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CEO education and the ability to raise capital

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Abstract

Research Question/Issue: Using a unique hand-collected dataset, this study examines the role of chief executive officer (CEO) educational attainments in relation to newly public firms.

Theoretical/Academic Implications: Using human capital, institutional and upper echelon theories, we hypothesize and demonstrate that CEO educational attainments do not unambiguously affect investors' perceptions of a firm's future prospects. Instead, their influence depends on the quality of CEO education as well as on the degree of uncertainty regarding the firm's future performance and the level of information asymmetry between issuers and prospective investors. To our knowledge, this is the first study that provides a comprehensive treatment of the role of CEO education in the IPO context.

Research Findings/Insights: We find that initial public offering (IPO) firms led by CEOs with superior educational credentials—in terms of level and quality—are associated with lower levels of IPO underpricing. This association is mainly driven by CEOs that hold advanced degrees. Notably, a difference-in-differences approach based on two quasi-natural experiments indicates that the impact of CEO education on IPO underpricing is more pronounced within environments characterized by lower information transparency. The baseline results also hold in the longer term, thereby confirming the value of signaling prestigious academic awards at the time of the IPO.

Practitioner/Policy Implications: Our evidence on the importance of CEO education, and especially that CEOs with varying levels and quality of educational training might differentially affect newly listed firms, is useful to providers of financial capital and boards of directors interested in assessing the viability of new ventures. The implication of our study for IPO investors is that it is worth paying more to take an equity position in firms run by better educated CEOs.

KEYWORDS

corporate governance, CEO education, initial public offerings, post-IPO performance, signaling

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1 | INTRODUCTION

Does it pay to invest in higher education? Numerous studies have extensively examined the effect of education on a variety of organizational outcomes such as innovation and strategic change (Barker & Mueller, 2002), mergers and acquisitions (Wang & Yin, 2018), and financial performance (Bennedsen, Perez-Gonzalez, & Wolfenzon, 2020; Chevalier & Ellison, 1999; King, Srivastav, & Williams, 2016; Li, Zhang, & Zhao, 2011; Miller, Xu, & Mehrotta, 2015). Yet only a few studies have explicitly focused on young, fast-growing, entrepreneurial organizations (Chemmanur & Paeglis, 2005; Cohen & Dean, 2005; Colombo, Meoli, & Vismara, 2019; Higgins & Gulati, 2006), and none in this context have examined in detail the role of the education of the chief executive officer (CEO), despite its potential significance in shaping corporate vision and organizational policies.

In this study, we explore the role of CEO academic achievements on the most notable entrepreneurial setting, namely, initial public offerings (IPOs). The IPO market represents a vital asset for the aggregate economy, given its role in facilitating entrepreneurship, job creation, and sustainable growth (Butler, Fauver, & Spyridopoulos, 2019; Doidge, Karolyi, & Stulz, 2013; Fama & French, 2004). In addition, the IPO constitutes a major development in the evolution of an entrepreneurial firm's life, because it provides substantial financial resources to support navigation of the transition from the private domain to the public arena (Certo, 2003).

However, investing in IPOs can be an especially risky proposition (Field & Lowry, 2009). Rather than mature firms, IPOs typically involve young companies, many with short operating histories and/or negative earnings when they go public (Cohen & Dean, 2005; Higgins & Gulati, 2006). Therefore, they are especially vulnerable to market speculation about their long-term prospects and their capacity to operate in the public domain (Cohen & Dean, 2005; Higgins & Gulati, 2006). In this turbulent environment, the major challenge for IPO issuers is to persuade external parties that their company represents a rational economic investment (Cohen & Dean, 2005).

How might CEO education influence IPO success? The extant literature demonstrates that CEO education provides access to scarce resources in at least three nonexclusive ways: (1) advanced degrees from stellar institutions can be an indicator of a CEO's unobservable talent, intellect, and capability to persevere in a challenging environment, because such institutions are very selective and have stringent entry requirements (Certo, 2003; Miller et al., 2015; Wally & Baum, 1994); (2) higher or better quality educational training can potentially enhance an individual's knowledge, skills, perspective, and ability to understand technical and abstract concepts (Bai, Tsang, & Xia, 2018)[1]; (3) higher education, especially from reputable institutions, might also be an indicator of a greater depth and quality of social networks acquired in college and graduate school (Colombo et al., 2019; Datta & Iskandar-Datta, 2014).

In light of the above, it can be argued that prestigious educational credentials (i.e., higher degrees from selective universities) provide access to scarce human and social capital (Barney, 1991; D'Aveni, 1990). Building on this resource-based perspective, we argue that CEO education might enhance a firm's performance by playing a substantive role and, possibly, a signaling role.

In terms of the substantive role, previous studies posit that CEOs that hold advanced degrees from selective institutions can convey the intrinsic value of their firm more credibly to outsiders (Chemmanur & Paeglis, 2005; Chemmanur, Paeglis, & Simonyan, 2010). This certification effect may occur because CEOs with prestigious educational credentials have greater inherent communication abilities or better access to networks of financial intermediaries, both of which lower information acquisition costs for outsiders. It may also occur because such managers are more likely to price their equity fairly because they have significant reputations at stake. Likewise, better educated managers should be able to select better projects and implement them more ably, which, in turn, leads to a larger scale of investment at equilibrium and better operating performance (Amore, Bennedsen, Larsen, & Rosenbaum, 2019; Chemmanur, Kong, Krishnan, & Xu, 2019). As for the signaling role, several scholars argue that, in addition to the concrete resources that well-educated individuals may provide to a firm, their (educational) background fulfills a signaling function that can influence investors' perceptions of the firm's prospects in several ways (e.g., Cohen & Dean, 2005; Colombo et al., 2019; Lester, Certo, Dalton, Dalton, & Cannella, 2006; Zimmerman, 2008). For instance, it is possible that investment bankers, as well as informed and uninformed investors, consider CEO educational credentials when deciding which equity issues to underwrite and financially support, respectively (Chemmanur & Paeglis, 2005; Colombo et al., 2019).

Collectively, we anticipate that CEO education affects newly listed firms either through substantive actions or by performing a signaling role; yet these functions have similar implications for IPO underpricing because both help to reduce uncertainty and information asymmetry in a firm's external environment. Therefore, if academic achievements enhance recognition and visibility of the IPO firm in the eyes of potential investors, then firms with better educated CEOs need to exert less effort to stimulate or maintain investor demand for their shares. In this regard, such firms would be subject to lower pressure to discount their IPO subscription price, which, in turn, translates to less money being "left on the table."

Nevertheless, we do not expect that all forms of education will be equally valuable to a firm's performance and, hence, to the eyes of potential investors. Instead, we predict that the benefits stemming from CEO education will be more pronounced among individuals with advanced degrees and/or degrees from elite institutions because, in these cases, CEOs are more likely to be associated with superior levels of knowledge, skills, cognitive complexity, training, intellectual capacity, and access to social networks (e.g., Miller et al., 2015; Zimmerman, 2008). Perhaps, most importantly, we anticipate that the uncertainty-reducing and value-enhancing benefits of CEO education around IPOs will be strongest in environments characterized by low transparency, that is, among firms that are more likely to suffer from uncertainty and information asymmetry between insiders and

outsiders in the equity market (Chemmanur et al., 2010; Colombo et al., 2019; Stuart, Hoang, & Hybels, 1999).

To explore the above hypotheses, we carefully construct a unique hand-collected dataset that captures CEO educational qualifications in relation to 1,601 US IPOs during the period 2000–2016. We categorize each academic qualification according to the level of training, namely, whether it is at undergraduate (BSc or BA), master's (MSc, MA, or MBA), or doctoral (PhD, JD, or MD) level, and identify the awarding institution in the US News & World Report 2017 rankings (USNWR) in order to determine whether it was obtained from a prestigious (i.e., Top 20) school (Bhagat, Bolton, & Subramanian, 2010; King et al., 2016).[2]

To determine whether CEO educational attainments matter in IPOs, we exploit the properties of our dataset and develop a CEO education index comprising three factors: undergraduate education (constituting a basic undergraduate level of training that aids the development of transferable skills), master's education (representing the level of technical or management training and knowledge acquired through more specialized degrees), and doctoral education (indicating a level of technical expertise obtained through an advanced degree or doctorate). Factor analysis is particularly suitable because it can mitigate issues arising from subjective research judgments such as the relative importance of each educational dimension (i.e., level and quality) and other measurement issues (Custodio, Ferreira, & Matos, 2013; King et al., 2016; Tetlock, 2007).

We examine whether CEO educational awards enhance the ability of a firm to raise capital effectively by focusing on the market's initial response to the company's stock offering, measured as the change in the stock price during its first day of trading. This difference, known as "underpricing," is a widely used metric of IPO success: a low value indicates that the firm was able to raise more capital through its IPO in relative terms (Certo, Daily, & Dalton, 2001; Higgins & Gulati, 2006).

In line with our hypotheses, we find that our three CEO education factors are negatively associated with IPO underpricing. Interestingly, this link is strongest for advanced degrees. To get a feeling of the economic magnitude involved, a one-standard-deviation increase in the doctoral factor is associated with a 1.56% decrease in IPO underpricing. Most notably, by resorting to a difference-in-differences approach, we exploit two "natural" experiments—the introductions of the Sarbanes–Oxley (2002) and JOBS (2012) Acts—that exogenously affected firms' information environments and show that the impact of CEO education on IPO underpricing is strongest among firms suffering from the greatest information asymmetry problems.

An important issue in relation to our sample is the need to control for endogenous firm–CEO matching, whereby we acknowledge that the assignment of a particular CEO to a particular firm is not random. This recognition is motivated by the assortative matching literature, which describes a two-sided matching process in which managers and firms select one another, leading to strong relationships between the characteristics of a firm and those of its CEO (e.g., Gabaix & Landier, 2008). Such forms of matching may involve, for example, more talented CEOs being sorted competitively into firms with better prospects (Tervio, 2008), or executives with stronger educational credentials commanding greater value in the labor market, thereby being in a better position to self-select into the most viable IPO firms (Rivera, 2012). Alternatively, a firm–CEO match may be determined in part by the risk preferences of the firm and/or the CEO (Blankerspoor, Hendricks, & Miller, 2017).

Our econometric framework accounts for endogenous firm–CEO matching by adopting an instrumental variable (IV) analysis method, in which the first stage predicts the probability of a firm being able to hire a manager with a given educational background. Specifically, we follow Chemmanur et al. (2019) and instrument for CEO quality (as measured by our three education factors) using a plausible exogenous shock to the supply of top executives available for hire by a firm, namely, the number of acquisitions in the industry and the (U.S.) state of the sample firm in the 5 years before, weighted by an index measuring the enforceability of noncompete clauses in that state. Our second-stage results show that our baseline inferences remain unchanged.

Last, our results also hold in the post-IPO period. Our analysis of long-run investment and operating performance reveals that the companies of CEOs with prestigious educational degrees outperform those of CEOs without such degrees. These results are important because they confirm the signaling value of CEO education. This finding is supportive of a separating equilibrium, given that a necessary equilibrium condition is satisfied, in which investors are willing to pay extra for firms run by well-educated CEOs at the time of the IPO, because these firms outperform others in the long run.

This study contributes to the literature in various ways. Prior studies on the link between CEO education and organizational outcomes have mostly explored the potential substantive benefits for large, established firms (e.g., Barker & Mueller, 2002; Beber & Fabbri, 2012; Bhagat et al., 2010; Chevalier & Ellison, 1999; Fedaseyeu, Linck, & Wagner, 2018; Gottesman & Morey, 2006; Hitt, Bierman, & Shimizu, 2001; King et al., 2016; Wang & Yin, 2018). By focusing on newly listed firms, we demonstrate that the benefits of CEO educational achievements extend to the IPO context, because these awards seem to materially affect a firm's ability to raise capital in the primary equity market. Moreover, we suggest that, in addition to providing concrete resources, prestigious CEO educational credentials may serve a vital signaling function, because our findings indicate that it is worth paying more to take an equity position in the IPO of firms run by well-educated CEOs. Thus, we extend and complement the extant literature by providing a more complete picture of the role of CEO education in corporations.

Our study is also closely related to the IPO underpricing literature, where prior research has largely focused on disclosures related to firm-specific characteristics, outside parties, and/or human capital (Carter & Manaster, 1990; Certo, 2003; Megginson & Weiss, 1991). In this respect, our work is closely related to a series of studies that examine the relationship between the quality of a firm's top management team and various aspects of its IPO performance (e.g., Chemmanur & Paeglis, 2005; Zimmerman, 2008). While these studies indicate that IPO investors appear to reward firms with well-educated managers, they

focus on the role of specific degrees (such as MBAs; see Chemmanur & Paeglis, 2005) and pay limited attention to the CEO, the individual who is most responsible for shaping corporate vision and future strategies (Hambrick & Mason, 1984). We complement this work by providing a comprehensive treatment of CEO educational degrees—in terms of both level and quality—and by documenting a heterogeneous impact for the educational backgrounds of CEOs among firms with differing levels of information transparency.

The paper continues as follows: Section 2 presents a brief background to the role of CEO education and discusses our hypothesis development, Section 3 introduces the dataset and gives an overview of the methodology, and Section 4 reports the descriptive statistics and empirical findings in relation to the impact of CEO educational attainments on underpricing. Sections 5 and 6 provide details of the battery of tests conducted to check the robustness of the results, while Section 7 presents several additional tests on the effect of CEO academic qualifications on IPOs, and Section 8 concludes the paper.

2 | THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

In this section, we describe how CEO academic credentials influence the decision-making process that investors use when purchasing shares of firms undertaking IPOs. We begin by briefly discussing how a CEO's educational background might affect the success of an IPO. Next, we analyze how the substantive role of CEO education, alongside the signaling one, might enhance a firm's ability to raise capital in the equity market. Finally, we consider whether the effect of CEO education varies between environments characterized by different degrees of information transparency.

2.1 | The information content of qualitative disclosures around IPOs

The IPO is a watershed event. It provides the firm with a substantial cash infusion to support navigation of the transition from the private domain to the public arena (Certo, 2003). But it also constitutes the very first interaction of a private firm with financial markets, and as such, its success is largely determined by the information conditions that characterize this event (Barth, Landsman, & Taylor, 2017; Chaplinsky, Hanley, & Moon, 2017; Colombo et al., 2019; Sundaramurthy, Pukthuanthong, & Kor, 2013). This suggests that private firms going public should be as transparent as possible (Welbourne & Cyr, 1999). To this end, firms undertaking an IPO must prepare a registration statement (S-1) that includes the firm's prospectus (Lowry, Michaely, & Volkova, 2017).

While the informational content of the IPO prospectus is widely acknowledged, the financial disclosures contained in this document only reduce the information asymmetry between insiders and outsiders to a limited extent (Hanley & Hoberg, 2010; Loughran & McDonald, 2013). Hence, despite the mandatory disclosure of certain financial and strategic information in the registration filings, an IPO can still by characterized by the condition of incomplete and asymmetrically distributed information, wherein potential investors possess substantially inferior knowledge in relation to a management's underlying motives and a firm's long-term prospects (Beatty & Ritter, 1986; Cohen & Dean, 2005; Colombo et al., 2019; Hanley & Hoberg, 2010; Loughran & McDonald, 2013; Lowry et al., 2017; Ritter & Welch, 2002; Rock, 1986).[3]

Given that objective indicators of quality are limited or not readily available, investors, when valuing IPOs, are likely to turn their attention to secondary sources of information to help identify qualitative differences between firms (Certo, 2003; Cohen & Dean, 2005; Higgins & Gulati, 2006; Park, Borah, & Kotha, 2016; Zimmerman, 2008). Specifically, because of the limited records of performance, it is conceivable that, in addition to relying on traditional indicators of firm quality (such as accounting-based disclosures), potential IPO investors may resort to nonaccounting disclosures in order to address specific concerns about corporate quality or the risks a company may face that are otherwise unobservable.

Consistent with such reasoning, the literature documents that markets may rate firms based on a wide variety of IPO prospectus nonfinancial disclosures (if the latter are perceived to be correlated with unobservable actions and attributes), thereby alleviating concerns related to both adverse selection and moral hazard. These disclosures typically include a firm's corporate governance structure (Certo et al., 2001; Certo, Daily, Cannella, & Dalton, 2003; Chahine & Filatotchev, 2008; Sanders & Boivie, 2004), its founder status (Nelson, 2003), the experience and functional background of its top executives (Cohen & Dean, 2005; Higgins & Gulati, 2006; Lester et al., 2006; Zimmerman, 2008), prominent affiliations with prestigious institutions (Colombo et al., 2019), certification by top auditors (Beatty, 1989), and certification by prestigious underwriters or venture capitalists (Krishnan, Ivanov, Masulis, & Singh, 2011; Loughran & Ritter, 2004).

2.2 | How a CEO's educational background might affect the success of an IPO

A common theme of the aforementioned studies is that investors may assess corporate quality by examining qualitative (i.e., nonaccounting) disclosures of the IPO prospectus. In a similar vein, several studies show that the prestige associated with the educational background of a firm's upper echelons is favorably associated with the stock market's valuation of the newly public firm (e.g., Certo et al., 2001; Chemmanur & Paeglis, 2005; Cohen & Dean, 2005; Colombo et al., 2019; Higgins & Gulati, 2006; Lester et al., 2006; Zimmerman, 2008).[4]

While this line of research indicates that investors appear to reward firms that have high levels of educational prestige, it primarily focuses on the board of directors or the top management team, thus neglecting the role of the CEO—the most influential and most visible executive member (Hambrick & Mason, 1984). Importantly, it does not provide a comprehensive treatment of the role of executives'

education, because it fails to consider how different facets of educational training might differentially affect IPO performance.

In this study, we attempt to address this gap by developing a more refined understanding of educational credentials and the ways in which different types of educational degrees may enhance an entrepreneurial firm's visibility and ability to attract the attention of financial supporters. In particular, we conceptualize CEO educational prestige along two dimensions of quality: the level of education and the reputation of the awarding institution.

Accordingly, we argue that executive (CEO) education provides access to scarce resources in at least three mutually nonexclusive ways. First, higher degrees from stellar institutions can be an indicator of a CEO's unobservable but influential talent, intellect, and capability to persevere in a challenging activity, because such institutions are highly selective and have very tough entry requirements (Certo, 2003; Miller et al., 2015; Wally & Baum, 1994). Second, higher or better quality educational training has the potential to enhance an individual's knowledge, skills, perspective, and ability to understand technical and abstract concepts (Bai et al., 2018). Third, higher education, especially involving reputable institutions, might also indicate a greater depth and quality of social networks acquired in college and graduate school (Colombo et al., 2019; Datta & Iskandar-Datta, 2014).

Therefore, it can be argued that prestigious educational credentials provide access to scarce human and social capital (Barney, 1991; D'Aveni, 1990). Building on this resource-based perspective, we hypothesize that an executive's education might enhance a firm's performance through two main channels: one involving a substantive role and the other a signaling role.

2.2.1 | The substantive role of CEO education in relation to IPOs

In terms of the substantive role, Chemmanur and Paeglis (2005) and Chemmanur et al. (2010) posit that the quality and reputation of a firm's management can have a certifying effect on corporate value. Thus, to the extent to which prestigious educational credentials reflect ability and reputation, it follows that better educated managers can convey the intrinsic value of their firm more credibly to outsiders, thus reducing the information asymmetry associated with the firm in the equity market.

This may occur because of the management's inherent abilities and/or through exploitation of social ties with financial intermediaries or other influential capital market players. As a consequence, investment bankers, institutional investors, and/or financial analysts will incur lower costs in producing information concerning firms with better educated CEOs. This certification effect may also occur because holders of prestigious educational degrees have a significant reputation at stake. In this case, they will not take the risk of overpricing or "hyping" their stock (or deceiving the financial markets in other ways), which, in turn, implies that they will price their equity more fairly.

Besides the importance of education in certifying corporate value, it is possible that well-educated managers are able to select better projects and implement them more ably (before and after the IPO). This means that, to the extent that CEOs holding higher degrees and/or degrees from more selective institutions are higher quality managers, they are likely to have a larger scale of investment at equilibrium and better (post-IPO) operating performance (Chemmanur et al., 2010, 2019; Chemmanur & Paeglis, 2005). This is consistent with various studies that show executives' education to be associated with a series of outcomes that may enhance sustainable performance, such as more innovation (Chemmanur et al., 2019; Chemmanur, Gupta, & Simonyan, 2020; Wiersema & Bantel, 1992), more sustained investment in a firm (Bertrand & Schoar, 2003), a greater focus on corporate social responsibility activity (Amore et al., 2019), and a facility to make more valuable alliances (Palmer & Barber, 2001).

2.2.2 | The signaling role of CEO education in relation to IPOs

As already discussed, given the uncertainty at the time of an offering, IPO issuers must persuade potential stakeholders that a firm is able to respond to the rigors and pressures of public scrutiny and shareholder value (Arthurs, Hoskisson, Busenitz, & Johnson, 2008; Zimmerman, 2008). To this end, well-educated CEOs may seek to influence investor perceptions by actively engaging in a series of actions, ranging from certifying their firm's value to identifying and implementing value-enhancing investment projects ahead of the IPO.

While this reasoning suggests that better educated managers can reduce adverse selection costs for potential IPO investors, because of their active involvement in the IPO price-discovery process and value-enhancing projects, it is possible that a CEO's educational background can also influence investors' perceptions of managerial and corporate quality regardless of its substantive role. In fact, several scholars in the management literature argue that, in addition to the concrete resources that well-educated (influential) individuals may provide to a firm, the characteristics of their background can also serve a signaling function that can influence organizational performance (e.g., Cohen & Dean, 2005; Colombo et al., 2019; Lester et al., 2006; Zimmerman, 2008).

CEO educational disclosures can affect investors' perceptions in several ways. It is possible, for instance, that informed investors (institutional investors and venture capitalists) and financial intermediaries (investment bankers) consider CEO educational credentials when deciding which equity issues to financially support and underwrite, respectively (Chemmanur & Paeglis, 2005; Daily, Certo, & Dalton, 2005). At the same time, uninformed (retail) investors may exhibit an increased reliance on secondary sources of information, such as the top executive's background, because, compared with informed investors, they typically lack the sophistication to properly analyze higher risk ventures or the access to direct channels of communication with IPO issuers (Colombo et al., 2019).

In either case, the literature regards the disclosure of executives' educational background as a valid signal of quality because it satisfies two important conditions: it is observable, and it is costly to imitate

(Spence, 1973, 1974). Because a firm undertaking an IPO must disclose executive biographical information in its prospectus, all potential investors are able to observe a CEO's academic achievements prior to the IPO. In addition, the resources obtained from formal education can be costly or difficult to imitate (Chemmanur & Paeglis, 2005; Spence, 1973, 1974). This is particularly the case for individuals with advanced degrees and/or who graduated from elite institutions (Miller et al., 2015). Thus, it is arguable that CEO educational credentials enhance the recognition and visibility of an IPO firm in the eyes of potential investors.

2.2.3 | The link between CEO education and IPO underpricing

The preceding discussion suggests that CEO education helps to reduce uncertainty and information asymmetry in a firm's external environment, either through substantive action or by performing a signaling role (or both). If firms undergoing an IPO with better educated CEOs are favorably perceived by investors, they need exert less effort to stimulate or maintain investor demand for their shares. In this respect, they would be subject to relatively less pressure to discount the IPO subscription price (the fixed pre-IPO price for insiders and investment banks).

Lower discounting implies that the final offering price more closely reflects the secondary market (first-day closing) price. Therefore, firms run by CEOs with prestigious degrees could be expected to exhibit lower underpricing than their counterparts. Underpricing is of particular concern to an entrepreneur undertaking an IPO because it represents money "left on the table," that is, money that accrues to initial investors in an IPO rather than the initial owners of the IPO (Daily et al., 2005). Furthermore, underpricing represents a form of cost of capital; it is a proxy for information uncertainty and is critical to the issuing firm, because a smaller gap between the offer and market prices indicates that a firm has captured more of the value added during the IPO process (Lowry et al., 2017). Higher amounts of capital raised in an IPO are a key source of funding for the pursuit of higher risk growth opportunities (Sundaramurthy et al., 2013).

Nevertheless, we do not expect all forms of CEO education to be equally valuable to a firm's performance and hence to the eyes of potential investors. The benefits stemming from education vary according to the level of an academic degree and the quality of the awarding institution: managers with advanced degrees and/or degrees from elite institutions are associated with superior levels of knowledge, skills, cognitive complexity, training, and intellectual capacity, as well as better access to social networks (e.g., Miller et al., 2015; Zimmerman, 2008). Thus, we expect investors to require a lower valuation discount from firms run by CEOs that have advanced degrees and/or have graduated from prestigious universities. More formally, we hypothesize:

H1. Better CEO education—in terms of level and quality—is associated with lower levels of IPO underpricing.

2.3 | Does CEO education affect all IPO issuers equally?

Our central hypothesis is that better CEO education should be favorably perceived by IPO investors because of its potential to reduce uncertainty and enhance value. However, we do not expect these effects to be homogeneous for all firms undergoing an IPO.

Prior studies show that the substantive (i.e., the certifying and value-enhancing) effect of more able and more reputable managers is particularly important for firms that are likely to suffer from significant information asymmetry in the equity market (Chemmanur et al., 2010, 2020; Chemmanur & Paeglis, 2005). Therefore, to the extent that better educated managers are more capable and more reputable than their counterparts, the substantive benefits of their education should be more visible among firms that have less information available. In a similar spirit, several scholars argue that the signaling effect of education is more pronounced in environments characterized by low transparency (Colombo et al., 2019; Lester et al., 2006; Stuart et al., 1999). Based on this reasoning, we hypothesize that the signaling effect (either positive or negative) of the IPO disclosure of an executive's educational background is also likely to be stronger when less information is available:

H2. The negative relationship between better CEO education and lower levels of underpricing is more pronounced in environments characterized by lower transparency.

3 | DATA FORMATION PROCEDURE

Our data consist of three parts: IPO selection criteria, accounting and financial data, and educational data for the CEO. We start by retrieving the population of IPOs that have been floated on U.S. exchanges during the period 1 January 2000 to 31 December 2016 from the Global New Issues database of Thomson Financial's Securities Data Company (SDC). The SDC database is also employed for the collection of the offering characteristics. Consistent with the literature (e.g., Farag, Mallin, & Ow-Yong, 2014; Loughran & Ritter, 2004; Lowry et al., 2017), we apply standard IPO filters to exclude foreign issues, unit offerings, reverse leveraged buyouts (LBOs), spinoffs, closed-end funds, real-estate investment trusts (REITs), royalty trusts, financial institutions, limited partnerships, and American depositary receipts (ADRs), as well as all IPOs with a filing price below $5. This process yields 1,750 IPOs and is summarized in Table 1.

The remaining sample is merged with the databases of Compustat and the Center for Research in Security Prices (CRSP), from which we obtain accounting and market data, respectively. In the next step, we rely on the SEC's Electronic Data Gathering Analysis and Retrieval system (EDGAR) to manually retrieve S-1 filings of all IPOs and create a list of associated CEOs, that went public during our sample period. In doing so, we follow a conservative approach and discard firms with co-CEOs (10 cases), firms without nominated CEOs (128 cases), and firms with no S-1 filings available on EDGAR (11 cases).

TABLE 1 Sample selection procedure

Description and criteria	Firms
Initial sample (SDC data, 2000–2016)	3,202
Less real-estate investment trusts (REITs), unit offerings, closed-end funds, foreign issues, royalty trusts, limited partnerships, spinoffs, reverse leveraged buyouts (LBOs), and American depositary receipts (ADRs)	(1,192)
Less financial institutions	(169)
Exclude firms with offer prices below $5	(91)
Total observations before excluding firms without nominated CEOs, with co-CEOs, or missing S-1 filings	1,750
Exclude firms without nominated CEOs	(128)
Exclude firms with co-CEOs	(10)
Exclude firms with missing S-1 filings	(11)
Final sample	1,601

Based on the resulting CEO list, we extract CEO biographical information (age, gender, and tenure) and data about the CEO's educational background (i.e., information on the types of degrees held—undergraduate, MBA, or doctorate—and the awarding institutions) from S-1 filings or IPO prospectuses (424B filings). Hand-collecting education data from IPO prospectuses are extremely cumbersome because there is no standard format for reporting this type of information. For illustrative purposes, Section A1 of the Internet Appendix (see Supporting Information section on the journal website) provides two examples of such disclosures. To ensure the quality of our dataset, we also carefully hand-check our data on educational attainments against BoardEx of Management Diagnostics Limited and supplement our dataset where necessary.[5] Our final sample consists of 1,601 IPOs with complete financial, accounting, and educational data.

3.1 | Measurement of educational variables

As already mentioned, we rely on IPO prospectuses and executive profiles provided by BoardEx to populate the educational data pertaining to our universe of firms. For each CEO, we collect several educational institution characteristics. We begin by identifying each degree according to its level: undergraduate, master's, or doctoral. We also record the name of the institution that the CEO attended, recognizing distinctions within schools (for example, the University of California at Berkeley is coded differently from the University of California at Los Angeles). Utilizing the name of the educational institution for each degree permits us to differentiate the quality among schools using the prestigious US News & World Report rankings (USNWR).

The USNWR scores and ranks each school according to a variety of factors, including peer assessment, retention, faculty resources, student selectivity, financial resources, graduation rate, and alumni giving rate.[6] Based on the USNWR rankings, we identify top-quality awarding institutions as those ranked in the Top 20 list (i.e., those with a Top 20 designation among National Universities or Liberal Arts Colleges).[7]

3.1.1 | A three-dimensional CEO education index

One way to assess the role of CEO education in the IPO setting is to simultaneously consider in the same regression all levels of education as well as the quality of the awarding institutions. However, this approach is subject to measurement issues because of the high intercorrelation of our educational variables. Another method would be to construct a weighted average index of education; however, such a measure introduces bias from the subjective judgment associated with the potential arbitrariness of assigning weights to each category of education (Tetlock, 2007).

In light of the above, factor analysis could be used to develop a composite measure of education based on the common variance of our education-based variables (Tetlock, 2007). The intuition underlying this approach is that our six educational variables (three for each level of degree and three for the quality of the corresponding awarding institution) represent a fundamental construct (or latent variable). Importantly, this method mitigates issues arising from multicollinearity and subjective research judgments (Custodio et al., 2013; Kaplan, Klebanov, & Sorensen, 2012).

Prior work confirms the application of factor analysis techniques in similar contexts. For example, Custodio et al. (2013) employ factor analysis to constitute a composite measure of general CEO ability based on prior work experience and show that it is a reliable predictor of executive compensation. Falato, Li, and Milbourn (2015) develop an index of CEO ability based on reputational, career, and educational credentials and find that it reliably predicts executive pay and performance differences. Similarly, Kaplan et al. (2012) assess interview transcripts of potential CEO candidates and show that a factor solution identifies CEO ability based on three dimensions that capture overall CEO talent, communication and interpersonal abilities, and execution skills. Florackis and Sainani (2018) develop a CFO "resistance" index by using CFO financial expertise as a component and find that "strong" CFOs hold less cash. Finally, King et al. (2016) exploit information about the level and quality of education of CEOs in the U.S. banking sector and develop an education index comprising three factors: undergraduate education, MBA education, and PhD education; the authors offer robust evidence that banks led by CEOs with MBAs awarded by prestigious universities outperform their peers.

In the spirit of these studies, we employ factor analysis to extract an underlying structure from the variance–covariance matrix of our six educational categories. As noted, factor analysis takes into account the total variance of each educational variable and groups them into broader factors according to their common variance. These factors share a common core and likely represent an economic association for what they collectively represent.

Table 2 reports the factor solution for our CEO education index. Specifically, factor analysis yields a three-dimensional CEO education index (undergraduate, master's, and doctoral) based on the common variance of the level and quality of CEO degrees. These factors capture 69.0% of the total variance. Each factor represents a linear combination of variables that accounts for more variance of the data than any other possible combination. The factor loadings for each

TABLE 2 CEO education index—factor analysis

	Factor 1	Factor 2	Factor 3
	Doctoral education	Master's education	Undergraduate education
Level of education			
Undergraduate degree			0.630
Master's degree		0.576	
Doctoral degree	0.515		
Quality of education			
Undergraduate-TOP20			0.672
Master's-TOP20		0.578	
Doctoral-TOP20	0.739		
Model statistics			
Eigenvalue	1.841	1.419	1.181
% variance explained	0.285	0.230	0.175
Cumulative % variance explained	0.285	0.515	0.690

Note: This table reports analysis of the first three factors based on six educational characteristics (three for the level of education and three for the quality of the awarding institutions) for 1,601 observations in our sample from 2000 to 2016. Factor loadings are presented after a normalized orthogonal varimax rotation. Factor loadings with absolute values below 0.5 are blank. The factors have been sorted according to the percentage of variance explained.

variable of the three factors indicate the correlation of each variable with the broader factor and indicate the contribution of each variable in defining that factor.

The first factor, representing 28.5% of the variation, is a combination of two key variables, the level and quality of doctoral degree (PhD, MD, or JD). Hereafter, we use the term *Doctoral Education* to refer to this first factor and interpret it as indicating the technical expertise of a CEO as acquired through a doctoral degree. The next factor loads significantly on two key items, the level and quality of master's education (MBA, MSc or MA), and represents 23.0% of the total variation. This factor reflects the general management knowledge and training of a CEO as acquired through an MBA. It also represents technical skills acquired from advanced but less management-oriented degrees. Hence, we interpret this factor as measuring *Master's Education*. Similarly, the last factor represents *Undergraduate Education* because it loads significantly on two variables, the level and quality of undergraduate degree (BA or BSc).

We follow Tetlock (2007), Kaplan et al. (2012), and King et al. (2016) in using these factor loadings to predict factor scores for each of our three factors. The factor score is a standardized value that is computed using all of the variables, with their respective influence based on these factor loadings. Factor analysis helps in first deriving the structure of our multidimensional CEO education index construct, which lays the conceptual foundation, and we then use this factor solution to assess the relationship between CEO education and IPO underpricing.

A good example of a CEO in our sample with a high doctoral education factor is Michael M. Wick, CEO of Telic Inc., who was awarded a PhD by Harvard University and has a doctoral education factor score of 1.955. By contrast, Paul L. Foster, CEO of Western Refining Inc., has no doctoral qualifications and his doctoral education factor score is −0.685. Another example, illustrating differences in the score of the master's education factor, can be found by comparing Kenneth E. Westrick, CEO of New Focus Inc., and Nathan Stasko, CEO of Novan Inc. Kenneth E. Westrick has an MBA from Stanford University and a master's education factor score of 1.373, while Nathan Stasko has a master's degree from a non-Top 20 U.S. institution and a master's education factor score of −1.473. Finally, one can obtain a better understanding of the undergraduate education factor by considering the following example: Lance Fors, CEO of Third Wave Technologies Inc., has an undergraduate degree from the University of California at Berkeley and has an Undergraduate Education factor score of 1.205, while Paul F. Truex, CEO of Athera Pharmaceuticals, has an undergraduate degree from a non-Top 20 U.S. institution and an undergraduate education factor score of −0.947.

3.2 | Research design

To examine the effect of CEO education on IPO pricing, we estimate the following model:

$$\begin{aligned} Underpricing = {} & \alpha + \beta_1 CEO\ Education\ Factors + \beta_2 Control\ Variables \\ & + Industry\ Fixed\ Effects + Year\ Fixed\ Effects + \varepsilon, \end{aligned} \quad (1)$$

where the variable *CEO Education Factors* refers to each of the three CEO educational factors (i.e., undergraduate education, master's education, and doctoral education). IPO *Underpricing* represents the first-day returns and is estimated as the percentage difference between the immediate aftermarket price and the IPO offer price. It is apparent that a small discount (i.e., an offer price that is closer to the aftermarket price) is preferable, because it allows the firm to capture more of the value created. This implies that with effective signaling, the need to underprice or discount the stock price to attract

investment is mitigated. Thus, reduced underpricing is viewed positively because it implies a superior ability on the part of the firm to raise capital (Daily et al., 2005).

Our primary variables of interest are the three factors: undergraduate education, master's education, and doctoral education. Degrees from international universities are accounted for by an indicator variable (*International*).[8] Similarly, qualifications from professional accounting or financial investment bodies (e.g., CPA, ACCA, CFA, or ICEAW) are controlled with a dummy (*Professional Qualification*). We expect CEOs with such qualifications to be associated with greater information transparency, higher cost efficiency, and better skills in performing financially related tasks such as the acquisition of external financing through stock offerings (Aier, Comprix, Gunlock, & Lee, 2005; Hoitash, Hoitash, & Kurt, 2016). *Control Variables* are the vector of explanatory variables that are discussed below. *Industry Fixed Effects* and *Year Fixed Effects* control for time-invariant macro- and industry-specific conditions.

Cao and Shi (2006) provide a theoretical model of why we would expect within-industry or within-year (auto)correlation in IPO underpricing. Following this logic, and that of Petersen (2009) and Liu and Ritter (2011), we double-cluster the standard errors by industry and year, thus allowing for within-industry and within-year residual correlation.[9]

3.3 | Control variables

Our regressions contain a set of CEO, firm-specific, and offering characteristics that appear to account for much of the variability of IPO underpricing. These variables are incorporated into our regression models in order to help isolate the effect of the education-based factors and rule out alternative explanations.

With respect to CEO attributes, we initially consider the CEO's skill set and, in particular, the lifetime work experience obtained in publicly traded firms prior to the current CEO position. To this end, we follow Custodio et al. (2013) and manually construct a general ability index (*GAI*) for each CEO. This measure represents the first factor of the principal component analysis of the following five aspects of a CEO's professional career: past number of (i) positions, (ii) firms, and (iii) industries in which the CEO worked; (iv) whether the CEO has held a CEO position at a different company, and (v) whether the CEO worked for a conglomerate firm.[10]

Custodio et al. (2013) argue that a CEO who has worked in multiple positions, firms, and industries may accumulate general human capital that can be useful when a firm needs to invest in transformative change. This is particularly relevant for the IPO process because newly listed firms often need to engage in substantial restructuring and adopt more sophisticated corporate governance mechanisms in order to cope with the rigors and demands of going public (Jain & Kini, 2000, 2008). Further, one could argue that CEOs with a diverse background or experience in running publicly listed corporations should better navigate the transition from the private to the public domain than CEOs without such experience. This reasoning implies a negative link between *GAI* and underpricing.

We use *CEO Age* and *CEO Tenure* to capture additional aspects of CEO ability. We hypothesize that older CEOs are generally more experienced than younger ones, while long-tenured CEOs possess more firm-specific human capital than newly hired CEOs (Cline & Yore, 2016). Hence, older or long-tenured CEOs may be associated with lower levels of underpricing because they carry greater human capital than their counterparts.

A crucial CEO dimension that might affect the IPO process lies in a CEO's beliefs about their firm's prospects. Age and tenure may partially capture managerial overconfidence because they are naturally related to overoptimism. Similar arguments can be made for founder-CEOs (*Founder*) and male CEOs (*Gender*), because such managers tend to overestimate the strength and long-term prospects of their firms (Alkalbani, Cuomo, & Mallin, 2019; Lee, Hwang, & Chen, 2016). However, all of these variables are noisy or imperfect proxies of managerial overconfidence and are subject to a variety of interpretations (Abebe & Tangpong, 2017; Malmendier & Tate, 2005).

To better control for CEO overconfidence, we follow Boulton and Campbell (2016) and contend that managerial overconfidence should lead managers to invest aggressively, resulting in greater levels of investment. Accordingly, we classify managers as highly overconfident during the IPO if they choose high levels of investment for their firms (measured by industry-adjusted capital expenditures scaled by opening property, plant, and equipment (PP&E) for two consecutive years ending with the IPO year).[11] Because Boulton and Campbell (2016) report that overconfidence bias distorts the information production process during IPOs, we anticipate that CEO overconfidence will lead to higher levels of underpricing.

Relatedly, IPO success may also depend on how the board rewards the CEO. Prior studies argue that CEO compensation during the IPO might perform a symbolic role because it indicates how hard the CEO is expected to work toward shareholders' interests (Certo et al., 2003). CEO pay is used to discern CEO ability, because one way to attract and retain managerial talent is through higher compensation (Falato et al., 2015). If these arguments hold, higher CEO pay should convey a certification role to investor's eyes about the effort and ability of a CEO. In this case, CEO compensation should be negatively related to underpricing.

In terms of firm-specific attributes, we use the natural logarithm of total assets to proxy for firm size (*Size*). Because larger IPOs suffer less from valuation uncertainty, firm size should be associated with less underpricing (Beatty & Ritter, 1986). Prior research shows that firms with longer operating histories have proven more resilient to market-wide shocks and thus constitute safer investments (e.g., Carter, Dark, & Singh, 1998; Schultz, 1993). Thus, we expect firm age (*Firm Age*) to be negatively associated with IPO underpricing. Furthermore, given the limited information about an IPO firm's prospects, accounting earnings may also be considered an important determinant of IPO performance. To the extent that the pre-IPO performance is sustainable, earnings per share (*EPS*) should alleviate valuation uncertainty.

A potential source of both uncertainty and future growth opportunity lies in a firm's financial interest and investment in intangible capital. In this regard, we control for a firm's borrowing capacity (*Leverage*) and its intensity of research and development expenditure (*R&D Intensity*). Jensen (1986) posits that a reasonably high level of leverage acts as an internal deterrent to opportunistic managerial actions. Hence, we expect that firms relying on debt financing will leave less money on the table (i.e., show a lower level of underpricing). On the other hand, firms with more intangible assets face more valuation difficulties and thus exhibit higher levels of underpricing (Jain & Kini, 2008).

Our last set of firm-specific variables accounts for the quality of governance mechanisms. Chahine and Filatotchev (2008) and Chancharat, Krishnamurti, and Tian (2012) argue that, together, board independence, the percentage of outside directors, and board size capture the effectiveness of internal monitoring. Hence, we expect *Board Independence* and *% of Outside Directors* to relate negatively to underpricing and *Board Size* to relate positively.

Turning our attention to the offering (IPO-specific) characteristics, we control for firm visibility using the natural logarithm of proceeds (*Proceeds*). The increased visibility of larger companies may result in a relatively bigger footprint in the investment community, which in turn should translate into higher investor demand for a firm's shares and increased underpricing (Gounopoulos, Kallias, Kallias, & Tzeremes, 2017).

However, a challenge in the interpretation of our results is that the regression estimates might be contaminated by bias associated with the decision to go public or the timing of the IPO. The literature demonstrates that many firms time their capital-raising activities to coincide with investor optimism, that is, favorable market or IPO conditions (e.g., Baker & Wurgler, 2002). Relatedly, Yung, Çolak, and Wang (2008) report that hot markets increase the temptation of bad firms to go public (cold markets having the opposite effect). Thus, underpricing should be higher when there is favorable investor sentiment (and lower when sentiment is unfavorable; e.g., Bernstein, 2015; Bodnaruk, Massa, & Simonov, 2009; Çolak & Gunay, 2011).

A rational manager should prefer, of course, to avoid selling stock during a cold (or hot) market when the firm would receive a lower (or higher) price for newly issued shares than their intrinsic worth. Therefore, to the extent that CEO education correlates with the ability to (opportunistically or rationally) time the IPO or the tendency to go public according to wider economic conditions, variation in CEO education may not just capture CEO ability, but also reflect other factors, such as differences in IPO quality caused by shifts in market sentiment or IPO waves. To control for this possibility, we consider *Market Return*, the (cumulative) return on the CRSP value-weighted index over the calendar month (22 trading days) immediately prior to the IPO issue (Bradley & Jordan, 2002; Derrien, 2005; Derrien & Womack, 2003; Lowry & Schwert, 2004). We also capture IPO conditions with the moving average, MA(4), of the number of IPOs in each quarter divided by the sample average IPO volume (*Market Heat*).

One should also bear in mind that a firm's valuation does not only depend on investors' perceptions about the firm. It is also affected by the level of the offer price set during the book-building process. Therefore, it is plausible that the effect of CEO education on underpricing (the need to discount) is partially shaped by the efforts of the firm itself to determine the final offer price.[12] For example, better educated CEOs or CEOs with greater knowledge about their firm may choose to invest more time in information production during roadshows or be more capable of extracting favorable information from informed investors. This scenario would predict a higher or a more reliable final offer price relative to the initially proposed price range and, hence, a lower need to discount the issue. We therefore control for price changes that occur due to information revelation during the book-building period (Lowry & Schwert, 2004), and *IPO Revision* is defined as the ratio of difference between the final offer price and the initial midpoint of the price range over the latter.[13]

Prior studies suggest that a small overhang represents a higher number of new shares issued at the IPO (and a large overhang a smaller number; Bradley & Jordan, 2002). Assuming that a minimum degree of stock discounting is necessary to ensure investor demand, a higher number of new shares issued at the IPO should translate into more money being left on the table. Therefore, a higher share overhang (*Overhang*) should be costlier for pre-IPO shareholders and positively associated with the degree of underpricing. Furthermore, Lee and Wahal (2004) find a positive relationship between venture backing and underpricing and attribute this finding to reputation-related incentives for venture capitalists (VCs) to improve the first-day returns of new shareholders (the well-documented grand-standing effect). We control for this possibility by considering the presence of VCs. We also account for the role of investment bankers by utilizing the underwriter rankings (*Underwriter*) of Carter and Manaster (1990) to capture the perceived quality of these financial intermediaries. While prestigious underwriters signal legitimacy, they also have strong incentives to reward new investors with higher first-day returns, that is, higher underpricing (Chiang, Lowry, & Qian, 2019). Thus, the impact of top-tier underwriters on underpricing is not clear *ex ante*.

Finally, we use the dummy variable *Nasdaq*, which is a categorical variable that takes a value of one if the firm is listed on the Nasdaq stock exchange (and zero otherwise). The regulatory environment of Nasdaq is less restrictive than those of NYSE and AMEX, thereby serving as the preferred marketplace for small, young, and high-tech IPOs. In a similar spirit, dummy variables for *Technology* and *Internet* firms are incorporated into our model to account for the excessive underpricing that such firms experience (Loughran & Ritter, 2004).

4 | MAIN EMPIRICAL RESULTS

4.1 | Descriptive analysis

Tables 3 and 4 provide a preliminary description of our sample based on its educational, professional, firm-specific, and offering characteristics. Detailed definitions of all variables are provided in Appendix A. Panel A of Table 3 shows that the average CEO holds

TABLE 3 Descriptive statistics of educational characteristics

	Mean	SD
Panel A: General education indicators		
Years of Education	5.46	2.61
Number of Degrees	1.65	0.85
Panel B: Undergraduate degrees		
Undergraduate Degree	0.90	0.29
Undergraduate Degree International	0.11	0.31
Bachelor of Science (BSc)	0.65	0.48
BSc International	0.09	0.29
BSc-Top20	0.11	0.31
BSc Ivy League	0.03	0.16
Bachelor of Arts (BA)	0.27	0.44
BA International	0.01	0.12
BA-Top20	0.11	0.32
BA Ivy League	0.05	0.22
Undergraduate Education	0.00	0.54
Panel C: Master's and professional degrees		
Graduate Degree	0.47	0.49
Graduate Degree International	0.04	0.20
Master of Science (MSc)	0.19	0.39
MSc International	0.03	0.18
MSc-Top20	0.08	0.28
MSc Ivy League	0.01	0.11
Master of Arts (MA)	0.02	0.15
MA International	0.00	0.05
MA-Top20	0.01	0.09
MA Ivy League	0.01	0.06
Master of Business Admin. (MBA)	0.30	0.46
MBA International	0.01	0.10
MBA-Top20	0.17	0.38
MBA Ivy League	0.08	0.28
Master's Education	0.00	0.75
Professional Qualification	0.04	0.20
Panel D: Doctoral degrees		
Doctoral Degree	0.20	0.40
Doctoral Degree International	0.04	0.19
Doctor of Philosophy (PhD)	0.11	0.31
PhD International	0.02	0.15
PhD-Top20	0.05	0.22
PhD Ivy League	0.01	0.08
Juris Doctor (JD)	0.05	0.22
JD International	0.01	0.04
JD-Top20	0.02	0.14
JD Ivy League	0.01	0.08
Medical Doctor (MD)	0.05	0.22
MD International	0.01	0.12
MD-Top20	0.02	0.14

(Continues)

TABLE 3 (Continued)

	Mean	SD
MD Ivy League	0.01	0.09
Doctoral Education	0.00	0.71

Note: This table presents descriptive statistics for the main education variables used in our analysis. Besides the years of education and the number of degrees, the variables include CEO educational qualifications at the undergraduate (BA and BSc), master's (MA, MSc and MBA), and doctoral (PhD, JD and MD) levels of study. Professional qualifications are also included. The sample consists of 1,601 IPOs announced between 1 January 2000 and 31 December 2016. The variables that capture the quality of CEO education (Top-20 BSc/BA/MSc/MA/MBA/PhD/JD/MD) take a value of 1 if a CEO obtained their degree from a relevant Top 20 U.S. institution according to the 2017 USNWR rankings. All variables are defined in Appendix A.

1.65 university degrees and spent 5.46 years in higher education. Specifically, there are 1,447 (90%) chief executives with at least one university degree and, among them, 176 obtained at least one undergraduate degree from a non-U.S. institution. In panel B, a type-based categorization of undergraduate degrees in our sample reveals that most CEOs hold a BSc (1,043), with a BA (432) being a less common qualification.

With respect to advanced degrees, panel C shows that 756 firms (47%) are managed by CEOs having a master's degree. As expected, most of these CEOs chose to pursue a Master of Business Administration degree (30%); the next most common is a Master of Science (MSc) degree (19%), while the proportion of CEOs with a Master of Arts (MA) degree is a mere 4%. Furthermore, we identify that 66 executives (4%) hold qualifications awarded by professional accountancy bodies (CPA, ACCA, or CIMA). In panel D, we split the doctoral qualifications into three categories, namely, PhD (Doctor of Philosophy), JD (Juris Doctor), and MD (Doctor of Medicine); we observe that 315 (20%) of our sample CEOs hold a doctoral qualification (11% holding a PhD and 5% each holding a JD or MD), and 62 of these obtained their doctoral title in a university outside the United States.

Table 4 documents the CEO, firm, and IPO characteristics used as control variables in our regressions. Panel A indicates that, on average, a CEO is approximately 51 years old and has been serving his or her firm for at least 3 years. Female CEOs account for 5% of the sample, and 31% of CEOs are also founders of their firm. Panel A also shows that, on average, IPO firms have a history of around 14 years' operation prior to opting to go public. At this point, 42% of these firms report positive profits, while the average pre-IPO leverage is 33%. Moreover, IPO issuers exhibit an initial mean valuation response (underpricing) of 19%. Around half of the IPOs are venture-backed, and 37% are underwritten by top-tier investment banks. In addition, 33% of firms are in the high-tech industry, 9% are in the Internet sector, and 62% are listed on Nasdaq. Finally, around 70% of the firms have independent board members and each firm has, on average, eight board members.

If we concentrate on examination of these characteristics in relation to the type of educational degrees involved, several interesting patterns emerge. For example, it appears that individuals who pursue doctoral degrees (JD, MD, and PhD) are more likely to be founders and specialists (i.e., having low values of general managerial capital). This is not surprising, given that such individuals tend not to be professional CEOs, and hence have a less diverse (i.e., more focused) work background. Further, it is noteworthy that VCs show a higher presence in firms with CEOs that have a doctoral degree, which is consistent with the notion that companies that have greater needs for specific knowledge than general managerial talent are backed by early-stage investors (Kaplan et al., 2012). Lastly, firms led by CEOs with doctoral degrees seem to have higher board independence, a greater percentage of outside directors, larger board sizes, and more aggressive R&D expenditures than firms led by CEOs without such qualifications.

Panel C of Table 4 classifies IPO firms by sector and reveals a relatively high concentration of IPOs in the chemical products sector, as well as that of computer equipment and services. In contrast, the food products and entertainment services sectors have the lowest representation of IPO firms. In terms of the distribution of degrees across sectors, it is interesting to observe that doctoral degrees are concentrated in the chemical products and computer equipment and services sectors.

4.2 | The impact of CEO education on underpricing

In this section, we examine the relationship between educational attainments and underpricing in a multivariate setting. Table 5 reports estimates from the baseline regression, where we introduce our CEO education factors sequentially in columns 1 to 3 and present the full model in column 4. All education factors load negatively and significantly on IPO underpricing, either individually or collectively. This observation is consistent with the idea that CEO educational attainments deliver substantial benefits to the IPO process and help a firm to certify value and establish investor recognition, thereby alleviating concerns about management quality and the firm's prospects.

What is more interesting, though, is that, among the education factors, *Doctoral Education* is the strongest determinant of IPO underpricing. Economically, for the average firm in our sample, a one-standard-deviation increase in the doctoral factor is associated with underpricing that is 1.56% lower.[14] This observation is particularly important because it supports our main hypothesis that better education, in terms of level and quality, serves as a strong indicator of managerial talent, thereby reducing information asymmetry in relation to managerial ability and the associated impact on corporate performance. In addition, we find that international degrees do not seem to have a significant impact on underpricing. By contrast, the coefficient of professional qualifications is negative and significant across all columns, suggesting that financial training is highly valued by IPO investors because it manifests in lower valuation discounting. This

TABLE 4 Summary statistics by degree

Panel A: CEO attributes and firm characteristics

	Overall sample	Undergraduate degree	Master's degree	Doctoral degree
General Ability Index	0.00	0.03	0.07	−0.07
CEO Age	50.72	50.66	51.01	51.77
CEO Tenure	3.03	3.03	3.25	3.16
Founder	0.31	0.31	0.29	0.44
Gender	0.95	0.95	0.95	0.95
CEO Overconfidence	0.45	0.41	0.39	0.38
CEO Compensation	$1,442,562	$1,380,631	$1,446,88	$1,482,315
Size	4.15	4.12	4.13	3.74
Firm Age	13.77	13.33	12.97	10.13
EPS	0.42	0.41	0.41	0.28
Leverage	0.33	0.32	0.30	0.35
R&D Intensity	4.49	4.95	6.55	12.02
Board Independence	0.69	0.70	0.69	0.75
% of Outside Directors	0.55	0.55	0.55	0.60
Board Size	7.61	7.68	5.14	7.98

Panel B: IPO (offering) characteristics

	Overall sample	Undergraduate degree	Master's degree	Doctoral degree
Underpricing	18.82	19.04	17.30	16.59
IPO Revision	−1.32	−1.42	−1.28	−1.17
Proceeds	4.04	4.04	4.01	3.92
Market Heat	1.33	1.33	1.33	1.31
Overhang	3.60	3.66	3.72	3.29
Nasdaq	0.62	0.63	0.63	0.79
Underwriter	0.37	0.37	0.38	0.31
VC	0.47	0.49	0.53	0.67
Technology	0.33	0.35	0.37	0.26
Internet	0.09	0.09	0.10	0.05

Panel C: Education degrees by industry

	SIC2	Overall sample	Undergraduate	Master's	Doctoral
Oil and Gas	(13)	121	77	36	8
Food Products	(20)	20	12	7	1
Chemical Products	(28)	583	287	154	142
Manufacturing	(30–34)	55	34	19	2
Computer Equipment and Services	(35, 73)	611	374	196	41
Electronic Equipment	(36)	250	129	88	33
Scientific Instruments	(38)	199	109	60	30
Transportation and Public Utilities	(41, 42, 44–49)	195	123	59	13
Wholesale and Retail Trade	(50–59)	180	121	51	8

Note: This table presents descriptive statistics for a sample of 1,601 US IPOs from 1 January 2000 to 31 December 2016. All IPOs are retrieved from the Thomson Financial database. Education data are retrieved from EDGAR and BoardEx and accounting data from CRSP. The statistics provided include the mean for all control variables used in the regression analysis. Panel A describes the firm and CEO characteristics and Panel B the IPO characteristics; Panel C reports the distribution of education degrees by industry.

interpretation is consistent with the notion that professional finance or accountancy training aids managers in performing financial tasks and improves the quality of a firm's financial environment (Aier et al., 2005; Custodio et al., 2020).

With respect to the results for the remaining control variables, their sign and significance across all specifications are generally consistent with our expectations and the existing literature. For instance, the general ability index loads significantly on underpricing, suggesting

TABLE 5 The impact of CEO education index on IPO underpricing

	(1)	(2)	(3)	(4)
Undergraduate Education	−1.31*** (−2.75)			−1.04* (−1.71)
Master's Education		−1.43*** (−2.84)		−1.20** (−2.01)
Doctoral Education			−1.90*** (−4.80)	−2.17** (−2.45)
International Degree	2.15 (1.03)	1.04 (1.02)	2.71 (1.01)	1.45 (0.77)
Professional Qualification	−0.44*** (−5.39)	−0.17*** (−5.19)	−0.15*** (−2.95)	−0.14*** (−5.54)
General Ability Index	−0.25* (−1.76)	−0.42* (−1.91)	−0.52* (−1.85)	−0.43* (−1.99)
CEO Age	−0.03 (−0.92)	−0.02 (−0.67)	−0.02 (−0.66)	−0.02 (−0.76)
CEO Tenure	−0.32 (−1.50)	−0.21 (−1.30)	−0.22 (−1.35)	−0.21 (−1.28)
Founder	6.30*** (3.38)	5.37*** (2.62)	5.65*** (2.71)	5.59*** (2.62)
Gender	5.56 (1.33)	5.02 (1.17)	4.77 (1.10)	4.77 (1.11)
CEO Overconfidence	0.41* (1.76)	0.15* (1.80)	0.09* (1.94)	0.17* (1.71)
CEO Compensation	−0.90* (−1.86)	−1.11* (−1.85)	−1.08* (−1.80)	−1.09* (−1.78)
Size	0.01 (0.02)	−0.05 (−0.07)	−0.06 (−0.09)	−0.09 (−0.12)
Firm Age	−0.47 (−0.90)	−0.86 (−1.14)	−0.88 (−1.10)	−0.85 (−1.09)
EPS	2.33 (0.79)	2.69 (0.87)	2.49 (0.80)	2.55 (0.87)
Leverage	−1.11 (−0.30)	−0.95 (−0.07)	−1.07 (−0.29)	−1.13 (−0.32)
R&D Intensity	0.02* (1.96)	0.02* (1.85)	0.03* (1.80)	0.03* (1.70)
Board Independence	−3.26* (−1.85)	−2.77** (−2.29)	−2.91** (−2.30)	−2.69** (−2.28)
% of Outside Directors	3.32 (0.35)	2.07 (0.22)	2.61 (−0.28)	2.39 (0.25)
Board Size	3.19* (1.75)	2.44 (1.12)	2.37 (1.06)	2.42 (1.12)
Proceeds	0.62 (0.48)	0.57 (0.40)	0.53 (0.37)	0.59 (0.41)
Market Return	1.20 (1.18)	0.80 (1.25)	0.85 (1.21)	0.75 (1.31)
Market Heat	2.01* (1.86)	2.01** (2.43)	1.99* (1.95)	1.94** (2.31)
IPO Revision	0.93*** (3.68)	0.94*** (3.69)	0.95*** (3.64)	0.94*** (3.59)
Overhang	1.04*** (5.81)	1.05*** (6.09)	1.04*** (5.85)	1.04*** (5.82)
VC	9.17*** (2.66)	9.09** (2.48)	9.15** (2.47)	9.27** (2.59)
Underwriter	2.02 (0.92)	2.20 (1.03)	2.41 (1.18)	2.33 (1.16)
Nasdaq	3.40 (1.16)	3.17 (1.08)	3.24 (1.12)	3.14 (1.07)
Technology	4.15*** (3.14)	4.07*** (3.28)	3.87** (2.61)	4.24*** (3.32)
Internet	−3.11 (−0.99)	−2.95 (−1.20)	−2.72 (−0.90)	−2.85 (−0.97)
Industry and Year Fixed Effects	Y	Y	Y	Y
N	1,601	1,601	1,601	1,601
Adjusted R^2	0.336	0.331	0.332	0.332

Note: This table reports results from ordinary least-squares (OLS) regressions of a three-factor CEO education index on IPO underpricing. The dependent variable is IPO underpricing and is calculated as the percentage change of the first-day closing price from the offer price. Our primary variables of interest are the three education factors: undergraduate education, master's education, and doctoral education. Year and industry fixed effects are included but coefficient estimates are not reported. *T* statistics are included in parentheses and are adjusted for heteroscedasticity-robust standard errors clustered by industry and year. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

that the market perceives prior CEO experience in public-domain firms to be essential for firms transitioning from the private to the public. The coefficients of *CEO Age* and *CEO Tenure* are both negative, consistent with the notion that older and long-tenured CEOs possess greater human capital (Chemmanur & Paeglis, 2005). However, they are statistically indistinguishable from zero. In contrast, founder, overconfident, and male CEOs all tend to increase underpricing, suggesting that it is important to control for managerial biases during stock offerings (Chahine & Goergen, 2011; Lee et al., 2016). Interestingly, the coefficient of total CEO pay, regarded as a proxy for both managerial talent and effort, is negative, which confirms the symbolic role of executive compensation mechanisms (Certo et al., 2003).[15]

In terms of firm-specific variables, size, age, and leverage are negatively but insignificantly related to underpricing. On the other

hand, *EPS* and *R&D Intensity* tend to increase underpricing, although only the effect of the latter is reliably different from zero (Jain & Kini, 2008). The corporate governance variables (*Board Independence* and *% of Outside Directors*) are negatively related to IPO underpricing (Chahine & Filatotchev, 2008).

Lastly, the positive estimates on IPO-specific variables such as the amount of proceeds, share overhang, and market return are in line with previous IPO studies (Leone, Rock, & Willenborg, 2007; Loughran & Ritter, 2004). Importantly, *Market Heat*, a measure of IPO activity and investor overenthusiasm, is strongly and positively related to the amount of money left on the table (Yung et al., 2008). Consistent with Loughran and Ritter (2004), we find that the presence of prestigious underwriters and VCs is associated with greater levels of IPO underpricing, and similarly to Gounopoulos et al. (2017), we find that technology and Nasdaq-listed firms also tend to have greater levels of underpricing.

5 | THE HETEROGENEOUS IMPACT OF CEO EDUCATION ON IPO UNDERPRICING: EVIDENCE FROM TWO NATURAL QUASI-EXPERIMENTS

The results in the previous section establish a negative relation between CEO education credentials and underpricing. To provide further insights (and alleviate some endogeneity concerns), we turn our attention to whether the effect of CEO education on underpricing varies in the IPO cross section in a theoretically predictable manner. Our basic premise is that both the substantive role and (perhaps to a larger extent) the signaling role of CEO education should be more pronounced in settings where the need to reduce information asymmetry between issuers and investors is greatest (Chemmanur & Paeglis, 2005; Cohen & Dean, 2005; Colombo et al., 2019). To this end, we consider two natural quasi-experiments that exogenously affected the extant level of information transparency: the introductions of the Sarbanes–Oxley Act (2002) and the JOBS Act (2012).

In 2002, the Sarbanes–Oxley (SOX) Act was adopted in the United States to increase corporate governance standards of U.S.-listed firms. This tightening of corporate governance induced greater transparency and less information asymmetry, leading to greater investor confidence in the equity market. In particular, Chhaochharia and Grinstein (2007), Iliev (2010), and Johnston and Madura (2009), among others, examine the valuation and pricing of IPO shares in the United States before and after SOX was enacted: they find that, on average, underpricing (a common proxy for information asymmetry in the IPO literature) is lower for IPO shares issued post-SOX.

In the European Union (EU), Akyol, Cooper, Meoli, and Vismara (2014) show that a similar tightening of corporate governance standards (through so-called "EU-SOX") diminished, *ceteris paribus*, the information asymmetry between issuers and investors, as documented by a lower level of underpricing. Likewise, Colombo et al. (2019) show that the signaling effect of prestigious university affiliations on IPO valuations is reduced following the introduction of EU-SOX. Building on these studies, we predict that the link between CEO education and underpricing in the United States will be weaker after the introduction of SOX.

In 2012, the Jumpstart Our Business Startups (JOBS) Act was signed into law with the goal of reducing the regulatory burden on small firms seeking to raise capital in the United States. A key feature of this regulatory shock was the reduction of mandatory disclosures and compliance provisions for a specific category of firms, titled "Emerging Growth Companies" (EGCs).[16] Although this initiative stimulated IPO activity, it undermined the credibility of an issuer's disclosures at the time of the IPO, as evidenced by greater underpricing following the act (Barth et al., 2017; Chaplinsky et al., 2017; Dambra, Field, & Gustafson, 2015; Gupta & Israelsen, 2016). Based on this observation, we anticipate that the impact of CEO education on underpricing should be more pronounced among EGCs following the implementation of the JOBS Act.

In panel A of Table 6, we make use of the SOX regulatory change to test whether the effect of CEO education on IPO underpricing changed after the introduction of the new corporate governance codes.[17] The results show that the interaction term between our CEO education factors and a post-SOX dummy is positive and significant. In terms of the JOBS Act, the results reported in panel B indicate that the impact of CEO education is more pronounced after the act's introduction, particularly among EGCs.[18] As a whole, these findings confirm our hypothesis that the benefits of education should be more visible within environments with lower information transparency (and less visible where transparency is higher).

6 | IDENTIFICATION ISSUES

6.1 | Instrumental variable analysis

There is a concern that our estimates could be biased as a result of endogenous matching between CEO quality and firm characteristics. This form of bias may be attributed either to omitted time-invariant or time-variant firm/CEO variation that affects both CEO education and underpricing in a similar manner. For instance, CEOs with better education might be self-selected into firms with better prospects, or CEOs with higher education credentials may be appointed by boards with certain characteristics (e.g., propensity to innovate, tolerance of failure, and conservatism). In either case, CEO education could correlate with corporate factors that could in turn affect corporate performance.

We could address unobserved time-invariant heterogeneity by including firm–CEO fixed effects or by focusing on exogenous CEO turnover events (Fee, Hadlock, & Pierce, 2013). Unfortunately, this is infeasible in a cross-sectional setting such as IPOs. Given that each CEO can go public with the same company only once, it follows that each firm–CEO pair in this context is unique. As such, we are unable to control for firm–CEO fixed effects or consider exogenous CEO replacements. Our closest substitute was the inclusion of a wide array

TABLE 6 Uncertainty effect on the association between CEO education and underpricing

	(1)	(2)	(3)
Panel A: The effect of Sarbanes–Oxley (SOX)			
Undergraduate Education	−0.45 (−0.42)		
Master's Education		−1.54 (−1.11)	
Doctoral Education			−0.59* (−1.95)
Post-SOX	−1.57* (−1.98)	−1.67* (−1.89)	−1.48* (−1.87)
Undergraduate Education × Post-SOX	0.65* (1.89)		
Master's Education × Post-SOX		1.10* (1.94)	
Doctoral Education × Post-SOX			1.25* (1.80)
Control variables	Y	Y	Y
Industry and year fixed effects	Y	Y	Y
N	731	731	731
Adjusted R^2	0.311	0.313	0.300
Panel B: The effect of the JOBS Act			
Undergraduate Education	−0.30 (−0.80)		
Master's Education		−0.71 (−0.79)	
Doctoral Education			−0.96* (−2.02)
EGC	1.10** (2.35)	1.55* (1.85)	1.30* (1.96)
Undergraduate Education × EGC	−1.23 (−1.62)		
Master's Education × EGC		−1.55** (−2.20)	
Doctoral Education × EGC			−1.66** (−2.27)
Control variables	Y	Y	Y
Industry and year fixed effects	Y	Y	Y
N	606	606	606
Adjusted R^2	0.285	0.286	0.294

Note: This table shows the results of regressing a three-factor CEO education index on IPO underpricing using a difference-in-differences approach. Panel A exploits the enactment of Sarbanes–Oxley (SOX), while Panel B exploits the enactment of the JOBS Act. *Post-SOX* is a dummy variable equal to 1 if the firm goes public following the passage of SOX (July 30, 2002), and 0 otherwise. When we examine the impact of SOX in our sample, we limit our sample to 2000–2006. *EGC* is an indicator variable that equals 1 for Emerging Growth Company (EGC) firms, and 0 for non-EGC (NEGC) firms. EGC firms are those with EGC status and IPOs after the JOBS Act, and NEGC firms are those with IPOs before the act that would have qualified for EGC status had their IPO occurred after the act (i.e., firms below the $1 billion revenue threshold but with IPOs before the act). To remove from our analysis any confounding effects associated with the 2008 financial crisis, as well as the effect of SOX (2002), we estimate the impact of the JOBS Act from 2009 to 2016. Furthermore, to obtain an appropriate control sample in terms of size, we follow Barth et al. (2017) and exclude from our sample those IPO firms with revenues below $1 billion before 5 April 2012 (118 firms). Year and industry fixed effects are included, but coefficient estimates are not reported. Control variables are the same as in Table 5. *T* statistics are included in parentheses and are adjusted for heteroscedasticity-robust standard errors clustered by industry and year. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

of CEO control variables intended to capture a range of managerial attributes such as managerial risk aversion and career concerns (*CEO Age*, *Gender*, and *CEO Tenure*), general human capital (*GAI*), overconfidence (CEO-founder status, industry-adjusted investment in capital expenditure), CEO effort, and incentives (*CEO Compensation*). To the extent that the underlying constructs captured by these factors do not change during the IPO period, we can reasonably assume that they can absorb, to some extent, time-invariant heterogeneity.[19] Nevertheless, because of the absence of observable firm–CEO variation, we cannot conclusively rule out all of the alternative explanations that are associated with time-invariant characteristics of the firm–CEO pair, such as the quality of the match or the innate talent of the CEO. In this respect, we urge caution in interpreting our results.

The remaining concern is that unobserved time-varying factors correlated with both CEO education and underpricing may affect the quality of the firm–CEO matching, thus giving rise to reverse causality. To overcome this challenge, we follow Chemmanur et al. (2019) and instrument for managerial talent/ability (as measured by our CEO education factors) using a plausibly exogenous shock to the supply of new managers available for hire by a firm. Our instrument is the number of

acquisitions in the industry and the state of the sample firm 5 years beforehand, weighted by an index that measures the enforceability of noncompete clauses in that state, aggregated to the national level.

The rationale for this instrument is that if managers are deliberately selected because of an identified attribute that the board wants to harness, we could expect boards to be more successful in doing so when there is a relatively large and diverse pool from which to choose. Given that geography induces labor-market frictions (Yonker, 2016), we assume that firms located in states with a higher mobility of managerial talent are, all else being equal, able to select from a deeper pool of managers. Therefore, the quality of the firm–CEO match depends on the depth of the pool of potential candidates, which, in turn, is a function of local labor-market frictions, as reflected in the degree of managerial mobility within the industry and the state.

We identify two sources of variation in the mobility of managers that are unlikely to be related to corporate performance (and hence underpricing). The first is the number of acquisitions within an industry. Chemmanur et al. (2019) note that incoming managers, that is, the pool of potential managers available for hire by a firm, often come from established firms that are dominant players in the acquisition market. Hence, one would expect to find a strong correlation between the number of acquisitions in an industry and the movement of managers across firms within that industry.[20]

However, managers made possible for hire by acquisitions are subject to labor-market frictions. One such friction lies in the enforceability of noncompete clauses, which constitutes our second source of variation in the mobility of managers among firms. Noncompete clauses are commonly used in the employment contracts of top management teams to prohibit senior executive members from joining or founding a rival company within 1 or 2 years of leaving. For instance, Bishara, Martin, and Thomas (2015) analyze the properties of a broad sample of CEO employment contracts and show that 80% of these contracts contain noncompete clauses, often with a broad geographic scope. In addition, a burgeoning literature demonstrates that the high enforceability of these noncompete clauses constrains employees' mobility, including those of managers (Garmaise, 2011; Kini, Williams, & Yin, 2019; Marx, Strumsky, & Fleming, 2009). Because the enforceability of noncompete clauses is a common feature of executive employment contracts, changes in this feature can lead to variations in the mobility of managers that are unlikely to be related to a firm's prospects. In support of this conjecture, Ewens and Marx (2018) exploit variability in the enforceability of noncompete agreements across states and over time to instrument for founder replacement of start-ups, while Custodio, Ferreira, and Matos (2017) use the same instrument to identify exogenous variation in the degree of general managerial capital.

Based on the evidence above, we construct an instrumental variable (IV) that captures a plausibly exogenous shock to the supply of managers available for hire by our sample of IPO firms, utilizing the strong correlation between industry acquisitions, the movement of top managers, and the exogenous variation in the ability of managers to move between firms. Specifically, the IV for our three CEO education factors in a firm i in industry j is computed as follows:

$$Instrument_{j,t} = \sum_{s} Acquisitions_{j,s,t-5} \times Enforceability\ Index_{s,t}, \quad (3)$$

where j, s, and t stand for the industry, state, and year, respectively. $Acquisitions_{j,s,\ t-5}$ is the number of acquisitions made by established (public) companies in industry j in state s in year $t-5$. The information on mergers and acquisitions required to construct this variable is collected from the SDC Mergers & Acquisitions database. As already noted, the 5-year lag allows for the expiration of retention contracts that work as "golden handcuffs" for managers, and thus, $Acquisitions_{j,s,\ t-5}$ works as a measure of the supply of managers from state s in industry j in year t. $Enforceability\ Index_{s,t}$ is an index that measures the enforceability of noncompete agreements across different U.S. states based on Garmaise (2011) and updated from Ertimur, Rawson, Rogers, and Zechman (2018).[21] The enforceability index used here is constructed as the difference between 12 and the value of Garmaise's (2011) index scaled by 12, so that it potentially ranges from 0 to 1.[22] Because greater enforceability of noncompete clauses restricts managerial mobility, we multiply the enforceability index by −1 in order to facilitate the interpretation of the impact of these clauses. As such, higher values of the enforceability index indicate greater mobility of managerial talent.

The product $Acquisitions_{j,s,t-5} \times Enforceability\ Index_{s,t}$ therefore captures the supply of managers who are able to move among firms and are available for hire from state s in industry j in year t. In this respect, this product instruments for the probability of a firm being able to hire a manager with a given educational background. We then aggregate this variable to the industry-year level across all 50 U.S. states, to recognize that the market for top managers is likely to be nationwide, and use this as an instrument for the top management quality of a firm in industry j in year t.

We expect this instrument to be positively correlated with each of the three CEO education factors of our sample of IPO firms, thus satisfying the relevance condition of a valid instrument. Therefore, in our IV analysis of the relation between underpricing and each of the three CEO education factors of firm i in industry j in year t, we run the following first-stage regression:

$$\begin{aligned} CEO\ Education\ Factor_{i,j} = {} & \alpha + \beta Instrument_{j,t} + \delta Acquisitions_{j,t-5} + \gamma Z_i \\ & + Industry\ FE + Year\ FE + State\ FE. \end{aligned} \quad (4)$$

One potential concern is that the lagged number of acquisitions may reflect some unobservable industry-level trends (e.g., an industry-wide shock such as merger waves) in underpricing and thus confound our IV. Therefore, in both the first and second stages of our IV regressions, we explicitly control for the total number of acquisitions in the sample firm's industry 5 years beforehand ($Acquisitions_{j,t-5}$). In this way, our identifying variations come from the number of acquisitions in states where the noncompete agreements are comparatively less strictly enforced, while controlling for the overall acquisition conditions within an industry.[23] We further control for state-level time-invariant factors by including in our regressions fixed effects for the state in which the

firm is headquartered. Therefore, the exclusion restriction for this IV is also likely to be satisfied.[24]

Panel A of Table 7 reports the results of the first stage of our IV analysis. The coefficient of the instrument is positive (as predicted) and is statistically significant at the 1% level for each CEO education factor. Stock and Yogo (2005) suggest that weak instruments could lead to biased IV estimators. The Kleibergen-Paap rank Wald *F*-statistics exceed 10, which is the critical value derived from Stock–Yogo's test and rejects the null hypothesis that the IV is weak. These findings confirm that the relevance condition for the instrument is satisfied. In Panel B of Table 7, we report the results of our IV second-stage results. We find that after controlling for the potential endogeneity between CEO education and IPO underpricing, the CEO education factors continue to have a negative and significant effect on underpricing, confirming that unobserved firm heterogeneity is unlikely to be the main driver of our findings.

In summary, the results documented in this section suggest a negative causal relationship between CEO education and IPO underpricing, thereby lending strong support to our main hypothesis.[25] In the Internet Appendix (Section A7), we also explore whether our results are sensitive to selection bias associated either with the choice to appoint a well-educated CEO or the decisions to go public and on the timing of the IPO. The results show that the relationship between CEO education and IPO underpricing is not severely affected by this form of bias. Finally, we acknowledge that while the IV approach accounts for selection bias due to unobservable factors, it does not address bias due to observable factors or model mis-specification. Employing entropy balancing to control for observable differences among firms (Chapman, Miller, & White, 2019; Hainmueller, 2012; Jacob, Michaely, & Müller, 2018) reinforces our baseline results (see Section A7 of the Internet Appendix).

7 | ADDITIONAL ANALYSIS

7.1 | Alternative definitions of educational quality

7.1.1 | USNWR Top 30 ranking and Ivy League designation

Given our previous findings, it is important to ensure that our conclusions are not sensitive to varying definitions of educational quality. To this end, we initially rerun our regressions by constructing alternate factors of CEO educational quality on the basis of the USNWR Top 30 ranking and the Ivy League list rather than the USNWR Top 20 ranking.[26] The results, in Table 8, reaffirm our key findings. Firms that employ CEOs with higher education factor scores perform better.

7.1.2 | Years of education

An alternative treatment would involve considering the number of years of education. For example, Amore et al. (2019) show that CEO education, measured in terms of years, is (positively) associated with greater environmental awareness. In our sample, the level of education is negatively associated with underpricing, because the doctoral education factor is more highly related to underpricing than the master's or undergraduate education factors. Based on this observation, we would expect a negative link between the years in education and the money left on the table during the first trading day (i.e., underpricing) because, in general, a doctoral title requires more years of study than master's or undergraduate degrees.

In panel A of Table 9, we examine the distributional properties of the years of education (as well as the number of degrees). The average number of years (and number of degrees) is larger for CEOs holding PhDs (10.6 years) than those with either an MD or a JD (8.28 and 6.54 years, respectively). Interestingly, closer inspection reveals that, while the maximum number of degrees is the same (4) across all doctoral titles, the minimum number of education years exhibits differences. The PhD holders obtain at least two degrees, whereas MD or JD holders may not have more than one degree. This is not surprising, because MDs and JDs can be a first degree and, hence, the only academic qualification of a doctor and a lawyer, respectively.

The implication of this finding is that the univariate correlation between the years of education and the number of degrees should be less than 100%. In fact, in our sample, it is 66%. Second, although the link between the years of education and underpricing should be negative, the strength of this relationship should depend on whether the CEO's doctoral title is their only degree. Panel B of Table 9 explores these conjectures. As expected, in column 1, the number of education years is negatively related to underpricing, though insignificantly. In columns 2 and 3, we exclude CEOs whose MD or JD is their first degree, having identified that in 45 out of 85 cases, the MD is the only degree obtained, while in 33 out of 81 cases, the JD is the only degree obtained. We exclude these cases sequentially in columns 2 and 3 and simultaneously in column 4. Under these specifications, the negative relationship between the years of education and underpricing becomes significant at the 10% level. Therefore, we conclude that the years spent in education lead to similar inferences as our CEO education factors, albeit at a lower level of statistical significance.

7.2 | The role of education fields

So far, we have shown that higher CEO educational attainments are associated with lower levels of IPO underpricing. We measure educational achievement by focusing on two dimensions, the educational level and the quality of the awarding institution. Our study shows that these aspects transmit similar signals to the market, because they tend to reduce underpricing either collectively as a common factor or separately (see Table IA3 in the Internet Appendix for the latter result). However, there is another significant dimension of education, namely, the field of expertise. The role of field(s) of expertise is an important discussion in the literature of finance and labor economics, where returns to education and the matching between employees and firms are correlated with the education discipline involved (e.g., Altonji,

TABLE 7 Two-stage least squares

Panel A: First-stage results			
	(1)	(2)	(3)
	Undergraduate education	Master's education	Doctoral education
Instrument	0.01*** (2.70)	0.01*** (2.77)	0.02*** (3.14)
$Acquisitions_{j,t-5}$	−0.02 (−1.39)	−0.01 (−0.60)	−0.01** (−2.57)
International Degree	0.04 (1.46)	0.03 (0.29)	0.44*** (9.17)
Professional Qualification	0.13*** (2.99)	0.01 (0.03)	−0.15*** (−5.29)
General Ability Index	0.01 (0.40)	0.10*** (2.99)	0.04* (1.89)
CEO Age	−0.01 (−0.33)	−0.01 (−0.81)	−0.01 (−0.71)
CEO Tenure	0.01 (0.03)	0.01 (1.36)	0.01* (1.78)
Founder	0.03 (0.78)	−0.14*** (−2.77)	0.04 (0.89)
Gender	−0.01 (−0.01)	−0.03 (−1.12)	−0.09 (−1.00)
CEO Overconfidence	0.04 (1.47)	0.03 (0.90)	−0.10** (−2.31)
CEO Compensation	−0.01 (−0.18)	0.01 (0.65)	0.03* (1.94)
Size	−0.01* (−1.72)	−0.01 (−0.33)	0.01 (1.08)
Firm Age	0.01 (0.98)	0.01 (0.16)	−0.01 (−0.20)
EPS	−0.01 (−0.11)	0.08** (2.02)	−0.06 (−0.97)
Leverage	−0.02 (−0.70)	−0.04* (−1.93)	−0.05 (−1.13)
R&D Intensity	0.01*** (4.43)	0.02*** (2.78)	0.01*** (3.31)
Board Independence	0.06* (1.85)	0.13* (1.75)	−0.02 (−0.19)
% of Outside Directors	0.01 (0.16)	−0.26** (−4.41)	0.01 (0.07)
Board Size	−0.01 (−0.10)	0.06 (1.39)	0.03 (0.62)
Proceeds	0.05** (2.25)	−0.03 (−1.34)	−0.04 (−1.49)
Market Heat	−0.03* (−1.91)	−0.02 (−0.79)	−0.01 (−0.29)
IPO Revision	−0.01 (−1.58)	−0.01 (−1.63)	0.01 (1.61)
Overhang	−0.01 (−0.74)	0.01 (0.85)	−0.01 (−0.57)
VC	0.05* (1.69)	0.02 (0.60)	0.22*** (7.35)
Underwriter	−0.04* (−1.71)	0.01 (0.31)	0.04 (1.33)
Nasdaq	−0.02 (−0.54)	−0.11** (−2.48)	0.03 (0.77)
Technology	0.13*** (23.80)	0.18*** (2.76)	−0.19*** (−12.98)
Internet	−0.07* (−1.67)	0.02 (0.35)	0.10*** (4.10)
Industry and year fixed effects	Y	Y	Y
State fixed effects	Y	Y	Y
N	1,601	1,601	1,601
Adjusted R^2	0.021	0.055	0.104

Panel B: Second-stage results				
	(1)	(2)	(3)	(4)
Undergraduate education	−1.89** (−2.52)			−1.96 (−1.61)
Master's education		−2.11*** (−3.15)		−2.33*** (−3.85)
Doctoral education			−2.84*** (−2.75)	−3.12*** (−2.78)
Control variables	Y	Y	Y	Y
Tests of endogeneity, relevance, and validity of instrument				
Kleibergen-Paap rank Wald *F*-statistic	26.70	22.40	23.50	
Industry and year fixed effects	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
N	1,601	1,601	1,601	1,601
Adjusted R^2	0.333	0.345	0.344	0.312

Note: This table displays the results of multivariate analysis using two-stage least-squares. Panel A presents the first-stage results in which the dependent variables are the undergraduate, master's, and doctoral education factors, respectively. The instrument is the following product: $Acquisitions_{j,s,t-5} \times Enforceabiliy\ Index_{s,t}$. Panel B reports the second-stage results. The sample consists of initial public offerings from 2000 to 2016 in the U.S. stock market. *T* statistics are included in parentheses. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

TABLE 8 CEO education factors based on alternative measures of CEO education quality

	USNWR Top 30	Ivy League
	(1)	(2)
Undergraduate education	−1.95 (−1.61)	−1.73* (−1.85)
Master's education	−2.35** (−2.05)	−2.47 (−0.80)
Doctoral education	−2.85*** (−2.78)	−3.34* (−1.91)
Control variables	Y	Y
Industry and year fixed effects	Y	Y
N	1,601	1,601
Adjusted R^2	0.332	0.330

Note: This table shows the results of OLS regressions of alternate measures of CEO education quality on IPO underpricing. The dependent variable is IPO underpricing and is calculated as the percentage change of the first-day closing price from the offer price. We construct the three-factor education index using alternative measures of CEO education quality. In column 1, we measure quality of education in terms of whether the CEO received their undergraduate, master's, or doctoral degree from a university ranked among the top 30 according to USNWR rankings. In column 2, we measure CEOs' quality of education through dummy variables that take a value of 1 if the CEO received their undergraduate, master's, or doctoral degrees from a university classified as an Ivy League university, and 0 otherwise. Control variables are the same as in Table 5. *T* statistics are included in parentheses and are adjusted for heteroscedasticity-robust standard errors clustered by industry and year. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

Kahn, & Speer, 2016; Choi, Lou, & Mukherjee, 2018; Kinsler & Pavan, 2015).[27]

Based on such reasoning, one could argue that, in addition to the level and quality of CEO education (as captured by our three CEO educational factors), market participants might relate specific qualifications to agency cost reductions where relevant to the business and, in some instances, to the scope and nature of the industry concerned. This logic implies that CEO education might help firms to gain legitimacy by conforming with institutional logics (Higgins & Gulati, 2006; Lester et al., 2006; Thornton, Ocasio, & Lounsbury, 2012).[28] While this notion seems plausible, the institutional relevance of a particular degree can only be reliably isolated and effectively assessed within industry-specific contexts. For instance, King et al. (2016) study the substantive role within banks of CEOs holding an MBA, whereas Colombo et al. (2019) explore the certification role of prestigious university affiliations on biotechnology IPO firms. The inferences of these studies are not generalizable to a multi-industry sample (like ours), and therefore, it is unclear which education disciplines are relevant to particular industries.[29]

In addition, the effect of a particular discipline might be context-dependent, thereby making it difficult to predict its net impact on performance (and its validity as a signal). For instance, several studies show that MBA holders may be associated with aggressive (and possibly value-destroying) growth policies (Bertrand & Schoar, 2003), or with self-serving behaviors that are potentially costly to shareholders (Miller & Xu, 2016). At the same time, other studies find that MBA degrees foster an improved attitude to corporate social responsibility (CSR; Lewis, Walls, & Dowell, 2013), spur financial ability (King

TABLE 9 The impact of education years and number of degrees on underpricing

Panel A: Number of degrees and education years by doctoral type

	PhD			MD			JD		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Number of degrees	2.79	2	4	1.76	1	4	1.69	1	4
Education years	10.60	4	16	8.28	4	16	6.54	4	14

Panel B: The effect of education years on IPO underpricing

	All (1)	Exclude CEOs with MD as the only degree (2)	Exclude CEOs with JD as the only degree (3)	Exclude CEOs with MD or JD as the only first degree (4)
Education years	−0.03 (−1.45)	−0.03* (−1.77)	−0.03* (−1.69)	−0.07* (−1.98)
Control variables	Y	Y	Y	Y
Industry and year fixed effects	Y	Y	Y	Y
N	1,601	1,556	1,568	1,523
Adjusted R^2	0.333	0.345	0.338	0.350

Note: This table presents the effects of the number of education years and the number of degrees on underpricing using OLS regressions. The sample consists of initial public offerings from 2000 to 2016 in the U.S. stock market. Control variables are the same as in Table 5. *T* statistics are included in parentheses. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

TABLE 10 The impact of education field on underpricing

Panel A: Descriptive statistics of education fields							
	Mean						
Business degree	0.44						
Technical degree	0.27						
Pharmaceuticals degree	0.03						
Biosciences degree	0.08						
Law degree	0.05						
Degrees in other field	0.28						
Panel B: The effect of education field on IPO underpricing							
Field of degree	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Business	−1.45*** (−3.37)						−1.08** (−2.39)
Technical		0.88 (1.03)					0.64 (1.20)
Pharmaceuticals			−1.75*** (−4.42)				−1.46* (−1.87)
Bioscience				1.27 (0.80)			1.25 (0.75)
Law					−1.42** (−2.18)		−1.38** (−2.56)
Other						0.53 (0.37)	0.42(1.44)
Control variables	Y	Y	Y	Y	Y	Y	Y
Industry and year fixed effects	Y	Y	Y	Y	Y	Y	Y
N	1,601	1,601	1,601	1,601	1,601	1,601	1,601
Adjusted R^2	0.331	0.331	0.330	0.333	0.331	0.330	0.336
Panel C: The effect of CEO education field on IPO underpricing at different educational levels							
Field of degree	**Undergraduate (1)**		**Master (2)**		**Doctoral (3)**		
Business	−0.72 (−0.96)		−1.19*** (−3.96)		−1.26** (−2.13)		
Technical	0.70 (1.08)		0.58 (0.90)		0.37 (0.42)		
Pharmaceuticals	−0.85 (−1.65)		−1.32* (−1.90)		−1.68* (−1.93)		
Biosciences	1.27 (0.85)		1.17 (0.83)		1.11 (0.85)		
Law (only JDs)					−1.15** (−2.40)		
Other	0.77 (1.12)		0.55 (1.52)		0.30 (1.12)		
Control variables	Y		Y		Y		
Industry and year fixed effects	Y		Y		Y		
N	1,475		829		346		
Adjusted R^2	0.357		0.442		0.359		

Note: This table displays the effects on IPO underpricing of the education field (discipline) of university qualifications held by CEOs using OLS regressions. The sample consists of initial public offerings from 2000 to 2016 in the U.S. stock market. The dependent variable is IPO underpricing and is calculated as the percentage change of the first-day closing price from the final offer price. Panel A presents the descriptive statistics for the education field. The mean percentages in panel A do not sum to 100 because the CEO education fields are not mutually exclusive. Panel B reports OLS regression results using the education field of each CEO as the main independent variable. Panel C presents OLS regression results for the effect of CEO education field on IPO underpricing across different levels of education. The control variables are the same as in Table 5. Year and industry fixed effects are included but their coefficient estimates are not reported for brevity. *T* statistics are included in parentheses and are adjusted for heteroscedasticity-robust standard errors clustered by industry. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

et al., 2016), and contribute to superior operating performance (Chemmanur & Paeglis, 2005).

In light of the above, we would like to note that the goal of this study is not to assess whether firms conform to the institutional pressures of publicly traded firms by examining the discipline of the CEO's education degrees. Rather, our focus is to explore whether the quality of education (as proxied by the level of education and the ranking of the awarding institution) contributes to superior short- and long-term IPO performance.

Nevertheless, we acknowledge that the discipline of a CEO's education might play a role in our findings, in the sense that the negative link between CEO education and underpricing could be attributable to particular disciplines. If this is so, we anticipate that if the CEO's educational discipline is held constant, the link between CEO education

TABLE 11 CEO education and post-IPO performance

Panel A: The effect of CEO education on post-IPO investment

	Total investment				Investment efficiency			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Undergraduate education	0.01 (0.59)			0.01 (0.67)	0.01 (1.00)			0.01 (1.00)
Master's education		0.01** (2.05)		0.01* (1.78)		0.01* (1.98)		0.01* (1.95)
Doctoral education			0.01** (2.25)	0.01** (2.13)			0.01** (2.42)	0.01** (2.46)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y
Industry and year FE	Y	Y	Y	Y	Y	Y	Y	Y
N	1,320	1,320	1,320	1,320	1,130	1,130	1,130	1,130
Adjusted R^2	0.365	0.365	0.365	0.366	0.148	0.145	0.156	0.156

Panel B: The effect of CEO education on post-IPO operating performance

	Average ROA				Average Tobin's Q			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Undergraduate education	−0.06 (−0.69)			−0.05 (−0.63)	2.20 (0.99)			2.12 (1.01)
Master's education		0.07* (1.89)		0.07* (1.77)		4.10* (1.95)		4.07* (1.85)
Doctoral education			0.06** (2.18)	0.06** (2.24)			4.19** (2.17)	4.48** (2.25)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y
Industry and year FE	Y	Y	Y	Y	Y	Y	Y	Y
N	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320
Adjusted R^2	0.137	0.139	0.137	0.139	0.102	0.101	0.099	0.104

Panel C: The effect of CEO education on firm failure

	(1)	(2)	(3)	(4)
Undergraduate education	−0.05 (−0.15)			−0.03 (−0.12)
Master's education		−0.19*** (−4.81)		−0.19*** (−4.16)
Doctoral education			−0.23* (−1.74)	−0.26* (−1.70)
Control variables	Y	Y	Y	Y
Industry and year FE	Y	Y	Y	Y
N	1,006	1,006	1,006	1,006
χ^2	285.15	312.45	273.77	305.70

Note: This table reports results from regressions of CEO education on post-IPO performance. Post-IPO operating performance is the average value of ROA for the 3 years following IPO. *Total Investment* is the ratio of the sum of capital expenditures and research and development expenses to total assets. We apply the investment model of Gomariz and Ballesta (2014) to compute *Investment Efficiency* and average this measure over the 3 years following the IPO. ROA is equal to net income divided by total assets. Firm value is approximated by Tobin's *Q*, where Tobin's *Q* is the ratio of the market value of assets to their book value. All measures are industry-adjusted at the two-digit SIC system level and averaged over the three years following IPO. *Firm Failure* is a dummy variable equal to 1 if the firm is delisted within 5 years of its IPO, and 0 otherwise. Panel A presents the effect of CEO education on post-IPO investment, while panel B reports the effect of CEO education on post-IPO performance. Panel C illustrates the estimation of the Cox proportional hazards model of probability of failure. Control variables are the same as in Table 5. *T* statistics are included in parentheses and are adjusted for heteroscedasticity-robust standard errors clustered by year and industry. All variables are defined in Appendix A.

*Significance at the 10% level.

**Significance at the 5% level.

***Significance at the 1% level.

and underpricing should become more negative (or at least less positive) where higher levels of education and/or more selective institutions are involved.

To explore these conjectures, we divide CEO educational attainments into six groups: (1) business (including accounting, business, economics, finance, management, and MBAs); (2) technical (including engineering, physics, mathematics, statistics, and operational research); (3) pharmaceuticals; (4) biosciences; (5) law; (6) other disciplines (including all other fields, such as humanities, history, arts, education, politics, journalism, history, and defense studies). We note that this categorization is based mainly on advanced degrees (i.e., master's and doctoral degrees) and to a more limited extent on undergraduate degrees (i.e., BA or BSc), because the information coverage in IPO prospectuses is more detailed for the former than the latter.[30]

In panel A of Table 10, we observe that the largest proportion of CEOs holds a degree in business (44%), followed by a degree in technically oriented fields (27%). Some 5% hold a degree in law, while about 13% hold a degree in either pharmaceuticals (3%) or biosciences (8%).[31] Panel B reports the regression output in which the dependent variable is underpricing and the main independent variable is the CEO's education field. Because a CEO may have studied more than one discipline, we introduce the CEO education fields sequentially in columns 1 to 6 and consider all fields together in column 7. The results indicate that the negative relationship between CEO education and IPO underpricing is primarily driven by CEOs who obtained a degree in business, pharmacy, or law.

Panel C of Table 10 explores whether the sign and economic significance of these fields varies between different educational levels. As expected, the results indicate that for higher levels of education the link between education field and underpricing becomes more negative (or less positive). In unreported results, we consider for each field the quality of the awarding institution instead of the level of the degree and obtain similar outcomes.[32]

7.3 | Long-term effects of CEO education

Our finding that the academic credentials affect the perceptions of IPO investors confirms our central hypothesis, that is, that CEO education is a crucial determinant of short-term IPO success. A question that arises concerns its role in the long-term success of a firm: does CEO education deliver benefits to a firm beyond the IPO? Does it play a signaling role that can be confirmed by subsequent experience?

If higher or better CEO education is indeed a reliable indicator of unobservable but influential talents, it raises the question of exactly how it might affect a firm. Chemmanur and Paeglis (2005) argue that higher quality managers can select better projects (characterized by a larger net present value for any given scale) and implement them more ably. They may accomplish this by having better foresight of the potential of innovative investment opportunities, by more effectively managing innovative resources, such as physical assets and human capital, or by embracing managerial styles that enhance corporate efficiency (Amore et al., 2019; Chemmanur et al., 2019).

Taken together, these arguments lead to several testable predictions. First, assuming decreasing returns to scale, firms with better educated CEOs will be associated with a larger scale of investment at equilibrium. Second, well-educated CEOs will utilize physical and intangible assets more effectively, and this may be reflected in greater investment efficiency (i.e., lower deviations from equilibrium levels of investment). Third, firms with well-educated CEOs will have better future operating performance and higher corporate value.

To evaluate these predictions, we initially examine the association between our educational factors and the average level and efficiency of post-IPO investment for our sample firms. We define investment as the sum of investment in capital expenditures and research and development (*Average Total Investment*). We define investment efficiency as the absolute value of residuals of a regression in which the dependent variable is the total investment, following Gomariz and Ballesta (2014). Panel A of Table 11 indicates that our CEO education factors tend to be associated with greater levels of investment and higher investment efficiency. These relationships are mainly driven by the master's and doctoral education factors.

Then, we examine the link between CEO education and post-IPO performance. Specifically, we re-estimate Equation 1 using three measures of post-IPO performance (*Average ROA*, *Average Tobin's Q*, and *Firm Failure*) as alternative dependent variables.[33] The results in Panels B and C of Table 11 suggest that firms employing CEOs with higher undergraduate, master's, or doctoral education factor scores perform better (enjoy superior corporate performance and higher survival rates).[34] Notably, this observation is mainly attributable to doctoral degrees.[35]

Overall, these results imply that prestigious CEO educational credentials create a separating equilibrium because the expectations associated with the presence of such signals at the IPO are confirmed by the realization of better long-run performance in the post-IPO period.

8 | CONCLUSION

Most of the existing literature has focused on the impact of CEO educational attainments on corporate outcomes in the context of mature corporations. Conceptually and empirically, we extend this stream of literature by studying the specific role of CEO educational attainments in relation to IPOs. In particular, we investigate whether and how the level and quality of CEO educational training affects investor perceptions as reflected in IPO underpricing.

Building upon upper echelon, institutional, and signaling theories, we predict and find that superior educational credentials—in terms of level and quality—serve as a credible signal to investors of organizational quality that is otherwise hard to observe. Specifically, our analysis indicates that firms led by CEOs with doctoral degrees from highly ranked institutions have lower levels of underpricing and better post-IPO performance. In addition, we find evidence that the downward impact of better CEO education on the level of underpricing is more pronounced in environments characterized by higher uncertainty and

greater information asymmetry between issuers and prospective investors.

In conclusion, this study makes the following contributions. First, we extend previous works conducted on CEO education and organizational performance. Second, we expand the literature on CEO educational attainments in relation to IPOs, where prior research has largely focused on signals derived from firm-specific characteristics, outside parties, or the heterogeneous background of the top management team. Finally, our results have important implications for corporate decision-making by providing evidence of the role of CEO educational attainment as a screening device for prospective issuers, as well as a quality signal for individual executives in the financial and labor markets.

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NOTES

[1] This conjecture is consistent with several studies showing that education is important in settings where the reputation effect is less likely to be the prominent channel through which educational credentials affect firms. For instance, Custodio, Mendes, and Metzger (2020) focus on the knowledge role of education among small and medium or nonlisted companies and find that executive education programs in finance lead to improvements in corporate financial practices. Similar findings are reported by Bruhn, Karlan, and Schoar (2018).

[2] We obtain similar results if we consider the ranking of the school in the discipline which is relevant to the degree instead of the overall university ranking.

[3] For a detailed discussion of why IPOs are subject to severe uncertainty and substantial information asymmetry between insiders and outsiders, see Section A4 of the Internet Appendix.

[4] D'Aveni (1990) proposes managerial prestige as a crucial indicator of skills and competencies and contends that it is (partly) a function of an individual's human and social capital. Broadly speaking, human capital pertains to innate and learned abilities, expertise, and knowledge gained through education, training, and on-the-job experience (Becker, 1975), whereas social capital refers to an individual's ability to access resources through social linkages in a variety of contexts (Burt, 1992).

[5] BoardEx provides detailed curricula vitae for company officials of U.S. and European public and private companies, containing college, graduate, and professional education and degree information, past employment history, and current employment status. Apparently, for our sample CEOs, there is a significant overlap between the information reported in IPO prospectuses and BoardEx. In light of this, one could argue that there is low benefit in using IPO prospectuses. However, we argue that BoardEx is not particularly useful for constructing the CEO list because there are many company officials with the same or extremely similar full names, making the initial identification and matching difficult. Moreover, unlike IPO prospectuses, BoardEx does not always provide details of the awarding institution. For instance, there are cases where it states that the CEO has an MBA or an undergraduate degree, without naming the awarding university. Most importantly, BoardEx does not typically provide information about the education field, unless the CEO has obtained a degree in a discipline that is self-explanatory, such as an MD, MBA, or JD. Other information, such as whether a CEO's master's or undergraduate degree is in mathematics or finance, cannot be extracted from BoardEx.

[6] See https://www.usnews.com/education for complete methodology and rankings. USNWR recognizes that degrees may differ not only in terms of their major but also in terms of the purpose of the awarding institution. For example, National Universities offer a full range of undergraduate majors, plus master's and doctoral programs, and emphasize faculty research. National Liberal Arts Colleges focus almost exclusively on undergraduate education and award at least 50% of their degrees in the liberal arts.

[7] USNWR also provides more refined rankings based on the specific individual discipline, for example, science, history, law, medicine, business. While such a ranking approach is more precise, it makes the comparison of universities across different disciplines more difficult. For example, a Top-20 awarding institution specializing in medicine is not directly comparable —in terms of quality— with a Top 20 academic institution offering MBA programs. Nevertheless, in unreported tests, we find that if we rely on a ranking system based on the specific discipline of each degree, our inferences do not materially change.

[8] USNWR also provides rankings for non-U.S. universities; however, these rankings are not directly comparable with the rankings of domestic U.S. academic institutions. To control for this issue, we incorporate a variable that indicates whether the CEO holds an international degree. Alternatively, we resort to the best global universities rankings of USNWR or exclude education observations with an international degree from our sample. Unreported tests indicate that none of these alternative treatments affects our inferences.

[9] In unreported tests, we rerun our regressions without clustering the standard errors. We find that the t statistics of our variables of interest are slightly larger. Because the double-clustering leads to more conservative t statistics, we adopt this specification in our modeling process.

[10] We manually match our list of IPO CEOs with the BoardEx database to obtain detailed data on CEOs' prior professional experience. We use information about all of a CEO's past positions in publicly traded firms.

[11] A commonly used measure of overconfidence in the literature relies on the manager's personal investment decisions, specifically the purchase and sale of stock in their own firm (Malmendier & Tate, 2005). Although it is possible to construct a similar measure for IPO firms, it would require the use of information after the initiation of trading. This would introduce look-ahead bias and render the measure largely endogenous to post-IPO stock performance, because most managers commit to post-IPO lock-in periods during which they agree not to sell stock. An alternative treatment would involve the consideration of other managerial decisions around the IPO and, in particular, characteristics that are

likely to be associated with managerial overconfidence, such as firm age, share overhang, and recent market returns. The expectation is that, compared with less confident managers, highly overconfident managers will take their firms public sooner, retain a greater fraction of the firm's shares, and be less influenced by current market conditions when going public (Boulton & Campbell, 2016). As discussed subsequently, all of these factors are incorporated in our models.

[12] Underpricing is a function of both the difference between the closing market price at first trading and the final offer price.

[13] In untabulated analysis, we regressed *IPO Revision* on our CEO education factors using a similar specification to that of our baseline model. We find that all CEO education factors relate positively with *IPO Revision*, though only the doctoral factor is marginally significant, at the 10% level. Thus, if there is indeed a relationship between CEO education and underpricing, it is mostly attributable to the information production occurring during the first trading day rather than the book-building period.

[14] The economic significance is calculated as follows: coefficient of doctoral education factor (−2.17) × standard deviation (SD) of doctoral education factor (0.72) = −1.56%. The mean of the doctoral education factor is 0.00, while its SD is 0.72.

[15] Using the fraction of equity compensation to total compensation as a competing variable to CEO total pay yields similar results.

[16] *EGC* is an indicator variable that equals 1 for firms classified as emerging growth companies (EGCs), and 0 for non-EGC (NEGC) firms. EGCs are private firms that went public after the JOBS Act with an EGC status, while NEGC firms are those that went public before the act that would have qualified for EGC status (i.e., below the $1 billion revenue threshold) had their IPO occurred after the act. We follow Barth et al. (2017) and identify EGCs from their prospectuses.

[17] When we examine the impact of SOX in our sample, we limit the sample to the period 2000–2006. *Post-SOX* is a dummy variable equal to 1 if the firm goes public following the passage of SOX (July 30, 2002), and 0 otherwise.

[18] Our sample runs from 2009 to 2016 because we want to remove any confounding effects associated with the 2008 financial crisis as well as the effect of SOX (2002) from our analysis. Furthermore, to obtain a control sample in terms of size, we follow Barth et al. (2017) and exclude from our sample those IPO firms with revenues below $1 billion before 5 April 2012 (118 firms).

[19] Similar arguments can be developed for the inclusion of our set of firm-level and IPO-specific control variables.

[20] We count the number of acquisitions of public targets made by established firms (in the industry to which the sample firms belongs) 5 years beforehand as a measure of the supply of outside managers in that industry. The 5-year lag stems from the retention contracts popularly employed by acquirers for target firms. These contracts often compensate the managers of target firms for lost compensation for up to 5 years and provide strong incentives for these managers to stay with the target firms for another few years. The expiration of these contracts generates an exogenous source of variation in the supply of managers available for hire.

[21] Garmaise (2011) develops an index to measure the enforceability of noncompete clauses by considering 12 questions analyzed by Malsberger (2004), which is the central resource describing non-competition law in the 50 U.S. states and the District of Columbia, and assigning 1 point to each jurisdiction for each question if the jurisdiction's enforcement of that dimension of noncompetition law exceeds a certain threshold. Possible totals therefore range from 0 to 12.

[22] Garmaise's (2011) index measuring the enforceability of noncompete clauses originally covered the period 1992–2004. Ertimur et al. (2018) adopt the same methodology and extend the index to cover the period 1980–2014. In our analysis, we utilize the values of the index from Garmaise (2011) for the period 1992–2004 and from Ertimur et al. (2018) and Kini et al. (2019) for the period 2005–2014.

[23] However, even though we control for the direct effect of merger waves on underpricing, it may be argued that the requirement that the acquisitions in the industry in previous years be correlated with future IPO underpricing only through the supply of managers may not hold. In this latter scenario, the exclusion criterion for a valid instrument will not be satisfied. Given this, the results of our IV analysis should be viewed as suggestive, and should be interpreted with caution.

[24] Our results remain the same in terms of sign even when we do not include state fixed effects.

[25] In the Internet Appendix, we consider an alternative instrument that aims to capture exogenous variation in the relative demand for CEO educational credentials. To do so, we follow Falato et al. (2015) and consider the average quality of the awarding institutions for each level of education degree of U.K. CEOs as instruments for the educational achievements of their U.S. counterparts that are in the same industry group. The first-stage results of this IV approach provide strong support for the relevance of this instrument. In addition, the second-stage results imply that unobserved firm heterogeneity is unlikely to be the main driver our findings. However, we note that instrumenting CEO education with the industry level of CEO education relies on an assumption that the aggregation of multiple endogenous realizations at the firm level tend to cancel each other out. This is a rather bold assumption, and hence, the exclusion criterion is not very likely to be satisfied (we thank an anonymous referee for highlighting this aspect). Because of the limitations of this instrument, these results cannot be interpreted as evidence of a treatment effect, and instead, we take our findings as suggestive.

[26] There are eight Ivy League schools: Brown University, Columbia University, Cornell University, Dartmouth College, Harvard University, the University of Pennsylvania, Princeton University, and Yale University.

[27] Similarly, various studies in the finance and management domain document a relationship between the field of expertise and a series of corporate outcomes such as innovation, investment, energy efficiency, and corporate social responsibility (e.g., Amore et al., 2019; Benmelech & Frydman, 2015; Custodio & Metzger, 2014; Sunder, Sunder, & Zhang, 2017).

[28] According to institutional theory, a firm may seek to influence investor impressions of organizational legitimacy by developing signals that communicate the firm's capabilities. For instance, firms may gain resource legitimacy and access to investors' funds by hiring CEOs with prestigious educational credentials (DiMaggio & Powell, 1983; Lester et al., 2006; Xu, Patton, & Kenney, 2015). These credentials indicate access to human and social capital. Likewise, a firm may gain role legitimacy by hiring a CEO with an educational background that matches the firm's economic environment. However, while both the quality and field of education demonstrate a firm's ability to conform to the institutional pressures of publicly traded firms, only the benefits of the former rather than the latter are applicable to a wide variety of contexts. Arguably, the role of the field of education can only be reliably assessed with a sample that is confined to specific industries/contexts (e.g., Colombo et al., 2019; King et al., 2016).

[29] For example, although it is reasonable to assume that a pharmacy degree is more desirable than a mathematics degree in the biotech sector, it is more difficult to identify *ex ante* which of these disciplines is more useful in the retail sector.

[30] In particular, we are able to collect information about the field of study of advanced degrees for approximately 95% of our sample CEOs. In contrast, we are able to collect information about the discipline of undergraduate degrees for about 50% of our sample CEOs. To avoid losing observations, we combine the information about the major from

these two datasets. We have also explored the role of education fields using two alternative specifications. First, we included an indicator variable in our regressions to control for the fact that some firms do not provide information about the field of study of undergraduate degrees. Second, we restricted the sample only to CEOs with advanced business degrees (i.e., 67% of our initial sample). Untabulated results confirm that these treatments do not affect the tenor of our results.

[31] It should be noted that the field groups are not mutually exclusive, which means that a CEO may have a degree in more than one field.

[32] In the Internet Appendix, we adopt a different classification scheme for CEO academic qualifications and examine how it affects the initial responses of IPO investors. Specifically, instead of focusing on the specific major of each degree, we consider a slightly different and broader aspect of educational disciplines. For undergraduate degrees, we examine whether a BSc or a BA matters more to IPO investors. For advanced degrees, we ask whether an MBA or an MSc in a technical or research-oriented discipline is perceived differently by investors to an MA degree. For doctoral titles, we explore whether a PhD, an MD, or a JD are more important in the eyes of IPO investors. Table IA3 reveals that although most CEO education degrees —categorized by level— are negatively associated with underpricing, this relationship is weaker among CEOs with degrees in liberal arts or medical sciences (i.e., BA, MA, or MD). In the Internet Appendix, we offer several conjectures for these findings.

[33] We assess the impact of CEO education on the probability of IPO failure (survival) using the Cox proportional hazard model, instead of using ordinary least-squares (OLS) and logit or probit models, because the Cox model follows the firm over a specific time period that identifies precisely when a firm experiences an event of interest (i.e., delisting). This is particularly useful for censored data, that is, relating to events that either have different time horizons or have yet to occur (Gounopoulos & Pham, 2018; Hensler, Rutherford, & Springer, 1997). Specifically, in our study, the survival time of IPO firms is right-censored because many firms that went public are still trading but the time window is different for each firm depending on its IPO date. To determine whether they get delisted, our sample period starts from 2000 and tracks all IPO issuers until 31 December 2017. Because our minimum survival window is 5 years, our IPO population for the survival tests covers only the period 2000–2012. Thus, a firm that went public in 2000 is tracked for 17 years whereas a firm that went public in 2012 is only tracked for 5.

[34] We follow prior IPO literature (e.g., Carter et al., 1998; Ritter, 1991) by using 3 years as the long-run horizon over which to examine corporate performance. However, firms occasionally delist (e.g., via acquisition and bankruptcy) prior to their 3-year anniversary, and in such cases, we expect to have fewer observations in our regressions.

[35] The number of observations for all models is reduced either because some firms get delisted after the IPO or relevant accounting information is unavailable in Compustat.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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APPENDIX A: DEFINITIONS OF VARIABLES

Panel A: IPO pricing	
Underpricing	The difference between the first secondary market closing price available in CRSP and the IPO offer price, divided by the IPO offer price.
IPO Revision	The ratio of difference between the offer price and the midpoint of the price range over the latter.
Panel B: Education characteristics	
Years of Education	Total number of years of CEO educational study.
Number of Degrees	Total number of university degrees held by the CEO.
International Degree	Dummy variable equal to 1 if the CEO holds a degree from an international institution, and 0 otherwise.
Undergraduate Degree	Dummy variable equal to 1 if the CEO holds an undergraduate degree, and 0 otherwise.
Undergraduate Degree International	Dummy variable equal to 1 if the CEO holds an undergraduate degree from an international university, and 0 otherwise.
BA	Dummy variable equal to 1 if the CEO holds a BA degree, and 0 otherwise.
BA International	Dummy variable equal to 1 if the CEO holds a BA degree from an international university, and 0 otherwise.
BA-TOP20	Dummy variable equal to 1 if the CEO received a BA from a school ranked in the USNWR Top 20 National Universities, and 0 otherwise.
BA Ivy League	Dummy variable equal to 1 if the CEO received a BA from an Ivy League institution, and 0 otherwise.
BSc	Dummy variable equal to 1 if the CEO holds a BSc degree, and 0 otherwise.
BSc International	Dummy variable equal to 1 if the CEO holds a BSc degree from an international university, and 0 otherwise.
BSc-TOP20	Dummy variable equal to 1 if the CEO received a BSc from a school ranked in the USNWR Top 20 National Universities, and 0 otherwise.
BSc Ivy League	Dummy variable equal to 1 if the CEO received a BSc from an Ivy League institution, and 0 otherwise.
Master's Degree	Dummy variable equal to 1 if the CEO holds a master's degree, and 0 otherwise.
Master's Degree International	Dummy variable equal to 1 if the CEO holds a master's degree from an international university, and 0 otherwise.
MA	Dummy variable equal to 1 if the CEO holds an MA degree, and 0 otherwise.
MA International	Dummy variable equal to 1 if the CEO holds an MA degree from an international university, and 0 otherwise.
MA-TOP20	Dummy variable equal to 1 if the CEO received an MA from a school ranked in the USNWR Top 20 Liberal Arts Colleges, and 0 otherwise.
MA Ivy League	Dummy variable equal to 1 if the CEO received an MA from an Ivy League institution, and 0 otherwise.
MSc	Dummy variable equal to 1 if the CEO holds an MSc degree, and 0 otherwise.
MSc International	Dummy variable equal to 1 if the CEO holds an MSc degree from an international university, and 0 otherwise.
MSc-TOP20	Dummy variable equal to 1 if the CEO received an MSc from a school ranked in the USNWR Top 20 National Universities, and 0 otherwise.
MSc Ivy League	Dummy variable equal to 1 if the CEO received an MSc from an Ivy League institution, and 0 otherwise.
MBA	Dummy variable equal to 1 if the CEO holds an MBA degree, and 0 otherwise.
MBA International	Dummy variable equal to 1 if the CEO holds an MBA degree from an international university, and 0 otherwise.
MBA-TOP20	Dummy variable equal to 1 if the CEO received an MBA from a school ranked in the USNWR Top 20 Business Schools, and 0 otherwise.
MBA Ivy League	Dummy variable equal to 1 if the CEO received an MBA from an Ivy League institution, and 0 otherwise.
Professional Qualification	Dummy variable equal to 1 if the CEO holds a professional qualification (e.g., CPA, ACCA, CFA, or ICEAW), and 0 otherwise.
Doctoral Degree	Dummy variable equal to 1 if the CEO holds a doctoral degree, and 0 otherwise.
Doctoral Degree International	Dummy variable equal to 1 if the CEO holds a doctoral degree from an international university, and 0 otherwise.
MD	Dummy variable equal to 1 if the CEO holds an MD degree, and 0 otherwise.
MD International	Dummy variable equal to 1 if the CEO holds an MD degree from an international university, and 0 otherwise.
MD-TOP20	Dummy variable equal to 1 if the CEO received a BA from a school ranked in the USNWR Top 20 Medical Schools, and 0 otherwise.
MD Ivy League	Dummy variable equal to 1 if the CEO received an MD from an Ivy League institution, and 0 otherwise.

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JD	Dummy variable equal to 1 if the CEO holds a JD degree, and 0 otherwise.
JD International	Dummy variable equal to 1 if the CEO holds a JD degree from an international university, and 0 otherwise.
JD-TOP20	Dummy variable equal to 1 if the CEO received a JD from a school ranked in the USNWR Top 20 Law Schools, and 0 otherwise.
JD Ivy League	Dummy variable equal to 1 if the CEO received a JD from an Ivy League institution, and 0 otherwise.
PhD	Dummy variable equal to 1 if the CEO holds a PhD degree, and 0 otherwise.
PhD International	Dummy variable equal to 1 if the CEO holds a PhD degree from an international university, and 0 otherwise.
PhD-TOP20	Dummy variable equal to 1 if the CEO received a PhD from a school ranked in the USNWR Top 20 National Universities, and 0 otherwise.
PhD Ivy League	Dummy variable equal to 1 if the CEO received a PhD from an Ivy League institution, and 0 otherwise.
Business Degree	Dummy variable equal to 1 if the CEO has studied accounting, business, economics, finance, management or MBA, and 0 otherwise.
Technical Degree	Dummy variable equal to 1 if the CEO has studied engineering, physics, mathematics, statistics or operational research, and 0 otherwise.
Pharmaceutical Degree	Dummy variable equal to 1 if the CEO has studied pharmaceuticals, and 0 otherwise.
Biosciences Degree	Dummy variable equal to 1 if the CEO has studied biosciences, and 0 otherwise.
Law Degree	Dummy variable equal to 1 if the CEO has studied law, and 0 otherwise.
Degree in Other Field	Dummy variable equal to 1 if the CEO has studied other fields (such as humanities, history, arts, education, politics, journalism, history, and defense studies), and 0 otherwise.
Panel C: CEO and firm characteristics	
CEO Age	Age of CEO (in years).
Gender	Dummy variable equal to 1 if the CEO is male, and 0 otherwise.
Founder	Dummy variable equal to 1 if the CEO is both founder and CEO, and 0 otherwise.
CEO Tenure	Number of years working as CEO in the firm before the IPO.
CEO Overconfidence	We classify managers as highly overconfident at IPO if they chose very high levels of investment for their firms (measured by industry-adjusted capital expenditures scaled by opening PP&E) for two consecutive years ending with the IPO year (following Boulton & Campbell, 2016).
General Ability Index (GAI)	First factor of applying principal components analysis to five proxies of general managerial ability: number of roles, number of firms, number of industries, CEO experience dummy, and conglomerate experience dummy (Custodio et al., 2013).
Cash Compensation	The logarithmic value of salary and bonus awarded to the CEO as bonus in the fiscal year prior to the IPO.
Equity Compensation	The logarithmic value of equity (stock and options) awarded to the CEO as bonus in the fiscal year prior to the IPO.
CEO Compensation	The logarithmic value of the sum of all the above compensation elements awarded/granted to the CEO in the fiscal year prior to the IPO.
Equity Fraction	The ratio of *Equity Compensation* to total *CEO Compensation* in the fiscal year prior to the IPO.
Firm Age	The number of years elapsed between firm's foundation and IPO date, using foundation dates from the Thomson Financial database as well as from the Field–Ritter dataset. The variable is transformed in the regressions by adding 1 and taking the natural logarithm.
Size	The natural logarithm of pre-IPO total assets.
Proceeds	The natural logarithm of gross proceeds.
Leverage	The ratio of total liabilities to total assets in the fiscal year prior to IPO.
EPS	Dummy variable equal to 1 for positive earnings per share in the fiscal year prior to IPO, and 0 otherwise.
R&D Intensity	The ratio of research and development expenditures to total assets in the fiscal year prior to IPO.
Board Independence	The ratio of the number of independent outside directors to the total number of directors.
% of Outside Directors	The percentage of outside directors on the board that were appointed after the current CEO took office.
Board Size	The natural logarithm of the number of directors serving on the board.
Instrument	The product $Acquisitions_{j,s,t-5} \times Enforceability\ Index_{s,t}$
Enforceability $Index_{s,t}$	An index measuring the enforceability of noncompete agreements across different U.S. states based on Garmaise (2011) and updated from Ertimur et al. (2018). We multiply it by −1 so that higher values of this index indicate weaker enforceability and, hence, higher managerial mobility.

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$Acquisitions_{j,t-5}$	The number of acquisitions made by established (public) companies in industry *j* in state *s* in year $t-5$.
Average Total Investment	The average total investment from one year after the issue date to 3 years after going public. Total investment is the ratio of the sum of capital expenditures and research and development expenses to total assets.
Investment Efficiency	The absolute value of residuals of the investment model proposed by Gomariz and Ballesta (2014) multiplied by −1.
Average ROA	The average value of return on assets (ROA) from 1 year after the issue date to 3 years after going public. ROA is the ratio of net income to total assets.
Average Tobin's *Q*	The average value of Tobin's *Q* from 1 year after the issue date to 3 years after going public. Tobin's *Q* is the ratio of the market value of assets to the book value of assets.
Firm Failure	Dummy variable equal to 1 if the firm is delisted within 5 years of the IPO, and 0 otherwise.
Panel D: IPO (Offering characteristics)	
Overhang	The ratio of shares retained by the pre-IPO shareholders to shares issued in the offering.
Nasdaq	Dummy variable equal to 1 for Nasdaq-listed IPOs, and 0 otherwise.
Underwriter	Dummy variable equal to 1 for the most prestigious underwriters, and 0 otherwise. Most-reputable underwriters are those with a ranking score of 9.0 or above in Jay Ritter's underwriter (prestige) rankings.
VC	Dummy variable equal to 1 for venture-capital-backed firms, and 0 otherwise.
Technology	Dummy variable equal to 1 for IPO firms with Standard Industry Classification (SIC) codes 3571, 3572, 3575, 3577, 3578 (computer hardware), 3661, 3663, 3669 (communications equipment), 3671, 3672, 3674, 3675, 3677, 3678, 3679 (electronics), 3812 (navigation equipment), 3823, 3825, 3826, 3827, 3829 (measuring and controlling devices), 3841, 3845 (medical instruments), 4812, 4813 (telephone equipment), 4899 (communications services), 7371, 7372, 7373, 7374, 7375, 7378, or 7379 (software).
Internet	Dummy variable set to 1 for IPOs of internet firms, and 0 otherwise. Internet firms are classified as those with a business description containing any of the words “Internet,” “Online,” “eBusiness,” “eCommerce,” or “Website.”
Market Heat	The moving average, MA(4), of the number of IPOs in each state-quarter divided by its corresponding sample average.
Market Return	The compounded daily return on the CRSP value-weighted index over the 20 trading days following the IPO.