms with *PRESTIGE-UNI* greater than its median value (calculated among firms affiliated with a university), and we distinguish firms according to whether *PRESTIGE-SC* is above or below the median value. We aim to isolate the signaling effect of affiliation with a prestigious university through the following testing procedure.

First, we focus attention on firms which do not have prestigious scientists in their upper echelons (i.e., *PRESTIGE-SC* below or equal to the median value). We regress the IPO valuation (Tobin's Q) of these firms on a dummy variable identifying affiliation with prestigious universities (i.e., *PRESTIGE-UNI* above the median value, in the group of affiliated firms) and all control variables listed in Section 3.2.7. The effect of the treatment *PRESTIGE-UNI* on Tobin's Q is defined here as Δ1. Second, we repeat the same exercise for

[12] The matching sample of 254 firms was selected among all firm-year observations included in the Amadeus database during the sampling period.

Table 3
Descriptive statistics.

Statistics on time to first acquisition are calculated considering only observations with at least one deal, i.e. 58.3% of the sample. Statistics on *PRESTIGE-UNI* and *PRESTIGE-VC* are calculated considering only observations affiliated to universities or VCs, respectively. Statistics on Biotech M&As are calculated at the time of the acquisition, for targeted firms only. In the analysis of time-to-first acquisition, Biotech M&As is a time-varying regressor. In the analysis of time-to-first acquisition, CEO turnover and Scientific departures are calculated until the acquisition date.

	Mean	Std Dev	Median
Dependent variables			
Tobin's Q	3.94	2.99	2.94
3-year BHAR (%)	−30.15	103.72	−55.50
3-year ROA (%)	−24.55	56.61	−6.42
Time to first acquisition (months)	21.19	15.91	18.20
Explanatory variables			
University Affiliation (%)	25.59	43.72	0
VC Backing (%)	42.13	49.47	0
PRESTIGE-SC	2.76	7.07	0.42
PRESTIGE-UNI	204.71	225.93	184.34
PRESTIGE-VC	0.36	0.29	0.24
PRESTIGE-UW	0.19	0.15	0.15
Controls			
Firm size (Sales, €m)	40.29	135.13	4.38
Age (years)	9.53	11.76	7
Profitability (%)	−51.21	226.32	−11.11
Leverage (%)	75.85	70.68	44.96
Dilution ratio (%)	51.85	83.22	39.5
Participation ratio (%)	15.45	27.03	22.12
Patents (No.)	40.44	108.23	7
UE Size	9.43	4.45	9
UE with Ph.D. (%)	23.25	22.63	20.00
UE with MBA (%)	17.95	20.83	12.48
UE business experience (%)	33.82	12.93	35.00
Non executives (%)	28.39	19.46	28.57
Corporate spinoff (%)	35.04	47.80	0
Alliances (No.)	1.04	0.11	1
Additional controls for the analysis of long-run performances			
Biotech returns (%)	30.62	80.80	7.99
Biotech ROA (%)	−1.00	8.18	−0.55
Biotech M&As	30.68	35.72	14
Biotech Cluster Size	41.42	18.88	38
Biotech Tobin's Q	3.98	0.58	3.02
Biotech Underpricing	33.22	18.04	33.20
CEO turnover (%)	9.24	29.01	0
Scientific departures (%)	15.35	36.12	0

Table 4
Valuation at the IPO. Difference-in-difference estimation results.

Difference-in-difference tests including control variables. Firms are assigned to the group with prestigious (non-prestigious) scientists if *PRESTIGE-SC* is above (below) the median value. Firms are assigned to the group with prestigious university (treated) if they are affiliated to a university and *PRESTIGE-UNI* is above the median value.

	Tobin's Q	Std Dev	*t*-Test
Non-prestigious scientists			
Treated (T) – Firms affiliated with prestigious universities	6.24		
Control (C) – Firms affiliated with non-prestigious universities and non-affiliated firms	3.08		
Δ1 (T-C)	3.16	1.09	2.90***
Prestigious scientists			
Treated (T) – Firms affiliated with prestigious universities	6.64		
Control (C) – Firms affiliated with non-prestigious universities and non-affiliated firms	5.00		
Δ2 (T − C)	1.64	1.01	1.62
Δ = Δ1 − Δ2	1.52	0.66	2.30**

firms with prestigious scientists in their upper echelons (*PRESTIGE-SC* above the median value) and identify the effect of the treatment *PRESTIGE-UNI* on Tobin's Q, that we define as Δ2. Last, we calculate the difference in difference Δ = Δ1 − Δ2, which captures the signaling effect of affiliation with prestigious universities.

Results of this exercise are reported in Table 4. Our estimates show that the affiliation with a prestigious university results in a Tobin's Q 3.16 higher for firms with non-prestigious scientists in their upper echelon, and a Tobin's Q 1.64 higher for firms with prestigious scientists. Both estimates are positive (although only the first value is statistically significant). These results support our Hypothesis 1, according to which, affiliation with prestigious universities leads to higher IPO valuation. The difference-in-difference estimation shows a 1.52 difference between the two groups, statistically significant with $p\text{-value} < 0.05$, supporting our Hypothesis 2. Affiliation with a prestigious university has a stronger positive association with IPO valuation for firms that are *not* characterized by prestigious scientists in their upper echelon. These findings are further corroborated by the analysis that will be illustrated in the next section, relying on continuous measures of *PRESTIGE-UNI* and *PRESTIGE-SC*.

4.2. Results of OLS regressions

Table 5 reports the results of our OLS regressions on IPO valuations. Model 1 reports our baseline regression, including all control variables, and all prestige signals. Consistent with previous findings (see Meoli et al., 2013), the coefficient of *Firm size* is negative and significant ($p\text{-value} < 0.01$), indicating that the valuation of smaller firms benefits from higher growth opportunities. More indebted firms have higher valuations ($p\text{-value} < 0.01$), possibly because investors value the opportunity to free-ride on the monitoring efforts of lenders (Jensen and Meckling, 1976). Evidence of a positive relation with Tobin's Q is also found for our measures of profitability ($p\text{-value} < 0.05$). Variables identifying affiliation to a university (*University affiliation*) or to a VC are not statistically significant, showing that affiliation per se does not convey a valuable signal to investors.

By contrast, all measures of prestige (*PRESTIGE-UNI*, *PRESTIGE-SC*, *PRESTIGE-VC* and *PRESTIGE-UW)* are statistically significant. The coefficient of *PRESTIGE-UNI* is equal to 0.36 ($p\text{-value} < 0.01$). This effect is of great economic magnitude. With all continuous variables at their mean value and categorical variables at their median value, the predicted value of the Tobin's Q increases by 28% when the value of *PRESTIGE-UNI* increases by one standard deviation. This implies that, when evaluating a firm affiliated with a more prestigious university (i.e., *PRESTIGE-UNI* is at one standard deviation above the mean), rather than a firm affiliated with a less prestigious one (with *PRESTIGE-UNI* at the mean level), an investor is eager to pay 128 Euros, rather than 100, per 100 Euro of book value of assets. This evidence supports our Hypothesis 1 on the higher valuation of firms affiliated with prestigious universities.

In line with the literature, a positive and statistically significant effect is found also with respect to the other signal of prestige: *PRESTIGE-SC* (coefficient = 0.337, $p\text{-value} < 0.01$), *PRESTIGE-VC* (coefficient = 3.400; $p\text{-value} < 0.01$), and *PRESTIGE-UW* (coefficient = 4.546, $p\text{-value} < 0.01$). With all remaining variables at their mean or median value, we estimate that a one-standard-deviation increase in the value of these variables leads to an increase of the predicted value of the Tobin's Q equal to 21.3% (*PRESTIGE-SC*), 17.6% (*PRESTIGE-VC*), and 12.2% (*PRESTIGE-UW*).

In Model 2, we add the interaction term *PRESTIGE-UNI* × *PRESTIGE-SC* to the model specification. This term has a negative, significant ($p > 0.01$) coefficient, indicating that as predicted by Hypothesis 2, the positive association between *PRESTIGE-UNI* and Tobin's Q is negatively moderated by *PRESTIGE-SC*. Setting all continuous variables at their mean value and categorical variables at their median value, we find that a one-standard-deviation increase of *PRESTIGE-UNI* results in a 2.6 increase in the Tobin's Q if *PRESTIGE-SC* is at its mean value minus one standard deviation. It results in a much smaller increase (equal to 0.66) if *PRESTIGE-SC* is at its mean value plus one standard deviation. These results are in line with the view that the signaling effect of affiliation with a prestigious university is weaker when a firm is characterized by stronger scientific prestige in the upper echelon.

In Models 3 and 4, we test for the concurrent effects of the affiliation with prestigious universities and with prestigious VCs or UWs. Looking at the moderating effect of *PRESTIGE-VC* (Model 3) and *PRESTIGE-UW* (Model 4), we find that the two interaction terms of these variables with *PRESTIGE-UNI* are not statistically different from 0. These results show that the positive association between the affiliation with prestigious universities and Tobin's Q is not significantly weakened by affiliation with prestigious VCs or UWs.[13] These results support Hypotheses 3 and 4. Lastly, in Model 5, the three interaction terms are included together. Results are very close to those illustrated above.

4.3. Effects on long-run performance

Our analysis of the association between firms' affiliation with prestigious universities and their long-run performances starts off with a difference-in-difference test, as we did for IPO valuation. As reported in Table 6, we consider firms' financial performance, as measured by the three-year BHARs, operating performance, as measured by the three-year-average ROA, and time to the acquisition as a target following the IPO. Regarding firms with no prestigious scientists in their upper echelon, our estimates show that the affiliation with a prestigious university increases the financial performance ($p\text{-value} < 0.01$) by 6%, the operating performance ($p\text{-value} < 0.05$) by 4%, and reduces the time to the acquisition ($p\text{-value} < 0.01$) by 1.16 months. These effects are non-statistically

[13] Given the (non-significant) negative signs of the coefficient referring to the interaction between *PRESTIGE-UNI* and *PRESTIGE-VC*, we computed the marginal effect of the affiliation with prestigious universities as a function of the affiliation with a prestigious VC. The marginal effect is positive and statistically significant, with $p < 0.10$, for all values of VC smaller than 0.5 (only 17 out of 254 observations in our sample, or 7% of the sample, are beyond this threshold). By contrast, the (non-significant) coefficient referring to the interaction between *PRESTIGE-UNI* and *PRESTIGE-UW* is positive.

Table 5

Valuation at the IPO: OLS on the Tobin's Q.

OLS regressions on valuation at the IPO measured through Tobin's Q. Model (1) is our baseline specification. Model (2) includes the interaction between *PRESTIGE-UNI* and *PRESTIGE-SC*. Model (3) includes the interaction between *PRESTIGE-UNI* and *PRESTIGE-VC*. Model (4) includes the interaction between *PRESTIGE-UNI* and *PRESTIGE-UW*. Model (5) includes the three interactions. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. All models include the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)	(2)	(3)	(4)	(5)
Firm size	−0.260***	−0.258***	−0.254***	−0.262***	−0.254***
	(0.057)	(0.056)	(0.057)	(0.058)	(0.057)
Age	−0.003	−0.061	−0.025	0.000	−0.082
	(0.544)	(0.535)	(0.543)	(0.545)	(0.535)
Profitability	0.316**	0.336**	0.324**	0.316**	0.346**
	(0.146)	(0.144)	(0.146)	(0.146)	(0.143)
Leverage	0.459***	0.450***	0.465***	0.458***	0.457***
	(0.119)	(0.117)	(0.119)	(0.119)	(0.117)
Dilution ratio	0.217	0.201	0.210	0.229	0.211
	(0.330)	(0.324)	(0.329)	(0.332)	(0.326)
Participation ratio	1.081	1.098	1.111	1.069	1.113
	(1.182)	(1.162)	(1.180)	(1.185)	(1.161)
Patents	−0.018	−0.085	−0.017	−0.015	−0.082
	(0.153)	(0.152)	(0.153)	(0.154)	(0.152)
UE size	0.003	0.008	0.029	0.008	0.043
	(0.579)	(0.570)	(0.578)	(0.581)	(0.569)
UE with Ph.D.	−1.720	−1.596	−1.807	−1.711	−1.675
	(1.461)	(1.437)	(1.459)	(1.464)	(1.436)
UE with MBA	−2.211	−2.060	−2.264	−2.211	−2.114
	(1.445)	(1.422)	(1.442)	(1.448)	(1.420)
UE business experience	−0.227	−0.143	−0.109	−0.143	0.117
	(2.593)	(2.549)	(2.589)	(2.611)	(2.559)
Non executives	−2.418*	−2.520*	−2.237	−2.430*	−2.342*
	(1.411)	(1.388)	(1.414)	(1.414)	(1.392)
Corporate spinoff	0.213	0.205	0.212	0.229	0.227
	(0.638)	(0.628)	(0.637)	(0.642)	(0.629)
Alliances	5.490	5.285	5.553	5.346	5.133
	(4.236)	(4.182)	(4.229)	(3.272)	(3.208)
University Affiliation	−1.765	−1.164	−1.805*	−1.779	−1.206
	(1.075)	(1.076)	(1.073)	(1.078)	(1.074)
VC Backing	−0.542	−0.511	−0.466	−0.580	−0.483
	(0.718)	(0.706)	(0.718)	(0.729)	(0.716)
Prone to IPO (IMR)	−0.839	−0.888	−1.051	−0.840	−1.126
	(3.203)	(3.149)	(3.200)	(3.209)	(3.148)
PRESTIGE-UNI	0.360***	0.370***	0.358***	0.361***	0.370***
	(0.103)	(0.101)	(0.102)	(0.103)	(0.101)
PRESTIGE-SC	0.337***	0.370***	0.338***	0.336***	0.371***
	(0.094)	(0.093)	(0.094)	(0.094)	(0.093)
PRESTIGE-VC	3.400***	3.257***	3.072**	3.444***	2.955**
	(1.259)	(1.239)	(1.278)	(1.269)	(1.266)
PRESTIGE-UW	4.546***	5.139***	4.477***	4.342**	4.781***
	(1.670)	(1.654)	(1.668)	(1.789)	(1.760)
PRESTIGE-UNI × PRESTIGE-SC	–	−0.062***	–	–	−0.065***
		(0.021)			(0.021)
PRESTIGE-UNI × PRESTIGE-VC	–	–	−0.365	–	−0.403
			(0.260)		(0.256)
PRESTIGE-UNI × PRESTIGE-UW	–	–	–	0.094	0.141
				(0.293)	(0.288)
Constant	10.445***	10.762***	10.383***	10.421***	10.671***
	(3.191)	(3.139)	(3.184)	(3.198)	(3.135)
Observations	254	254	254	254	254
R-squared	0.428	0.457	0.429	0.428	0.460
Adjusted R-squared	0.307	0.339	0.305	0.304	0.336

Table 6
Long-run analysis. Difference-in-difference estimation results.

Difference-in-difference tests including control variables. Firms are assigned to the group with prestigious (non-prestigious) scientists if *PRESTIGE-SC* is above (below) the median value. Firms are assigned to the group with prestigious university (treated) if they are affiliated to a university and *PRESTIGE-UNI* is above the median value. Standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	3Y-BHAR	3Y-ROA	Time to first acquisition
Non-prestigious scientists			
Treated (T) – Firms affiliated with prestigious universities	0.88	−0.22	15.29
Control (C) – Firms affiliated with non-prestigious universities and non-affiliated firms	0.82	−0.26	16.45
Δ1 (T-C)	0.06**	0.04***	−1.16**
	(0.02)	(0.01)	(0.51)
Prestigious scientists			
Treated (T) – Firms affiliated with prestigious universities	0.89	−0.25	15.67
Control (C) – Firms affiliated with non-prestigious universities and non-affiliated firms	0.87	−0.25	15.71
Δ2 (T-C)	0.02	0.00	−0.04
	(0.026)	(0.01)	(0.04)
Δ = Δ1 – Δ2	0.04***	0.04***	−1.12***
	(0.016)	(0.01)	(0.26)

different from zero in the case of firms with prestigious scientists, such that the difference-in-difference estimations imply a 4% effect on financial performances, a 4% effect on operating performances, and a decrease by 1.12 months in the time to the acquisition as a target. All these results are statistically significant (p-value < 0.01).

Table 7 reports the results of our multivariate analysis of the long-run performance as measured by the three-year BHARs, the three-year-average ROA, and the hazard rate of becoming the target of an acquisition. For each dependent variable, we present one model with all prestige signals and all control variables, and one model which also includes the interaction terms between *PRESTIGE-UNI* and the other prestige variables. Apart from the dependent variable, the specifications of all models replicate those of the regressions on IPO valuation presented in Table 5 (i.e., Models 1 and 5), augmented by the specific controls for the analysis of long-run performance, as described in Section 3.2.8.

In Model 1, the four prestige variables are all significant, with p-value < 0.05 (*PRESTIGE-UNI*, *PRESTIGE-SC* and *PRESTIGE-UW*) and p-value < 0.01 (*PRESTIGE-VC*). In Model 2, where we include the interaction terms, we find evidence that *PRESTIGE-SC* negatively moderates *PRESTIGE-UNI*. Setting all continuous variables at their mean value and categorical variables at their median value, a one-standard deviation increase of *PRESTIGE-UNI* results in a 14.1% increase in the three-year BHAR, if *PRESTIGE-SC* is at its mean value minus one standard deviation; the increase is considerably smaller (equal to 9.9%) if *PRESTIGE-SC* is at its mean value plus one standard deviation. Vice versa, the interaction term between *PRESTIGE-UNI* and *PRESTIGE-VC*, as well as the interaction term between *PRESTIGE-UNI* and *PRESTIGE-UW* are not statistically significant.

In Models 3 and 4, we focus on firms' operating performance. In Model 3, all prestige variables have positive and significant coefficients: *PRESTIGE-UNI* and *PRESTIGE-UW* with p-value < 0.10, while *PRESTIGE-SC* and *PRESTIGE-VC* with p-value < 0.05. When we include the interaction terms, in Model 4, we find evidence of a negative weakly significant (p-value < 0.10) moderating effect of *PRESTIGE-SC* on *PRESTIGE-UNI*, of relatively small magnitude. A one-standard deviation increase in *PRESTIGE-UNI* results in an 8.3% increase in the three-year average ROA if *PRESTIGE-SC* is at its mean value minus one standard deviation, and in a 5.6% increase if *PRESTIGE-SC* is at its mean value plus one standard deviation. The interaction terms of *PRESTIGE-UNI* with *PRESTIGE-VC* and *PRESTIGE-UW*, again, are not significant.

Last, in Models 5 and 6, we model through Cox proportional hazard regressions the hazard rate for firms to be the target of an acquisition in the period following the IPO. Again, in Model 5, the four prestige variables are significant (*PRESTIGE-UNI* with p-value < 0.05; *PRESTIGE-SC* with p-value < 0.01, *PRESTIGE-VC* and *PRESTIGE-UW* with p-value < 0.10). When introducing interaction effects, in Model 6, we find evidence that the increase of the probability of becoming the target of an acquisition following the IPO generated by affiliation with a prestigious university is smaller the greater the scientific prestige of firms' upper echelons. When *PRESTIGE-SC* is set at one standard deviation below the mean value, the increase in the hazard rate given by a one-standard-deviation increase of *PRESTIGE-UNI* is equal to 5.5% (p-value < 0.01), while it is equal to 2.1% (p-value < 0.10) when *PRESTIGE-SC* is set at one standard deviation above the mean value. Conversely, the average marginal effect of *PRESTIGE-UNI* does not significantly vary with *PRESTIGE-VC* and *PRESTIGE-UW*.

Altogether, the above results confirm the predictions of Hypotheses 5, 6, 7, and 8 relating to the long-run performance of firms. They are in line with the view that the positive signal provided by the affiliation of firms with prestigious universities as reflected in their post-IPO performance, is less relevant when firms' upper echelons include prestigious scientists. Moreover, the affiliation of a firm with a prestigious university and a prestigious VC or UW are related to post-IPO performance in a positive, additive manner.

Table 7
Long-run analysis.
Models (1–4) are OLS regressions on post-IPO performances, measured through 3-year BHAR (Models 1–2) and 3-year average ROA (Model 3–4). Models (5–6) are Cox proportional hazard regressions on the time to the first acquisition (target), with a time-varying regressor (Biotech M&As) observed monthly up to five years post the IPO. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. All models include the Inverse Mills' Ratio (*Prone to IPO - IMR*) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	3Y-BHAR	3Y-BHAR	3Y-ROA	3Y-ROA	Time to first acquisition	Time to first acquisition
Firm size	−0.004	−0.010	0.001	0.004	0.040*	0.044*
	(0.015)	(0.015)	(0.009)	(0.008)	(0.024)	(0.024)
Age	0.038	0.039	0.187	0.166	0.299	0.361
	(0.147)	(0.139)	(0.145)	(0.143)	(0.256)	(0.259)
Profitability	−0.022	−0.058*	0.002	0.005	−0.144**	−0.144**
	(0.032)	(0.035)	(0.019)	(0.019)	(0.060)	(0.064)
Leverage	−0.003	−0.040	−0.037**	−0.036**	−0.056	−0.064
	(0.038)	(0.039)	(0.016)	(0.016)	(0.049)	(0.054)
Dilution ratio	−0.033	−0.085	0.032	0.030	0.049	0.160
	(0.130)	(0.135)	(0.020)	(0.019)	(0.212)	(0.226)
Participation ratio	−0.010	0.181	−0.092	−0.073	−0.332	−0.403
	(0.247)	(0.248)	(0.112)	(0.107)	(0.496)	(0.505)
Patents	0.014	0.034	0.044*	0.036	−0.007	−0.019
	(0.037)	(0.036)	(0.024)	(0.023)	(0.065)	(0.066)
UE size	0.041	0.084	−0.012	−0.010	−0.631*	−0.808**
	(0.143)	(0.135)	(0.075)	(0.075)	(0.365)	(0.370)
UE with Ph.D.	−0.155	0.208	0.255	0.268	0.165	0.080
	(0.285)	(0.281)	(0.227)	(0.222)	(0.749)	(0.747)
UE with MBA	−0.214	−0.156	−0.088	−0.075	0.467	0.650
	(0.309)	(0.298)	(0.209)	(0.207)	(0.741)	(0.729)
UE business experience	0.032	−0.044	0.008	−0.024	−0.155	−0.156
	(0.672)	(0.648)	(0.256)	(0.250)	(1.762)	(1.763)
Non-Executive Directors	−0.826*	−0.864*	0.168	0.184	−0.381	−0.721
	(0.463)	(0.454)	(0.200)	(0.201)	(0.754)	(0.776)
Corporate spinoff	0.082	0.034	0.057	0.043	0.243	0.249
	(0.193)	(0.194)	(0.064)	(0.064)	(0.306)	(0.312)
Alliances	0.812	1.110	−0.690	−0.657	−1.275	−1.906
	(0.551)	(0.877)	(0.652)	(0.630)	(1.527)	(1.607)
Biotech returns	0.081	0.111	–	–	–	–
	(0.129)	(0.123)				
Biotech ROA	–	–	0.329	0.333	–	–
			(0.403)	(0.390)		
Biotech M&As	–	–	–	–	0.003	0.004
					(0.005)	(0.005)
Biotech Cluster Size	0.002	0.005	−0.000	−0.000	0.465	0.351
	(0.004)	(0.005)	(0.002)	(0.002)	(0.333)	(0.344)
Biotech Tobin's Q	−0.113	−0.125	0.015	0.021	0.465	0.351
	(0.172)	(0.176)	(0.056)	(0.057)	(0.333)	(0.344)
Biotech Underpricing	0.319	0.397	−0.347	−0.355	2.131*	2.215*
	(0.598)	(0.566)	(0.281)	(0.278)	(1.088)	(1.195)
CEO turnover	−0.267*	−0.269*	−0.143	−0.121	−0.670	−0.745
	(0.148)	(0.147)	(0.101)	(0.104)	(0.632)	(0.651)
Scientific departures	−0.241	−0.161	−0.208	−0.212	0.724	0.944
	(0.184)	(0.163)	(0.180)	(0.182)	(0.524)	(0.626)
University Affiliation	−0.912**	−0.767*	−0.260	−0.177	0.214	0.208
	(0.456)	(0.411)	(0.172)	(0.163)	(0.384)	(0.414)
VC Backing	−0.341**	−0.273*	−0.101	−0.084	−0.117	−0.113
	(0.164)	(0.161)	(0.069)	(0.069)	(0.329)	(0.332)
Prone to IPO (IMR)	−0.145	0.112	0.770	0.722	0.623	1.188
	(0.838)	(0.782)	(0.567)	(0.567)	(1.415)	(1.451)
PRESTIGE-UNI	0.098**	0.082**	0.032*	0.031*	0.042**	0.033**
	(0.038)	(0.035)	(0.017)	(0.017)	(0.025)	(0.016)
PRESTIGE-SC	0.018**	0.022**	0.023**	0.023**	0.160***	0.190***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.047)	(0.048)
PRESTIGE-VC	0.809***	0.862***	0.220**	0.210**	0.130*	0.183*
	(0.270)	(0.262)	(0.087)	(0.095)	(0.077)	(0.093)

(*continued on next page*)

Table 7 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
	3Y-BHAR	3Y-BHAR	3Y-ROA	3Y-ROA	Time to first acquisition	Time to first acquisition
PRESTIGE-UW	0.242**	0.259***	1.004*	1.017*	0.157*	0.133*
	(0.122)	(0.082)	(0.567)	(0.593)	(0.078)	(0.073)
PRESTIGE-UNI × PRESTIGE-SC		−0.088***		−0.006*		−0.017**
		(0.027)		(0.003)		(0.007)
PRESTIGE-UNI × PRESTIGE-VC		−0.698		1.612		2.204
		(5.107)		(1.570)		(1.710)
PRESTIGE-UNI × PRESTIGE-UW		−0.597		−0.047		1.812
		(0.601)		(0.048)		(1.263)
Constant	0.687	0.173	−0.988	−0.998	–	–
	(1.528)	(1.578)	(0.766)	(0.762)		
Observations	254	254	254	254	254	254
(Pseudo) R-squared	0.596	0.649	0.334	0.335	(0.251)	(0.263)
Adjusted R-squared	0.486	0.537	0.240	0.252	–	–

4.4. Natural experiment

To determine whether the signal relating to affiliation with prestigious universities, scientists, VCs, and UWs actually work as signals, we rely upon the natural experiment set by an important change in the regulation of European financial markets. In 2002, the Sarbanes–Oxley (SOX) Act was adopted in the U.S. to increase corporate governance standards of U.S.-listed firms. The SOX served as a paradigm for reforms in the European Union (EU), where in the following years, reforms where approved in the different member states to introduce the same corporate governance standards (through the so-called "EU-SOX"). The adoption of corporate governance codes induced greater transparency and less information asymmetry, leading to greater investor confidence. Akyol et al. (2014) show, for instance, that the EU-SOX diminished, ceteris paribus, the information asymmetry between issuers and investors, as documented by a lower level of underpricing.[14]

We make use of this regulatory change to test whether the effects of the four prestige signals on firm valuation at IPO studied in this paper changed after the introduction of the new corporate governance codes. In particular, we take advantage of the staggered implementation of the same regulatory change across European countries to analyze its effect at different points in time. The first SOX-like regulatory change in our sample was implemented in Denmark on December 6, 2001, preceding the U.S. Most countries implemented a new regulatory setting within two years of the adoption of the U.S. SOX, while others did so as late as 2007 (see Table 1 in Akyol et al., 2014). Such a large timespan allows us to better analyze the regulatory effects by mitigating the influence of potential overlapping general trends. The effect of the introduction of the EU-SOX is tested only for companies going public in regulated markets, as these regulatory changes did not affect firms going public in unregulated market, such as London's Alternative Investment Market (AIM).

The results reported in Table 8 show that, while the *PRESTIGE-VC* (Model 3) and *PRESTIGE-UW* (Model 4) variables turn out to significantly reduce their positive effect on IPO valuation after the introduction of the EU-SOX,[15] no significant change is observed for the *PRESTIGE-UNI* (Model 1) and *PRESTIGE-SC* (Model 2) variables. In Model 3, indeed, the interaction term between *PRESTIGE-VC* with the post EU-SOX dummy is negative and significant (p-value < 0.01). The same result is found in Model 4 for the interaction between *PRESTIGE-UW* and the post EU-SOX dummy (p-value < 0.05). Conversely, the coefficients of the interaction term of *PRESTIGE-UNI* and the post EU-SOX dummy, and the interaction term of *PRESTIGE-SC* and the post EU-SOX dummy are not significant at conventional confidence levels. Moreover, an F-test rejects the null hypothesis that the effect of *PRESTIGE-UNI* on Tobin's Q in the post-EU-SOX period is equal to zero (F-test(1203) = 7.54, p-value < 0.01). A similar result is found with respect to the effect of *PRESTIGE-SC* (F-test(1203) = 6.96, p-value < 0.01). We interpret these results by stressing the different types of information asymmetry that the prestige signals challenge. Since prestigious VCs and UWs are expected to ameliorate the uncertainty surrounding the financial quality of the firms going public, their effect is weaker after the EU-SOX, as the new corporate governance codes imply higher financial transparency for all IPOs. Conversely, since the affiliation with a prestigious university aims to reduce the uncertainty related to firms' scientific quality, its role is not substantially affected by the adoption of EU-SOX. The same reasoning applies to the scientific prestige of firms' upper echelon members. As a whole, these results provide additional evidence that the effects of *PRESTIGE-UNI* (as well as that of *PRESTIGE-SC*) do not overlap with those of *PRESTIGE-VC* and *PRESTIGE-UW*. Model 5 tests the interactions between the single signals and the EU-SOX dummy at the same time, confirming earlier results.

Last, in Model 6 and 7, the interaction between the signals and the EU-SOX dummy is tested on two subsamples, comprising firms

[14] Similarly, Chhaochharia and Grinstein (2007), Iliev (2010), and Johnston and Madura (2009), among others, examine the valuation and pricing of IPO shares in the U.S. before and after SOX was enacted; they find that, on average, underpricing is lower for IPO shares issued post-SOX.

[15] The sum of the two *PRESTIGE-VC* coefficients (the coefficient over the full sample plus the marginal post-SOX coefficient) is equal to 1.9 and is not statistically significant. The sum of the two *PRESTIGE-UW* coefficients (the coefficient over the full sample plus the marginal post-SOX coefficient) is equal to 1.7 and again is not statistically significant.

Table 8
Natural experiment: Pre and post EU-Sox evidence.

This table reports our tests for interactions between "exchange-regulated markets" and "post-European-Sox-like provisions" dummies with the four measures of prestige considered in the paper. The dependent variable is Tobin's Q at the IPO. The interaction of the EU-Sox on regulated markets is analyzed with each signal: in Model (1) with *PRESTIGE-UNI*, in Model (2) with *PRESTIGE-SC*, in Model (3) with *PRESTIGE-VC*, in Model (4) with *PRESTIGE-UW*. In Models (5–7) all signals are interacted together with Eu-Sox on regulated markets: Model (5) refers to the full sample, Model (6) is estimated on the sub-sample of firms with *PRESTIGE-SC* below the median value, Model (7) is estimated on the sub-sample of firms with *PRESTIGE-SC* above the median value. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. All models include the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm size	−0.263***	−0.260***	−0.269***	−0.249***	−0.252***	−0.154*	−0.210***
	(0.058)	(0.057)	(0.057)	(0.057)	(0.057)	(0.082)	(0.076)
Age	−0.001	−0.083	−0.021	0.156	0.029	−0.170	0.443
	(0.547)	(0.549)	(0.538)	(0.546)	(0.541)	(0.571)	(0.997)
Profitability	0.316**	0.296**	0.307**	0.297**	0.257*	−0.189	0.357
	(0.147)	(0.148)	(0.145)	(0.146)	(0.145)	(0.460)	(0.298)
Leverage	0.453***	0.428***	0.447***	0.438***	0.399***	0.297**	0.443
	(0.120)	(0.121)	(0.118)	(0.118)	(0.119)	(0.122)	(0.317)
Dilution ratio	0.192	0.140	0.093	0.141	−0.023	0.071	−1.016
	(0.332)	(0.333)	(0.328)	(0.328)	(0.329)	(0.277)	(1.380)
Participation ratio	0.919	0.835	1.057	1.289	1.313	0.131	3.033
	(1.193)	(1.191)	(1.174)	(1.192)	(1.177)	(1.036)	(3.234)
Patents	−0.019	−0.020	−0.049	0.013	−0.017	−0.177	0.162
	(0.154)	(0.153)	(0.152)	(0.153)	(0.151)	(0.164)	(0.247)
UE size	−0.019	−0.012	0.019	−0.120	−0.075	0.564	−1.750
	(0.582)	(0.580)	(0.573)	(0.578)	(0.570)	(0.585)	(1.054)
UE with PhD	−1.855	−1.889	−1.624	−1.432	−1.271	−2.445	0.369
	(1.470)	(1.465)	(1.448)	(1.466)	(1.450)	(1.919)	(2.078)
UE with MBA	−2.212	−2.377	−1.895	−2.300	−2.217	1.023	−2.944
	(1.450)	(1.452)	(1.431)	(1.435)	(1.427)	(1.736)	(2.238)
UE business exp.	−0.040	0.111	−0.427	−0.729	−0.861	0.071	−3.072
	(2.607)	(2.601)	(2.566)	(2.595)	(2.570)	(2.375)	(5.136)
Non-Executive Directors	−2.443*	−2.308	−2.359*	−1.825	−1.564	−2.105	0.163
	(1.416)	(1.416)	(1.393)	(1.428)	(1.416)	(1.487)	(2.479)
Corporate spinoff	0.173	0.202	0.277	0.456	0.598	−0.440	0.852
	(0.641)	(0.640)	(0.632)	(0.647)	(0.640)	(0.657)	(1.082)
Alliances	5.273	4.929	5.036	5.544*	4.846	5.910*	3.068
	(3.250)	(3.252)	(3.198)	(3.217)	(3.186)	(3.251)	(4.963)
Exchange-Regulated Markets	−0.648	−0.694	−0.586	−0.701	−0.690	−0.703	−1.316
	(0.549)	(0.546)	(0.539)	(0.542)	(0.537)	(0.700)	(1.180)
Post EU Sox-like Provisions	0.429	0.438	0.386	0.496	0.457	1.322*	0.175
	(0.541)	(0.538)	(0.531)	(0.535)	(0.529)	(0.746)	(1.203)
University Affiliation	−1.784*	−1.722	−1.706	−1.668	−1.490	−0.470	−2.979*
	(1.079)	(1.076)	(1.061)	(1.068)	(1.058)	(1.083)	(1.577)
VC Backing	−0.498	−0.498	−0.244	−0.669	−0.394	0.469	−0.779
	(0.726)	(0.718)	(0.715)	(0.716)	(0.720)	(0.787)	(1.042)
Prone to IPO (IMR)	−0.859	−1.285	−1.894	−0.212	−1.786	−0.409	−6.914
	(3.214)	(3.222)	(3.182)	(3.192)	(3.190)	(2.951)	(7.436)
PRESTIGE-UNI	0.351***	0.359***	0.340***	0.353***	0.340***	0.369***	0.250**
	(0.114)	(0.103)	(0.101)	(0.102)	(0.112)	(0.105)	(0.098)
PRESTIGE-SC	0.340***	0.395***	0.318***	0.315***	0.367***	0.124	0.867***
	(0.095)	(0.105)	(0.094)	(0.094)	(0.103)	(0.143)	(0.312)
PRESTIGE-VC	3.445***	3.420***	3.586***	3.400***	3.487***	2.825**	4.342**
	(1.264)	(1.260)	(1.244)	(1.250)	(1.236)	(1.217)	(1.803)
PRESTIGE-UW	4.384**	4.004**	4.055**	4.764***	3.969**	3.443**	3.497*
	(1.695)	(1.704)	(1.658)	(1.673)	(1.684)	(1.460)	(1.935)
PRESTIGE UNI × Post EU Sox × Reg	0.013	–	–	–	0.006	−0.113	−0.101
	(0.128)				(0.135)	(0.207)	(0.182)
PRESTIGE-SC × Post EU Sox × Reg	–	−0.200	–	–	−0.282	0.093	−0.370
		(0.171)			(0.179)	(0.249)	(0.465)
PRESTIGE-VC × Post EU Sox × Reg	–	–	−1.647***	–	−1.598***	−0.949*	−2.529**
			(0.599)		(0.601)	(0.540)	(1.063)
PRESTIGE-UW × Post EU Sox × Reg	–	–	–	−3.066**	−3.051**	−2.829*	−2.892*
				(1.384)	(1.386)	(1.541)	(1.462)

(*continued on next page*)

Table 8 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	10.715***	11.130***	11.239***	9.521***	10.566***	7.283**	12.969*
	(3.222)	(3.224)	(3.170)	(3.229)	(3.205)	(2.909)	(7.428)
Observations	254	254	254	254	254	127	127
R-squared	0.429	0.432	0.456	0.441	0.470	0.703	0.642
Adjusted R-squared	0.299	0.302	0.332	0.313	0.339	0.508	0.406

with *PRESTIGE-SC* below the median value, and above the median value, respectively. In both sub-samples, the interaction of *PRESTIGE-UNI* and the EU-SOX dummy is not significant. As expected, the effect of *PRESTIGE-UNI* is stronger (0.367, p-value < 0.01 vs. 0.250, p-value < 0.05) in the sample of firms with less prestigious scientists in their upper echelons.

4.5. Robustness checks

This section describes the robustness checks with regard to (1) instrumenting the measures of *PRESTIGE-VC* and *PRESTIGE-UW*, to account for potential endogeneity; (2) interacting *PRESTIGE-VC* and *PRESTIGE-UW* with *PRESTIGE-SC* (as we do with *PRESTIGE-UNI*), to further check whether the former two signals also convey to IPO investors information about firms' scientific quality (as *PRESTIGE-UNI* does); (3) alternative specifications for the definition of the prestige variables; (4) the adoption of alternative dependent variables, namely Enterprise Value/Sales and underpricing; (5) the inclusion of a variable controlling for VC syndication; and (6) testing whether the strength of the signal generated by firms' affiliation with prestigious universities depends on the type of links between the firm and the university. All results discussed in this section are reported in the additional tables available in the Appendix.

First, in our previous analyses in Section 3.2.6, we considered that the endorsements by universities, VCs, and UWs enter the game sequentially. Here we aim to provide further support to our results by implementing an alternative modelling strategy, where the potential endogeneity of prestige signals entering at a second stage is treated through an instrumental variable approach. More precisely, in Table A5 in the Appendix, we report the results of instrumental variable regressions on IPO valuation of our sample firms, measured through Tobin's Q. While the outcome equation is the same we used in the previous section of the paper (as in Model 5 of Table 5), we employ here additional equations to instrument as potentially endogenous variables both *PRESTIGE-VC* and *PRESTIGE-UW*. *PRESTIGE-VC* is instrumented by *VC EU-Activity*, defined as the cumulative market capitalization of non-biotech IPOs backed by the focal VC over the population of European non-biotech IPOs in the period 1990–2009. *PRESTIGE-UW* is instrumented by *UW EU-Activity*, defined as the share of non-biotech IPOs taken public by the focal UW in the population of European non-biotech IPOs, in the period 1990–2009, as reported in the EURIPO database. Given that in our outcome equation *PRESTIGE-VC* and *PRESTIGE-UW* are interacted with *PRESTIGE-UNI*, two further instruments are created by interacting *VC EU-Activity* and *UW EU-Activity* with *PRESTIGE-UNI*. The four instruments are statistically significant in the corresponding instrumental equations reported in Models 1–4, indicating that they are positively associated with the prestige of the VCs and UWs involved in biotech IPOs. Further, *VC EU-Activity* and *UW EU-Activity* represent prior activity of VC and UW on *non-biotech* markets and are therefore unlikely to affect valuation of biotech IPO firms in the eyes of potential investors, if not through the prestige itself of VCs and UWs. Therefore, we support the excludability of the instrumental variables, and thus their validity. Model 5 of Table A5 reports the outcome equations, with results in line with those reported in earlier sections.[16]

Second, in Table A6 in the Appendix, we consider the interaction between *PRESTIGE-SC* and *PRESTIGE-VC* in Model 1 and between *PRESTIGE-SC* and *PRESTIGE-UW* in Model 2. If affiliation with prestigious VCs and UWs conveyed to IPO investors information about the scientific quality of affiliated firms, the smaller the value of *PRESTIGE-SC*, the larger the positive effects of these two variables on firms' IPO valuation should be. We do not find any evidence of these negative moderation effects. In Model 3, we insert the interaction between *PRESTIGE-VC* and *PRESTIGE-UW*, which is negative and (weakly) significant (p-value < 0.1). We interpret this result as evidence that the affiliations to prestigious VCs and UWs are perceived by investors as conveying overlapping signals, with sub-additive effects on Tobin's Q.

Third, we test the robustness of our results when measuring the prestige variables with several alternative specifications. In Table A7 in the Appendix, we replicate Model 5 in Table 5, replacing one measure of prestige at a time (two alternative definitions for each prestige measure). Models 1 and 2 include alternative measures of university prestige. *PRESTIGE-UNI* is defined in Model 1 according to the Annual Ranking of World Universities (ARWU) published by Jiao Tong University in Shanghai (*PRESTIGE-SC* = Ranking^{-1} when a ranking is available, 0 otherwise); in Model 2, by a dummy variable equal to 1 for universities listed in the Milken Ranking of universities in the biotech field, 0 otherwise. Models 3 and 4 include alternative measures of scientists' prestige. *PRESTIGE-SC* is defined in Model 3 as the total number of papers ("articles") published by members of the upper echelon of the focal IPO firm in the twenty years before the IPO year in biotech-related fields (see Table 2 for the list of fields) and normalized by the mean and standard deviation of all sampled articles published per year. In Model 4, it is captured by the total number of top papers ("articles" published

[16] Please consider that a first-stage equation for sample selection correction is also needed (see Section 3.2.8). Hence, our model actually consists here of six equations, estimated with structural equation modelling techniques (GSEM command in Stata).

in Nature, Science and Cell) published by members of the upper echelon of the focal IPO firm in the twenty years before the IPO year, normalized by the mean and standard deviation of sample top papers published per year and transformed into natural logarithms. Models 5 and 6 include alternative measures of VC prestige: *PRESTIGE-VC* is defined in Model 5 as the value of the LPJ Reputation Index 2001–2010 available at Timothy Pollock's website; in Model 6, it is measured by a dummy variable equal to 1 for all the VCs with above-median value of LPJ Reputation Index 2001–2010, 0 otherwise. Models 7 and 8 include alternative measures of UW Prestige. *PRESTIGE-UW* is defined in Model 7 as the share of IPOs taken public by a focal UW in sample IPOs; in Model 8 as the Carter Manaster ranking (Carter and Manaster, 1990). All results reported in Table A7 in the Appendix confirm our previous findings.[17]

Fourth, we replace our IPO valuation measure, the Tobin's Q, with alternative measures of valuation (see Table A8 in the Appendix). First, we rerun our analysis (Models 1 and 5 in Table 5) by using the ratio between the Enterprise Value (defined as the sum of the market value at IPO and the total value of debt in the latest balance sheet) and sales. Our results are qualitatively unchanged. Second, we consider underpricing at the IPO. Underpricing is commonly used in the management literature as a proxy of uncertainty (Daily et al., 2003). In this case, in line with our expectations, the signs of the estimated coefficients for the prestige variables are negative. Moreover, the interaction between *PRESTIGE-UNI* and *PRESTIGE-SC* is positive, while *PRESTIGE-UNI* is not significantly affected by interactions with *PRESTIGE-VC* or *PRESTIGE-UW*.

Fifth, we add to the model specification a variable measuring the number of VCs in a syndicate (see Table A9 in the Appendix). The variable is not statistically significant, and the results relating to our explanatory variables remain unchanged.

Lastly, our arguments are based on the prestige of the universities with which firms are affiliated and do not distinguish according to the nature of the "link" between the firm and the university. However, the nature of the link may influence the perception investors have of the affiliation as a quality signal. In other words, a firm "linked" to a non-prestigious university will not benefit from such affiliation independently of the nature of the link. However, we acknowledge that stronger and more visible links to a prestigious university may convey to IPO investors a stronger quality signal. For this reason, we investigate whether the strength of the signal generated by the affiliation with a prestigious university depends on the type of links between the firm and the university. For this purpose, we have proceeded as follows. First, we have coded all the links between firms and universities (both prestigious and non-prestigious) and have created the following four dummy variables: a) *ownership*: it equals 1 if the university holds an equity stake in the focal venture (45% of university affiliations), 0 otherwise; b) *upper echelon*: it equals 1 if one or more upper echelon members of the focal venture are (or were) also members of the faculty or research staff of the university (67% of cases), 0 otherwise; c) *license*: it equals 1 if the firm licenses results of university research (23%), 0 otherwise; and e) *research contract*: it equals 1 if the firm has given a research contract to the university (17%), 0 otherwise. Then, we have run a principal component analysis for binary variables (using a polychoric correlation matrix, as recommended by Kolenikov and Angeles, 2009). The PCA shows that there are two components with eigenvalue > 1, with the key discriminant between the two components being the presence of an equity stake. Further, based on the results of the PCA analysis, we have created two additional dummy variables, namely *PRESTIGE-UNI equity*, which equals 1 if the focal firm has an ownership-based link to a prestigious university, and *PRESTIGE-UNI non-equity*, which equals 1 if the focal firm has a non-ownership-based link to a prestigious university but no ownership-based link. Then we have replaced *PRESTIGE-UNI* with these two variables (including the interaction term with PRESTIGE-SC). We have done the same with *University affiliation* for symmetry reasons. The estimates are in Table A10 in the Appendix. They show that affiliation with a prestigious university provides a quality signal to IPO investors, independently of the type of links between the university and the focal firm. However, the signal is stronger, as is revealed by the magnitude and significance of its association with IPO valuations, when a prestigious university has an equity stake in the focal venture. With all remaining variables at their mean or median value, we estimate that a one-standard-deviation increase in the value of *PRESTIGE-UNI* leads to an increase of the predicted value of the Tobin's Q equal to 1.37 (24.5%) in case of equity affiliation, and 1.05 (18.7%) in case of non-equity affiliation. As far as the interaction with *PRESTIGE-SC* is concerned, setting all continuous variables at their mean value and categorical variables at their median value, the results are as follows. In case of equity affiliation, a one-standard-deviation increase of *PRESTIGE-UNI* results in a 1.85 (33.1%) increase in the Tobin's Q, if *PRESTIGE-SC* is at its mean value minus one standard deviation. It results in a much smaller increase (equal to 0.91, 16.3%) if *PRESTIGE-SC* is at its mean value plus one standard deviation. In case of other types of affiliation, the increases are limited to 1.45 (25.9%) in the former case and 0.64 (11.4%) in the latter. These results are in line with the view that the signaling effect of affiliation with a prestigious university is weaker when a firm is characterized by stronger scientific prestige in the upper echelon, and this applies to both equity and non-equity links.

5. Discussion and conclusions

5.1. Synthesis of results and contributions

The aim of this study was to investigate the beneficial effects on biotech firms' IPO valuation and post-IPO performance of their affiliation to a prestigious university, and the interaction with the affiliation to prestigious VCs and UWs. For this purpose, we have analyzed the population of European biotech IPOs in the period 1990–2009. Our results show that firms affiliated with prestigious universities exhibit higher IPO valuation and better post-IPO performance than either firms affiliated with other universities or non-affiliated firms. We are confident that this result is due to the signal of scientific quality provided by the affiliation with a prestigious

[17] In unreported results, we also tested for the non-linearity of prestige signals by including squared values for each prestige indicator. We found weak evidence of a more-than-linear effect for the university signal (i.e., the effect on valuation provided by prestigious universities grows more than linearly with university prestige).

university, as the effect of this affiliation is stronger the weaker the scientific prestige of scientists in the upper echelon of the focal IPO firm is. Moreover, this effect is not weakened by affiliations with prestigious VCs or UWs and is not affected by the introduction of the EU-SOX regulation of financial markets, while this regulatory change appears to significantly weaken the positive effects engendered by affiliations with prestigious VCs and UWs.

Our results provide fresh insights into the literature on signals at science-based IPOs. In this type of IPOs, investors' valuation of firms is negatively influenced by uncertainty relating to both the scientific and market potentials of firms. To reduce this uncertainty, firms need to rely on multiple signals, which certify their quality in both domains. We offer three original contributions to this literature. First, we disentangle the signaling effect of affiliation with a prestigious university from the substantive benefits provided by this affiliation by showing that this signal is more valuable in situations where there is more uncertainty as to the scientific quality of the focal firm. Second, we highlight that the positive effects of multiple signals can be additive if they convey non-overlapping information to investors. Accordingly, the scientific endorsement of a prestigious university is a signal of scientific quality recognized as beneficial by investors, independently of signals pertaining to the business and financial domains conveyed to investors by affiliation with prestigious VCs or UWs. Third, in line with Spence's (1973) original claim, we argue and document empirically that the signal of scientific quality conveyed to IPO investors by firms' affiliation with prestigious universities is confirmed by the superior post-IPO performance of these firms.

Further, our paper contributes to the literature on academic entrepreneurship (see Rothaermel et al., 2007 for a review). Most of the studies in this stream focus attention on the first steps, if not on the establishment, of university-affiliated firms, and compare their strategies and performance with those of non-affiliated firms (e.g., Colombo and Piva, 2012). In this work, we highlight that affiliation with a university may provide long-lasting financial benefits to affiliated firms but only if the university is prestigious. In doing so, we extend the scope of the academic spin-off literature by considering a so-far neglected set of stakeholders, namely IPO investors, and by expanding the measurement of the performance of academic spin-offs from the product to the financial markets.

5.2. Implications for practice and policy

This study focuses on science-based IPOs: its practical implications are first and foremost financial. Our results indicate to entrepreneurs of science-based ventures going through an IPO that it is important to signal the quality of their firms both in the scientific and business/financial domains, and that affiliations with prestigious universities, VCs, and UWs nicely serve this purpose, leading to greater IPO valuation. They also indicate to IPO investors that it is worth paying more to take an equity position in these firms at the IPO, as they outperform other firms in the long-run.

Second, our results are of interest to those involved in technology transfer at universities. IPOs are generally considered as the most attractive exit option for academic spin-offs, as for any start-up. However, managers of technology transfer offices and entrepreneurial scientists should be aware that valuations at the IPO closely depend on the prestige of the universities to which academic spin-offs are affiliated. In particular, IPO investors do not give any premium to firms affiliated with non-prestigious universities. Hence, one wonders whether an IPO is an attractive option for this category of firms.

Third, our study has implications for policymakers. The creation of academic spin-offs is a typical indicator used by policy makers to assess the third mission performance of universities. This positive view of the role of academic spin-offs was fostered by "success stories" in favorable contexts such as Silicon Valley. However, many academic spin-offs have weak business models and poor growth performances (Meoli and Vismara, 2016). Our results show that market investors do not pay a premium at IPO for academic spin-offs from non-prestigious universities, and these firms do not overperform non-academic start-ups in the post-IPO period. These results are in line with the view that policy schemes that indiscriminately stimulate the creation of academic spin-offs are a bad move (Mustar and Wright, 2010).

5.3. Limitations and future research directions

As with all studies, ours has limitations. First, in disentangling the signaling value of affiliation with a prestigious university from its substantive benefits through a difference-in-difference approach, we disregard that the composition of firms' upper echelon is not exogenous. Prestigious scientists are not uniformly distributed across universities and may have different incentives to start a new firm or sit on its board of directors depending on the prestige of the university with which the firm is affiliated. How prestigious scientists triangulate with universities and entrepreneurial firms is worth further investigation.

A second limitation relates to the generalizability of our results. We have analyzed the population of biotech firms listed on European stock exchanges in the period 1990–2009. Our sampling is therefore limited in terms of (1) industry, (2) geography, and (3) type of transaction. As for industry, biotechnology provides a fertile setting for the study of science-based IPOs, as investors face serious challenges in determining the scientific quality of IPO firms and relatedly their market value. Future research might broaden the perspective to investigate how signals provided by universities, VCs, and UWs interact in other high-tech industries like information technologies, where the relative importance of different sources of information asymmetries (e.g., market potential versus scientific potential) and the relations between different signals may be different.

A second boundary condition of our study is our European focus. Even if the number of biotech IPOs in Europe is comparable to the one in the U.S., the institutional characteristics relevant to biotech IPOs of these two geographical areas differ quite widely. In

Europe, the VC industry is less developed than in the U.S. and fragmented across countries. Moreover, the role of UWs is also quite different between the two regions. Unlike in the U.S., where companies going public select investment banks independently of, and even before, the listing market and the same established investment banks handle IPOs on both the NYSE and NASDAQ, in Europe, local banks operating almost entirely in a single country compete with top-tier international UWs. A replication of this study in the U.S. context would allow investigation of whether our results are influenced by these different institutional characteristics.

The study of IPO firms is our third boundary condition. Challenged with convincing a wide variety of potential investors of the long-term potential of the firm, the success of an IPO is largely a matter of conveying to investors the right signals. The focus on IPOs is therefore shared with most studies interested in assessing the uncertainty-reducing power of signals from third-party endorsements. Recently, crowdfunding platforms have offered an alternative way to raise funds from the "crowd." Crowdfunding, albeit a relatively new phenomenon, is growing rapidly around the world. Because of the specificities of the biotech industry, a number of dedicated platforms are being launched, through which campaigns are often led by university-based projects. Future studies might investigate whether the affiliation with a prestigious university is perceived as a signal of scientific quality also in these markets and what bundle of signals are used by firms to attract investors.

Appendix A

Table A.1
Top European Universities, ranked according to the number of citations in the 20 years previous the IPO of an affiliated firm.

Rank	University	Country	No. IPOs affiliated
1	University of Cambridge	United Kingdom	4
2	Karolinska Institute	Sweden	1
3	University of Oxford	United Kingdom	7
4	University of Edinburgh	United Kingdom	1
5	University of Amsterdam	The Netherlands	1
6	Munich Technical University	Germany	2
7	University of Oslo	Norway	1
8	University of Manchester	United Kingdom	3
9	University of Leeds	United Kingdom	1
10	Newcastle University	United Kingdom	1
11	University of Sheffield	United Kingdom	1
12	Imperial College London	United Kingdom	1
13	University of Erlangen-Norimberga	Germany	2
14	University College of London	United Kingdom	1
15	Swiss Federal Institute of Technology Zurich	Switzerland	1
16	Ecole Polytechnique	France	1
17	Ecole Normale Superieure, Paris	France	1
18	University of Göttingen	Germany	1
19	École Polytechnique Federale de Lausanne	Switzerland	1
20	University of Munich	Germany	2

Table A.2
Top Venture Capitalists, ranked by the number of venture-backed IPOs in the sample.

Rank	VC fund	Country	No. IPOs affiliated
1	3i plc	United Kingdom	36
2	Atlas Venture Fund	United States	12
3	Sofinova Capital II FCPR	United States	10
4	Abingworth Bioventures II	United Kingdom	8
5	TVM V Life Science Ventures GmbH & Co. KG	Germany	7
6	Invesco perpetual	United Kingdom	6
7	Merlin Ventures Limited	United Kingdom	6
8	Apax group	China	5
9	HealthCap Companies	Sweden	5
10	Life Science Partners	The Netherlands	5
11	Schroeder Funds	Luxembourg	5

(*continued on next page*)

Table A.2 (*continued*)

Rank	VC fund	Country	No. IPOs affiliated
12	Advent Venture Capital	United Kingdom	4
13	AlpInvest Partners	The Netherlands	4
14	Auriga Ventures	France	4
15	Euroventures	Hungary	4
16	GIMV	Belgium	4
17	Index Ventures	United Kingdom	4
18	KBC Private Equity	Belgium	4
19	ABN Ambro	The Netherlands	3
20	Alta Partners	United States	3

Table A3
Top Underwriters, ranked by the share of proceeds raised taking public the IPOs in the sample.

Rank	Investment bank	Country	No. IPOs affiliated
1	Morgan Stanley & Co. International	United States	5
2	Commerzbank	Germany	3
3	Goldman Sachs International	United States	5
4	Citigroup	United States	1
5	Intesa Sanpaolo	Italy	2
6	UBS	Switzerland	6
7	Noryt Company Establishment	Poland	1
8	Mediobanca	Italy	1
9	WestLB	Germany	8
10	Nomura Code Securities Ltd	Japan	4
11	Credit Suisse Securities	Switzerland	3
12	Collins Stewart	United Kingdom	9
13	HSBC Trinkaus	United Kingdom	2
14	Kleinwort Benson	United Kingdom	3
15	Deutsche Bank	Germany	3
16	Nomura International	Japan	3
17	Merrill Lynch International	United States	2
18	Bank Vontobel	Switzerland	1
19	ABG Sundal Collier	Norway	2
20	KBC Peel Hunt	United Kingdom	9

Table A4
Correlation matrix.

		1	2	3	4		6	7	8	9	10	11	12
1	Tobin's Q	1.000											
2	3-year BHAR	−0.157*	1.000										
3	3-year ROA	−0.123*	−0.134*	1.000									
4	Acquisition target	0.023	0.159*	0.009	1.000								
5	Firm size	−0.386*	0.145*	0.028	0.080	1.000							
6	Age	−0.200*	0.092	0.096	0.050	0.370*	1.000						
7	Profitability	−0.119	0.133*	0.117	0.055	0.231*	0.141*	1.000					
8	Leverage	0.219*	−0.104	−0.209*	−0.067	−0.135*	−0.111	−0.593*	1.000				
9	Dilution ratio	0.079	0.047	0.003	−0.118	−0.122*	−0.087	0.030	−0.037	1.000			
10	Participation ratio	0.203*	−0.081	−0.027	0.116	−0.314*	−0.256*	−0.122*	0.075	0.134*	1.000		
11	Patents	−0.005	0.040	0.090	0.105	0.051	−0.022	0.064	−0.038	−0.099	0.068	1.000	
12	UE size	−0.032	0.138*	−0.004	−0.071	0.099	0.045	−0.032	−0.005	−0.090	0.016	0.097	1.000
13	UE with PhD	0.111	−0.015	0.109	0.250*	−0.261*	−0.126*	−0.127*	0.029	−0.024	0.280*	0.162*	0.147*
14	UE with MBA	−0.043	0.061	0.069	0.195*	−0.095	−0.050	0.039	−0.037	0.018	0.284*	0.159*	0.178*
15	UE business exp.	0.068	−0.109	0.011	0.173*	−0.156*	−0.173*	−0.097	0.038	0.002	0.448*	0.082	−0.142*
16	Non-Executive Directors	−0.075	−0.010	0.070	0.070	−0.064	0.019	−0.066	0.018	−0.013	0.048	−0.014	0.191*
17	Corporate Spinoff	−0.040	0.007	0.016	−0.012	0.053	−0.138*	−0.044	0.112	−0.058	0.011	0.048	0.131*
18	Alliances	−0.052	0.038	−0.057	0.129*	0.095	0.081	0.037	−0.072	−0.028	−0.050	0.189*	0.127*
19	University Affiliation	0.207*	0.140*	−0.077	−0.004	−0.178*	−0.123*	−0.054	−0.018	−0.021	0.207*	0.027	0.005
20	VC Backing	0.120	0.003	0.010	0.205*	−0.142*	−0.020	−0.056	0.055	−0.029	0.155*	0.191*	0.092
21	PRESTIGE-SC	0.305*	−0.028	−0.018	−0.064	−0.265*	−0.171*	−0.172*	0.022	−0.131*	0.352*	0.205*	0.170*
22	PRESTIGE-UNI	0.298*	0.087	−0.095	0.156*	−0.200*	−0.200*	−0.067	0.008	−0.036	0.187*	0.018	0.056
23	PRESTIGE-VC	0.168*	0.066	0.010	−0.021	−0.097	0.033	−0.002	−0.013	0.085	−0.025	0.014	−0.009
24	PRESTIGE-UW	0.124*	−0.059	−0.011	0.217*	0.070	−0.021	0.013	−0.043	0.151*	−0.013	0.114	0.441*
		13	14	15	16	17	18	19	20	21	22	23	24
13	UE with PhD	1.000											
14	UE with MBA	0.306*	1.000										
15	UE business exp.	0.410*	0.374*	1.000									
16	Non-Executive Directors	−0.025	0.137*	−0.008	1.000								
17	Corporate Spinoff	−0.033	0.043	0.041	−0.011	1.000							
18	Alliances	0.004	−0.022	−0.115	0.022	−0.009	1.000						
19	University Affiliation	0.206*	0.056	0.211*	−0.101	−0.431*	−0.022	1.000					
20	VC Backing	0.252*	0.170*	0.188*	0.073	0.104	0.153*	0.000	1.000				
21	PRESTIGE-SC	0.507*	0.174*	0.234*	0.036	−0.072	0.085	0.285*	0.287*	1.000			
22	PRESTIGE-UNI	0.191*	0.117	0.199*	−0.040	−0.347*	−0.002	0.805*	0.004	0.303*	1.000		
23	PRESTIGE-VC	0.053	−0.022	−0.022	0.089	−0.032	0.115	0.000	0.582*	0.094	−0.046	1.000	
24	PRESTIGE-UW	−0.053	−0.050	−0.064	−0.037	0.066	0.367*	0.000	0.000	0.020	0.021	0.011	1.000

* Indicates significance at 5% level.

Table A5
Instrumental variable approach.

This table reports the results of instrumental variable regressions on Tobin's Q measured at the IPO. Model (1) and (2) are the first stage estimates for *PRESTIGE-VC* and *PRESTIGE-UW*. The two instruments are VC EU-Activity and UW EU-Activity. VC EU-Activity is defined as the cumulative market capitalization of IPOs backed by the VC over the population of European IPOs (excluding biotech IPOs) in the period 1990–2009. UW EU-Activity is the share of IPOs taken public by a particular underwriter in the population of European IPOs (excluding biotech IPOs) in the period 1990–2009. All models include the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1) PRESTIGE-VC	(2) PRESTIGE-UW	(3) PRESTIGE-UNI × PRESTIGE-VC	(4) PRESTIGE-UNI × PRESTIGE-UW	(3) TOBIN'S Q
Firm size	0.001	0.002	0.003	0.023*	−0.238***
	(0.000)	(0.002)	(0.004)	(0.012)	(0.059)
Age	−0.000	−0.002	0.014	−0.074	−0.100
	(0.005)	(0.021)	(0.040)	(0.115)	(0.536)
Profitability	−0.003**	−0.003	0.001	−0.003	0.340**
	(0.001)	(0.006)	(0.011)	(0.031)	(0.144)
Leverage	−0.002*	−0.001	−0.003	0.001	0.456***
	(0.001)	(0.005)	(0.009)	(0.025)	(0.117)
Dilution ratio	0.000	0.032**	0.002	−0.073	0.161
	(0.003)	(0.013)	(0.024)	(0.069)	(0.326)
Participation ratio	−0.002	−0.002	−0.017	0.114	1.192
	(0.010)	(0.045)	(0.086)	(0.250)	(1.165)
Patents	−0.002	0.007	−0.011	−0.015	−0.094
	(0.001)	(0.006)	(0.011)	(0.033)	(0.152)
UE size	0.003	0.007	−0.006	−0.034	0.005
	(0.005)	(0.022)	(0.042)	(0.123)	(0.570)
UE with PhD	0.007	−0.054	−0.088	−0.288	−1.783
	(0.013)	(0.056)	(0.107)	(0.309)	(1.443)
UE with MBA	−0.032**	−0.030	−0.064	−0.060	−2.148
	(0.012)	(0.056)	(0.105)	(0.305)	(1.423)
UE business exp.	0.015	0.005	0.247	−0.911*	−0.568
	(0.022)	(0.100)	(0.190)	(0.549)	(2.602)
Non-Executive Directors	0.018	−0.011	−0.027	0.002	−2.285
	(0.012)	(0.055)	(0.104)	(0.300)	(1.397)
Corporate spinoff	−0.003	0.033	−0.012	−0.110	0.145
	(0.005)	(0.024)	(0.046)	(0.134)	(0.631)
Alliances	0.052	1.251	1.662	5.513	5.563*
	(0.169)	(0.759)	(1.441)	(4.169)	(3.194)
University Affiliation	0.006	0.001	−0.014	0.054	−1.127
	(0.009)	(0.042)	(0.080)	(0.232)	(1.077)
VC Backing	0.065***	−0.022	0.061	0.304**	−0.205
	(0.006)	(0.026)	(0.049)	(0.143)	(0.747)

(*continued on next page*)

Table A5 (*continued*)

	(1) PRESTIGE-VC	(2) PRESTIGE-UW	(3) PRESTIGE-UNI × PRESTIGE-VC	(4) PRESTIGE-UNI × PRESTIGE-UW	(3) TOBIN'S Q
Prone to IPO	−0.009	0.061	−0.098	−0.004	−1.038
	(0.028)	(0.123)	(0.234)	(0.677)	(3.153)
PRESTIGE-UNI	−0.001	−0.000	−0.117***	−0.040*	0.362***
	(0.001)	(0.004)	(0.008)	(0.023)	(0.101)
PRESTIGE-SC	0.000	0.002	0.007	0.026	0.378***
	(0.001)	(0.004)	(0.007)	(0.020)	(0.094)
PRESTIGE-VC	–	–	–	–	2.623**
					(1.314)
PRESTIGE-UW	–	–	–	–	5.306***
					(1.680)
PRESTIGE-UNI × PRESTIGE-SC	0.000	0.002*	0.000	0.009**	−0.059***
	(0.000)	(0.001)	(0.002)	(0.004)	(0.021)
PRESTIGE-UNI × PRESTIGE-VC	–	–	–	–	−0.338
					(0.274)
PRESTIGE-UNI × PRESTIGE-UW	–	–	–	–	−0.579
					(0.583)
VC EU-Activity	0.931***	−0.016	−0.005	−0.566**	–
	(0.010)	(0.047)	(0.089)	(0.257)	
UW EU-Activity	0.036	1.571**	1.190	7.194**	–
	(0.136)	(0.611)	(1.160)	(3.355)	
PRESTIGE-UNI × VC EU-Activity	0.002	−0.015	1.008***	−0.160***	–
	(0.002)	(0.011)	(0.020)	(0.059)	
PRESTIGE-UNI × UW EU-Activity	−0.006	0.048**	−0.005	0.971***	–
	(0.005)	(0.022)	(0.042)	(0.121)	
Constant	−0.117***	−0.123	−0.012	0.302	11.403***
	(0.028)	(0.124)	(0.235)	(0.681)	(3.453)
Observations	254	254	254	254	254
R-squared	0.684	0.338	0.624	0.352	0.440
Adjusted R-squared	0.683	0.187	0.615	0.204	0.312

Table A6

Robustness on signals interactions.

OLS regressions on Tobin's Q at the IPO. The reference specification is that of Model (5) of Table 5. Model (1) includes the interaction between *PRESTIGE-SC* and *PRESTIGE-VC*. Model (2) includes the interaction between *PRESTIGE-SC* and *PRESTIGE-UW*. Model (3) includes the interaction between *PRESTIGE-VC* and *PRESTIGE-UW*. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. All models include the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)	(2)	(3)
Firm size	−0.255***	−0.254***	−0.247***
	(0.063)	(0.064)	(0.063)
Age	−0.090	−0.081	−0.129
	(0.515)	(0.514)	(0.512)
Profitability	0.350***	0.346***	0.332***
	(0.107)	(0.106)	(0.105)
Leverage	0.460***	0.457***	0.451***
	(0.096)	(0.095)	(0.092)
Dilution ratio	0.225	0.213	0.197
	(0.558)	(0.568)	(0.586)
Participation ratio	1.052	1.109	1.027
	(0.915)	(0.908)	(0.904)
Patents	−0.079	−0.081	−0.036
	(0.144)	(0.146)	(0.146)
UE size	0.059	0.041	0.027
	(0.592)	(0.586)	(0.584)
UE with PhD	−1.596	−1.665	−1.451
	(1.522)	(1.546)	(1.520)
UE with MBA	−2.067	−2.116	−1.930
	(1.383)	(1.389)	(1.396)
UE business exp.	0.174	0.123	−0.009
	(2.670)	(2.674)	(2.621)
Non-Executive Directors	−2.371*	−2.349*	−2.133
	(1.301)	(1.289)	(1.293)
Corporate spinoff	0.213	0.230	0.177
	(0.610)	(0.609)	(0.606)
Alliances	5.150	5.151	4.778
	(3.938)	(3.949)	(3.898)
University Affiliation	−1.252	−1.205	−0.918
	(1.463)	(1.467)	(1.485)
VC Backing	−0.476	−0.482	−0.442
	(0.780)	(0.780)	(0.768)
Prone to IPO	−1.133	−1.106	−1.140
	(2.375)	(2.418)	(2.391)
PRESTIGE-UNI	0.373***	0.370***	0.346**
	(0.136)	(0.137)	(0.137)
PRESTIGE-SC	0.370***	0.371***	0.344***
	(0.099)	(0.099)	(0.099)
PRESTIGE-VC	2.920**	2.961**	2.373*
	(1.417)	(1.438)	(1.372)
PRESTIGE-UW	4.825**	4.795**	3.994*
	(2.237)	(2.250)	(2.253)
PRESTIGE-UNI × PRESTIGE-SC	−0.065***	−0.065***	−0.068***
	(0.024)	(0.024)	(0.024)

(*continued on next page*)

Table A6 (*continued*)

	(1)	(2)	(3)
PRESTIGE-UNI × PRESTIGE-VC	−0.452	−0.401	−0.491
	(0.348)	(0.341)	(0.330)
PRESTIGE-UNI × PRESTIGE-UW	0.152	0.124	0.113
	(0.256)	(0.372)	(0.253)
PRESTIGE-SC × PRESTIGE-VC	0.145	–	–
	(0.319)		
PRESTIGE-SC × PRESTIGE-UW	–	0.036	–
		(0.587)	
PRESTIGE-VC × PRESTIGE-UW	–	–	−4.962*
			(2.895)
Constant	10.679***	10.657***	10.508***
	(2.846)	(2.904)	(2.830)
Observations	254	254	254
R-squared	0.460	0.461	0.476
Adjusted R-squared	0.333	0.335	0.353

Table A7
Alternative definitions for Prestige.

Models (1–6) are OLS regressions on Tobin's Q at the IPO. All models replicate Model (5) of Table 5, replacing one measure of prestige. Model (1–2) include alternative measures of University Prestige. *PRESTIGE-UNI* is defined in model (1) according to the Annual Ranking of World Universities (ARWU) published by the Jiao Tong University in Shanghai (*PRESTIGE-UNI* = Ranking^{-1} when the ranking is available, 0 otherwise); in model (2) as a dummy variable equal to 1 for universities listed in the Milken Ranking of universities in the biotech field, 0 otherwise. Model (3–4) include an alternative measures of Scientific Prestige: *PRESTIGE-SC* is defined in model (3) as the total number of papers ("articles") published by members of the TMT of a certain IPO firm in the twenty years before the IPO year in biotech-related fields (see Table 2), normalized by mean and standard deviation of all sample articles published in each year, and transformed into natural logarithms; in model (4) as the total number of top papers ("articles" published on Nature, Science and Cell) published by members of the TMT of a certain IPO firm in the twenty years before the IPO year, normalized by mean and standard deviation of all sampled top articles in each year, and transformed into natural logarithms. Model (5–6) include alternative measures of VC Prestige: *PRESTIGE-VC* is defined in Model (5) as the value of LPJ Reputation Index 2001–2010 available at Timothy Pollock's website; in Model (6) as a dummy variable equal to 1 for all the VCs with above-median value of LPJ Reputation Index 2001–2010 available at Timothy Pollock's website, 0 otherwise. Model (7–8) include alternative measures of UW Prestige. *PRESTIGE-UW* is defined in Model (7) as the share of IPOs taken public by a particular underwriter in sample IPOs; in Model (8) as the Carter Manaster ranking (1990) in Model. All models include the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm size	−0.241***	−0.257***	−0.265***	−0.265***	−0.252***	−0.255***	−0.249***	−0.255***
	(0.059)	(0.058)	(0.058)	(0.059)	(0.057)	(0.057)	(0.057)	(0.057)
Age	−0.362	−0.200	0.051	−0.004	−0.079	−0.102	0.030	−0.083
	(0.542)	(0.550)	(0.554)	(0.555)	(0.535)	(0.539)	(0.537)	(0.540)
Profitability	0.317**	0.339**	0.276*	0.245	0.333**	0.348**	0.383***	0.334**
	(0.147)	(0.148)	(0.146)	(0.149)	(0.144)	(0.144)	(0.145)	(0.145)
Leverage	0.466***	0.475***	0.403***	0.398***	0.445***	0.439***	0.457***	0.461***
	(0.119)	(0.120)	(0.120)	(0.121)	(0.117)	(0.118)	(0.117)	(0.118)
Dilution ratio	0.181	0.124	−0.028	0.002	0.220	0.284	0.412	0.373
	(0.331)	(0.336)	(0.331)	(0.332)	(0.326)	(0.326)	(0.319)	(0.321)
Participation ratio	1.008	0.967	1.684	2.118*	1.082	0.956	1.462	1.053
	(1.181)	(1.190)	(1.192)	(1.173)	(1.161)	(1.166)	(1.176)	(1.173)
Patents	−0.164	−0.129	−0.065	−0.024	−0.084	−0.084	−0.038	−0.031
	(0.155)	(0.155)	(0.158)	(0.157)	(0.152)	(0.154)	(0.152)	(0.153)

(*continued on next page*)

Table A7 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UE size	0.177	0.133	0.171	0.183	0.037	−0.010	0.082	0.060
	(0.577)	(0.585)	(0.586)	(0.590)	(0.569)	(0.572)	(0.571)	(0.575)
UE with PhD	−1.735	−1.902	−0.951	−0.391	−1.848	−1.919	−1.887	−1.916
	(1.462)	(1.471)	(1.520)	(1.482)	(1.437)	(1.447)	(1.439)	(1.450)
UE with MBA	−1.751	−1.609	−2.332	−2.451*	−2.096	−2.109	−2.251	−2.416*
	(1.439)	(1.447)	(1.462)	(1.467)	(1.421)	(1.431)	(1.423)	(1.436)
UE business exp.	0.576	0.544	−0.064	−0.239	0.087	−0.194	0.488	0.191
	(2.603)	(2.623)	(2.675)	(2.687)	(2.560)	(2.571)	(2.566)	(2.585)
Non-Executive Dir.	−2.283	−2.020	−2.003	−1.971	−2.330*	−2.065	−2.473*	−2.221
	(1.419)	(1.423)	(1.438)	(1.445)	(1.392)	(1.393)	(1.395)	(1.411)
Corporate spinoff	0.049	0.095	0.219	0.192	0.198	0.104	0.405	0.365
	(0.639)	(0.643)	(0.649)	(0.652)	(0.628)	(0.631)	(0.626)	(0.631)
Alliances	5.174	5.301	5.215	5.375	5.598*	5.590*	2.252	4.943
	(3.264)	(3.292)	(3.327)	(3.354)	(3.219)	(3.247)	(2.998)	(3.502)
University Affiliation	1.184	1.284	−1.167	−1.048	−1.259	−1.112	−1.516	−1.133
	(0.780)	(0.807)	(1.114)	(1.119)	(1.078)	(1.080)	(1.083)	(1.087)
VC Backing	−0.491	−0.514	−0.574	−0.389	−0.714	−0.447	−0.659	−0.729
	(0.729)	(0.736)	(0.751)	(0.744)	(0.791)	(0.849)	(0.715)	(0.720)
Prone to IPO	−1.844	−1.141	−0.666	−0.809	−1.070	−1.473	−1.273	−0.581
	(3.208)	(3.232)	(3.355)	(3.372)	(3.154)	(3.163)	(3.159)	(3.183)
PRESTIGE-UNI	14.168**	2.228*	0.402***	0.391***	0.366***	0.345***	0.414***	0.364***
	(6.223)	(1.262)	(0.103)	(0.104)	(0.101)	(0.101)	(0.102)	(0.102)
PRESTIGE-SC	0.397***	0.403***	0.347**	0.391***	0.375***	0.371***	0.360***	0.367***
	(0.094)	(0.095)	(0.169)	(0.104)	(0.093)	(0.094)	(0.094)	(0.094)
PRESTIGE-VC	2.653**	2.674**	2.908**	2.891**	1.031**	1.383*	3.101**	2.890**
	(1.284)	(1.298)	(1.302)	(1.309)	(0.454)	(0.785)	(1.269)	(1.283)
PRESTIGE-UW	5.133***	4.923***	4.849**	5.018***	4.917***	4.674***	2.274**	1.501*
	(1.790)	(1.804)	(1.884)	(1.891)	(1.760)	(1.778)	(0.923)	(0.894)
PRESTIGE-UNI × PRESTIGE-SC	−0.059***	−0.058***	−0.060***	−0.057***	−0.064***	−0.066***	−0.059***	−0.061***
	(0.021)	(0.022)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
PRESTIGE-UNI × PRESTIGE-VC	−0.310	−0.332	−0.384	−0.390	−0.330	−0.398	−0.350	−0.443*
	(0.265)	(0.270)	(0.263)	(0.265)	(0.255)	(0.254)	(0.258)	(0.259)
PRESTIGE-UNI × PRESTIGE-UW	0.098	0.124	0.182	0.093	0.146	0.107	0.337	0.328
	(0.293)	(0.295)	(0.301)	(0.302)	(0.288)	(0.289)	(0.272)	(0.277)
Constant	10.420***	9.940***	8.340**	8.770***	10.225***	10.839***	8.763***	9.928***
	(3.188)	(3.220)	(3.238)	(3.240)	(3.174)	(3.175)	(3.182)	(3.160)
Observations	254	254	254	254	254	254	254	254
R-squared	0.431	0.423	0.434	0.430	0.456	0.453	0.456	0.457
Adjusted R-squared	0.301	0.291	0.302	0.297	0.332	0.329	0.332	0.333

Table A8

Alternative dependent variables.

OLS regressions on valuation at the IPO measured as EV/Sales (Models 1–2) and on IPO underpricing (Models 3–4). *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *Prestige-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. All models include the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)	(2)	(3)	(4)
	EV/sales	EV/Sales	Underpricing	Underpricing
Firm size	−0.362***	−0.372***	−0.005	−0.005
	(0.042)	(0.042)	(0.013)	(0.013)
Age	−0.441	−0.424	0.048	0.106
	(0.390)	(0.385)	(0.122)	(0.123)
Profitability	0.016	0.026	−0.015	−0.018
	(0.105)	(0.104)	(0.033)	(0.033)
Leverage	0.181**	0.169**	−0.013	−0.010
	(0.086)	(0.084)	(0.027)	(0.027)
Dilution ratio	−0.083	−0.110	−0.079	−0.098
	(0.236)	(0.233)	(0.074)	(0.077)
Participation ratio	1.587*	1.571*	−0.020	0.041
	(0.849)	(0.835)	(0.267)	(0.269)
Patents	0.170	0.125	0.056	0.056
	(0.110)	(0.109)	(0.035)	(0.035)
UE size	0.076	0.033	0.098	0.076
	(0.420)	(0.413)	(0.130)	(0.131)
UE with Ph.D.	1.127	0.972	−0.027	−0.011
	(1.041)	(1.033)	(0.331)	(0.334)
UE with MBA	−1.578	−1.463	−0.075	−0.077
	(1.039)	(1.023)	(0.326)	(0.327)
UE business experience	−0.351	−0.080	0.412	0.445
	(1.874)	(1.845)	(0.583)	(0.585)
Non-Executive Directors	1.239	1.151	−0.208	−0.175
	(1.014)	(0.997)	(0.317)	(0.320)
Corporate spinoff	−0.459	−0.377	0.153	0.152
	(0.459)	(0.454)	(0.143)	(0.144)
Alliances	4.657	4.600	2.220	2.186
	(3.340)	(3.311)	(2.732)	(1.733)
University Affiliation	−0.577	−0.425	−0.295*	−0.435**
	(0.716)	(0.733)	(0.166)	(0.174)
VC Backing	0.340	0.295	−0.213	−0.218
	(0.468)	(0.460)	(0.155)	(0.156)
Prone to IPO (IMR)	−0.028	0.131	1.187*	1.238*
	(2.316)	(2.278)	(0.719)	(0.721)
PRESTIGE-UNI	0.149**	0.160**	−0.055***	−0.062***
	(0.067)	(0.066)	(0.019)	(0.019)
PRESTIGE-SC	0.135**	0.168**	−0.049**	−0.053**
	(0.066)	(0.066)	(0.021)	(0.021)
PRESTIGE-VC	2.007***	2.005***	−0.623**	−0.621**
	(0.736)	(0.724)	(0.265)	(0.265)
PRESTIGE-UW	2.404**	2.830**	−0.683*	−0.546*
	(1.210)	(1.198)	(0.376)	(0.281)
PRESTIGE-UNI × PRESTIGE-SC	–	−0.037**	–	0.011**
		(0.015)		(0.005)

(*continued on next page*)

Table A8 (*continued*)

	(1)	(2)	(3)	(4)
	EV/sales	EV/Sales	Underpricing	Underpricing
PRESTIGE-UNI × PRESTIGE-VC	–	−24.033	–	−4.659
		(15.083)		(4.889)
PRESTIGE-UNI × PRESTIGE-UW	–	46.212	–	−1.389
		(38.299)		(1.059)
Constant	7.715***	8.006***	−0.768	−1.001
	(2.320)	(2.284)	(0.715)	(0.717)
Observations	254	254	254	254
R-squared	0.614	0.631	0.263	0.287
Adjusted R-squared	0.532	0.547	0.108	0.124

Table A9
VC Syndication.
OLS regression on Tobin's Q at the IPO. The specification adds the dummy variable VC Syndicate (equal to 1 if more than one VC is investing in the company) to the specification of Model (5) of Table 5. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. This model includes the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)
Firm size	−0.251***
	(0.057)
Age	−0.095
	(0.535)
Profitability	0.341**
	(0.144)
Leverage	0.460***
	(0.117)
Dilution ratio	0.195
	(0.326)
Participation ratio	1.047
	(1.165)
Patents	−0.088
	(0.152)
UE size	0.018
	(0.570)
UE with PhD	−1.926
	(1.466)

(*continued on next page*)

Table A9 (*continued*)

	(1)
UE with MBA	−1.932
	(1.436)
UE business exp.	0.097
	(2.561)
Non-Executive Directors	−2.226
	(1.399)
Corporate spinoff	0.214
	(0.629)
Alliances	5.493
	(4.236)
University Affiliation	−1.328
	(1.084)
VC Backing	−1.063
	(0.981)
Prone to IPO	−1.120
	(3.149)
PRESTIGE-UNI	0.376***
	(0.101)
PRESTIGE-SC	0.379***
	(0.094)
PRESTIGE-VC	3.144**
	(1.285)
PRESTIGE-UW	4.793***
	(1.761)
PRESTIGE-UNI × PRESTIGE-SC	−0.064***
	(0.021)
PRESTIGE-UNI × PRESTIGE-VC	−0.417
	(0.257)
PRESTIGE-UNI × PRESTIGE-UW	0.157
	(0.288)
VC Syndicate	0.263
	(0.304)
Constant	10.586***
	(3.138)
Observations	254
R-squared	0.460
Adjusted R-squared	0.333

Table A10

Differentiating by type of University Affiliation.

OLS regression on Tobin's Q at the IPO. In this model, the University Affiliation variable of Model (5) of Table (5) is replaced by University Affiliation-Equity and University Affiliation-Other, disentangling affiliation comprising an equity stakes from other cases. Likewise, PRESTIGE-UNI is replaced by PRESTIGE-UNI-Equity and PRESTIGE-UNI-Other, also in the interaction terms. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables. This model includes the Inverse Mills' Ratio (Prone to IPO - IMR) estimated in a first stage regression, where age, revenues, number of employees, time dummies, market and sub-industry dummies estimate the probability to go public (see Table A11). Controls for years, markets and sub-industries are included. Robust standard errors in parentheses. ***, ** and * represent statistical significance at 0.01, 0.05 and 0.10 respectively.

	(1)
Firm size	−0.274***
	(0.059)
Age	−0.012
	(0.544)
Profitability	0.318**
	(0.147)
Leverage	0.477***
	(0.119)
Dilution ratio	0.334
	(0.330)
Participation ratio	0.600
	(1.190)
Patents	0.056
	(0.154)
UE size	−0.015
	(0.586)
UE with PhD	−1.736
	(1.460)
UE with MBA	−2.127
	(1.487)
UE business exp.	0.817
	(2.618)
Non-Executive Directors	−2.008
	(1.440)
Corporate spinoff	0.255
	(0.634)
Alliances	−3.529
	(3.321)
University Affiliation-Equity	−1.111
	(1.349)
University Affiliation-Other	−0.536
	(1.148)
VC Backing	−0.757
	(0.732)

(*continued on next page*)

Table A10 (*continued*)

	(1)
Prone to IPO (IMR)	−0.659
	(3.200)
PRESTIGE-UNI-Equity	0.367***
	(0.101)
PRESTIGE-UNI-Other	0.197**
	(0.094)
PRESTIGE-SC	0.336***
	(0.100)
PRESTIGE-VC	3.065**
	(1.273)
PRESTIGE-UW	4.830***
	(1.763)
PR.-UNI-Equity × PRESTIGE-SC	−0.065***
	(0.021)
PR.-UNI-Equity × PRESTIGE-VC	−0.407
	(0.257)
PR.-UNI-Equity × PRESTIGE-UW	−0.175
	(0.289)
PR.-UNI-Other × PRESTIGE-SC	−0.062**
	(0.029)
PR.-UNI-Other × PRESTIGE-VC	−0.204
	(0.456)
PR.-UNI-Other × PRESTIGE-UW	−0.219
	(0.444)
Constant	9.475***
	(3.180)
Observations	254
R-squared	0.390
Adjusted R-squared	0.308

Table A11
Auxiliary regressions.

Model (1) is the first-stage regression in the Heckman selection model employed to estimate the Inverse Mills' Ration (IMR – Prone to IPO), as included in Model (1) of Table 5. This model estimates the probability to go public for the firms in our samples, combined with a random sample of 254 private biotech firms that did not go public between 1990 and 2009 but were similar to the companies in our sample according to nearest neighbor propensity scores based on country dummies, industry dummies, size (total assets) and age. This first stage regression is estimated for all models in other tables. Model (2–4) are the Probit/OLS regressions for *VC Affiliation*, *PRESTIGE-VC* and *PRESTIGE-UW*. Residuals are employed in Model (1) of Table 5. These regressions are estimated for all models in other tables. *VC Affiliation* are the residuals after regressing the variable against *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-VC* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, country and year control variables; *PRESTIGE-UW* are the residuals after regressing the variable against: *University affiliation*, *PRESTIGE-UNI*, *PRESTIGE-SC*, *VC Backing*, *PRESTIGE-VC*, country and year control variables.

	(1) Probability to go public	(2) VC Affiliation	(3) PRESTIGE-VC	(4) PRESTIGE-UW
Firm size (total assets)	0.057***	–	–	–
	(0.018)			
Age	−0.029***	–	–	–
	(0.006)			
Number of employees	0.223***	–	–	–
	(0.092)			

(*continued on next page*)

Table A11 (*continued*)

	(1) Probability to go public	(2) VC Affiliation	(3) PRESTIGE-VC	(4) PRESTIGE-UW
University Affiliation	–	0.047**	0.075**	0.037*
		(0.022)	(0.035)	(0.020)
PRESTIGE-UNI	–	0.140***	0.090***	0.040**
		(0.031)	(0.027)	(0.018)
PRESTIGE-SC	–	0.118***	0.018***	0.033***
		(0.026)	(0.005)	(0.010)
VC Backing	–	–	–	−0.007
				(0.032)
PRESTIGE-VC	–	–	–	0.073***
				(0.015)
Constant	0.032	−0.228**	−0.014	0.008
	(0.359)	(0.115)	(0.024)	(0.017)
Observations	508	254	254	254
(Pseudo) R-squared	(0.098)	(0.120)	0.147	0.149
Adjusted R-squared	–	–	0.116	0.117

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