

More than Money: Prominent Investor Influence on Startup Professionalization and Performance

Annamaria Conti^{*}
Scheller College of Business
Georgia Institute of Technology

Stuart J.H. Graham
Scheller College of Business
Georgia Institute of Technology

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Abstract

This paper empirically examines how the involvement of prominent investors influences the professionalization of management in startup firms. Using a large dataset of investors, startups, and their characteristics, we focus on how introducing more prominent investors affects the replacement of incumbent CEOs, identifying the conditions associated with CEO transition, and relating these replacements to *ex-post* financial performance in the startup venture. We show not only that participation by more prominent investors increases the incidence of CEO replacement, but also that superseding CEOs who emerge from the involvement of prominent investors are drawn overwhelmingly from one pool: Outside candidates with previous startup management experience. We demonstrate that – following a CEO replacement – startups achieve superior financial performance, and that this performance is enhanced when the new CEO comes from outside the startup, and to an even greater degree when the replacement has prior experience managing another investor-funded startup. Importantly, we are able to demonstrate that these value-enhancing replacement effects are related specifically to the participation of more prominent investors.

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JEL Codes: G24 (Venture capital); G32 (Value of firms); L26 (Entrepreneurship); M13 (New firms; startups).

^{*} Corresponding author: 800 W. Peachtree St. NW, Atlanta, GA 30308. Annamaria.Conti@scheller.gatech.edu.

I. Introduction

In this paper, we undertake to empirically examine how the involvement of prominent investors influences the professionalization of management in startup firms. Using a large dataset of investors, startups, and their characteristics, we focus on how introducing more prominent investors affects the replacement of incumbent CEOs, identifying the conditions associated with CEO transition, and relating these replacements to *ex-post* financial performance in the startup venture. We show not only that participation by more prominent investors increases the incidence of CEO replacement, but also that superseding CEOs who emerge from the involvement of prominent investors are drawn overwhelmingly from one pool: Outside candidates with previous startup management experience. We demonstrate that – following a CEO replacement – startups achieve superior financial performance, and that this performance is enhanced when the new CEO comes from outside the startup, and to an even greater degree when the replacement has prior experience managing another investor-funded startup. Importantly, we are able to demonstrate that these value-enhancing replacement effects are related specifically to the participation of more prominent investors.

Finance theory has generally modeled financial intermediaries through an information lens, examining the principal-agent relationship, adverse selection and moral hazard (Diamond 1984; Fama 1985; Stiglitz, 1985; Bernanke et al., 1994). While the prior literature has recognized that financial intermediaries – typically venture capitalists (VCs) – often participate in managing and monitoring the investee startup (Sahlman, 1990; Gompers and Lerner, 2004), an emerging literature examines the different mechanisms VCs employ to screen and monitor their investments, including contractual agreements and convertible securities (Hellmann, 1998; Kaplan and Stromberg, 2002; 2004; Casamatta, 2003; Schmidt, 2003). Hellman and Puri (2000, 2002) contribute by investigating the effect VCs have on the management and organization of the companies in which they invest, choosing to examine the impact of VC funding on the professionalization of startup management, among other mechanisms. Kaplan and Schoar (2005) hypothesize that persistent returns among some VCs they observe may be due to heterogeneity in VC skills in screening and monitoring. Like these prior studies Sørensen (2007) focuses on VCs, contributing by exploring the relationship between the differential quality of VCs – as evidenced by investing experience – on the *ex-post* financial performance of investee startups.

Our paper combines disparate elements from this emerging literature to investigate a set of unanswered questions related to the participation of prominent investors in startups, professionalization at the top level of startup management, and – critically – whether these characteristics have implications for the financial performance of startup firms. Principally, we are interested in differences among startup investors in terms of their quality (Sørensen, 2007) so focus on prominent investors, and also in a particular monitoring mechanism identified in Hellman and Puri (2002): The professionalization of startup management through replacement of CEOs. Our investigation in this paper of how participation by prominent investors affects top executive turnover in startups fills a gap in the literature, since we provide causal evidence about the circumstances, conditions, and *ex-post* financial performance of startups experiencing a prominent-investor led CEO replacement. In so doing, we add meaningfully to the field’s understanding of the conditions for, and financial consequences of, the professionalization of managers in startup companies.

Our exploration of prominent investors is motivated by an unresolved question stemming from the findings of Hellmann and Puri (2002). Sørensen (2007), and Chemmanur, Krishnan, and Nandy (2011): Is superior startup financial performance influenced primarily by VCs in particular, or is the differential quality of investors – regardless of their type – the more important factor driving such performance? Characteristics specific to VCs may dominate, since venture-capital investment firms have developed distinctive organizational forms and use a particular set of institutions based in contract and equity when structuring their deals (Kaplan et al., 2002). But because in the context of VC startup investment differential quality of investors is consequential (Sørensen, 2007), we designed our study by constructing a measure of prominence in both VC and non-VC investors. In so doing, we recognize the importance of moving away from an exclusive focus on VCs to investigate other types of startup investors (Ueda, 2004; Kerr, Lerner, and Schoar, 2014). Following interviews with financiers,¹ we expect that startup performance will be influenced by investors’ experience, reputation, and relationships in entrepreneurial financing and the relevant (startup) industry sector. Because our measure of prominence uses prior investing relationships with other investors, and captures participation in prior deals, it is accurately viewed

¹ During June-September 2015 we conducted a series of interviews with investors from California, New York, and Atlanta with deep experience in funding startups in different sectors and at different stages.

as a proxy for investing experience, and an investor’s central position in industry networks (Hochberg *et al.*, 2006).

By employing our measure of prominence, we are able to relate differences in investor quality to a primary mechanism through which financiers exercise their monitoring role: The professionalization of startup management. Hellmann and Puri (2002), noting that traditional finance theory considers investors as primarily interested in only the financial aspects of investee firms, empirically investigated whether VCs take a role in professionalizing startup management. Using a dataset of 170 California-based startup companies, they collected detailed information on firms, including whether and when VC funding had arrived, and whether a founder CEO had been replaced with an “outsider” (defined as any non-founder, whether the replacement originated from inside or outside the startup). Their regression analysis demonstrated a positive correlation between a firm having VC funding and CEO turnover, helping bolster the notion that VCs were not simply acting as financial intermediaries, but were instead actively modifying the structure of startups in which they invested. While these findings are provocative, it is not obvious how to interpret their correlations. Due to endogeneity, their findings may be due either to the influence of VCs (monitoring) or the result of VC target selection (screening).

Our exploration is aimed at better understanding how investors and professionalization interact, but like Hellmann and Puri (2002) we face an endogeneity issue. We innovate by implementing a non-parametric matching approach called Coarsened Exact Matching (CEM) to overcome the limitations endogeneity imposes on generating and interpreting research results (Iacus *et al.*, 2011). While a limitation of matching algorithms is that they match treated and control observations based on observable characteristics only, we observe a rich set of startup characteristics which allow us to overcome this limitation. In fact, as we lay out in our methodology section below, our implementation of the CEM rests on a particularly strong foundation in that we achieve balance across a broad set of diverse indicators capturing organizational complexity, executive composition, and exit outcomes among others. We present compelling evidence that the effect of prominent investors’ involvement on a CEO replacement is not the result of screening. Moreover, in further support of the monitoring hypothesis, we find that the effect of prominent investors’ involvement is strongest for those startups that are likely to benefit the most from such involvement: startups in their earliest stages.

Because startup firms are often led in their early stages by technologists who lack professional managerial training, we explore the role of prominent investor involvement in the professionalization of startups by assessing at later stages the characteristics of superseding CEOs. Since investor motives for replacing a CEO may differ from case to case (Gompers and Lerner, 2004),² it is not *a priori* evident that CEO replacements deliver superior managerial abilities. Since we are interested in examining “professionalization” that brings specialized skills or education, we examine tractable attributes related to relevant executive experience in superseding CEOs. We specifically measure whether the succeeding CEO came from outside the firm, or had previously managed another investor-funded startup (“experienced outsiders”), finding that the involvement of prominent investors is strongly associated with CEO replacements who are experienced outsiders.

Building on these findings, the last question we answer in this paper is a fundamental one: Does a CEO replacement actually contribute to the *ex-post* financial performance of a startup? Again, in light of the disparate motives prominent investors may have for replacing existing CEOs in their investee startups, it is not clear that bringing in professional managers necessarily results in startups’ improved performance. Applying the CEM approach to address obvious endogeneity concerns, our empirical results demonstrate that the replacement of CEOs is responsible for superior *ex-post* financial performance, and that this performance effect is associated most strongly with succeeding CEOs that have prior experience managing investor-funded startups and who are hired from outside the firm. Finally and in strong support of the role of prominent investors on the professionalization of startups, our results point to a large performance effect of CEO replacements that are directly induced by the involvement of prominent investors.

The remainder of the paper is organized as follows. Section II describes the dataset. In Section III we present our results revealing the conditions under which CEO replacements in startups occur, the effects CEO replacement has on startup performance, and the influence that the participation of prominent investors has on both CEO turnover and performance in investee startups. Section IV presents a number of robustness checks. Section V concludes.

² Investors’ objectives may include maximizing the long-term value of their investment, securing a favorable type and timing of liquidity event, claiming a larger share of the distribution for investors, protecting complementary investments, or maintaining their position and reputation in the repeated game of investing among other financiers and potential future firm-founders.

II. The data

To assess the effect of investor prominence on the professionalization of startups we used data on startups' financing rounds and the identity of their CEOs from Thomson's Venture Economics.³ While Venture Economics only reports the most recent information about startups' executive personnel composition, we retrieved this information at two distinct points in time: once at the beginning of 2008 and the second time in April 2015.⁴ By so doing, we are in a privileged position to examine the impact of investor prominence on the probability that a startups' CEO is replaced as of 2015, and the role CEO replacement has on the startups' ability to attract follow-on financing.

To construct our sample, we began from the population of 28,150 US-based startup firms that appeared in the 2008 Thomson's Venture Economics dataset. We then retained those 16,772 companies that were also listed in the 2015 dataset. As the data show, not all startups observed in 2008 are included in the 2015 data: The information vendor declares that, in some cases, company names exit the data when the companies cease to operate (death) or change name, typically following an acquisition. Of the 16,772 startups we initially identified, we retain only those 16,228 companies for which we found complete information about founding dates, financing rounds, and the first and last names (including titles and suffixes) of individuals occupying firms' top management position (including "CEO" and "President," and their various forms).⁵ We excluded those startups that were founded prior to 1999, since we are only interested in the impact of investor prominence on the professionalization of relatively young companies, and eliminated startups operating in the utilities sector, given their small number (0.15% of the total). We are left with a sample of 6,787 companies.

In identifying the top managers in startups, we noted that of these 6,787 firms, 267 did not list a "CEO" (and various formulations) in 2008, but did report a "President." In these cases, we assume this President was the top manager in the firm. For robustness (presented later), we eliminate these instances from the sample and find results remain qualitatively the same. We also

³ Data from Thomson's Venture Economics have been used in several studies on venture capital (see, for instance, Lerner, 1995; and Kaplan and Schoar, 2005). Gompers and Lerner (2004) and Kaplan et al. (2002) find that this database comprises an extensive set of venture capital investments.

⁴ Venture Economics includes information on "executives," among companies appear in both periods listing in 2008 on average 7.8 executives (median=7) and in 2015 on average 6.7 (median=5).

⁵ For instance "CEO" can be listed as "Chief Executive Officer" and other formulations in these data; records were cleaned manually to include "President" but not "Vice President," and to exclude any Board Presidents, since we are interested in the top manager in the firm.

found 227 instances in which startups listed more than one CEO or President, but not as a “Co-CEO” or “Co-President.” Based on discussions we had with Thomson analysts, we excluded these startups from our analysis since the identified instances most probably corresponded to situations in which an old President or CEO was being replaced by a new one and the former’s name had not been removed from the dataset. Finally, we retained only those startups for which we could observe a financing round in 2008, 2007, or 2006, since we are interested in the impact of investor prominence on the probability that a CEO is replaced during 2008-2015. It is plausible to expect that a CEO replacement is related to, and even part of the same transaction surrounding, an investor’s participation in a given round. Based on the criteria just described, our final sample numbers 3,695 startups.

The distribution of these 3,695 startups across sectors is as follows: 272 operated in biotechnology, 490 in the medical sector, 89 in business services, 304 in communications, 109 in computer hardware, 801 in computer software, 814 in internet, 125 in consumer related sectors, 77 in financial services, 203 in energy, 314 in semiconductors, and the remaining in miscellaneous sectors. The distribution of our sample US-based startups closely mirrors that of all US-startups founded during the same period included in Venture Economics (our proxy for the population, following Kaplan et al., 2002).⁶ In our sample, average age since startup founding (in 2015) is 12 years (median=12). On average, our startups had received 3.5 rounds of financing (median=3) and a cumulative, constant USD funding stock by 2006 of 17 million (median=5 million). The average amount received by these companies is highest in the communications sector (30 million of constant USD, median=13 million).

In order to determine whether a CEO was replaced in the period from 2008 to 2015, we compared both by machine and by hand the names (first name, last name, title, and suffixes) of individuals listed in the top manager position in the cross-sectional data. Among the 3,695 startups, 40.5% (1,496) showed evidence of a CEO replacement as of 2015. By examining the Venture Economics data, we could also identify whether the CEO replacement was an insider or outsider (based on the list of people holding executive positions in the focal startup in 2008), and whether the individual had prior executive experience in a startup (by examining the entire corpus of

⁶ The largest difference is found for internet startups, which represent 22% of our sample and 15% of the Venture Economics population.

executives named in the 2008 and 2015 Venture Economics datasets).⁷ Accordingly, among the 1,496 startups we see experiencing a replacement, we observe 61% having their CEO replaced with an outsider, and 17% having their CEO replaced with an outsider with investor-backed startup managerial experience.

Investor Prominence. Consistent with our research questions, we are required to find an indicator for the prominence of participating investors. As a proxy for investor prominence, we use the eigenvector centrality measure (Bonacich, 1972), which weights an investor's ties to other investors by the importance of the investors the former is related to. We define w_{ij} as an indicator that equals 1 if investor i and investor j invested in the same company during a three-year window, and zero otherwise. Investor's i eigenvector centrality (v_i) can then be expressed as $v_i = \sum_j w_{ij} v_j$. According to this measure, investors who are tied to other investors having many ties are assigned higher values than those who are not.⁸

Based on this eigenvector centrality measure, we consider that a startup is “treated” with prominent investor financing if, in 2008, it received funds from an investor whose eigenvector value is in the 95th percentile of the distribution of eigenvector values, as computed for the entire population of investors who were active in 2008 according to Thomson's Venture Economics. We consider Venture Economics to be a good proxy for the population of US deals (Kaplan et al, 2002; Gompers and Lerner, 2004). If a startup, did not report any financing round in 2008, we use the 2007 round to compute our measure, while if the 2007 round is missing we use the 2006 round. According to our measure, 47.7% of the startups in our sample received funds from prominent investors during 2006-2008. As a robustness check, we alternatively built our treated indicator using as a reference those investors who participated in the financing rounds of our sample startups, rather than in the rounds of all startups in the population. Using this criterion, the percentage of treated startups decreases to 40.7%. As an additional robustness check, we built our treated indicator only for those “lead” investors that had invested the largest amount in a given startup

⁷ Naturally, Venture Economics does not list every startup company in the US. Nevertheless, we consider these data to be a good basis for examining relevant executive experience in managing technology startups that typically receive venture investing, recognized in the literature as being disproportionately high performers (Gompers and Lerner, 2004).

⁸ A number of studies have proxied for an investor's prominence with the eigenvector centrality measure. See for instance Hochberg et al. (2007) and Hsu and Ziedonis (2013).

relative to all other investors participating in a same round. Using this investor definition, the share of treated startups is 36.2%. We report these results in the robustness check section below.⁹

We complemented our main dataset with information on US patents granted to our sample startups prior to 2008. We machine and hand matched the company names in our Venture Economics sample to “assignee” information available from the US Patent & Trademark Office (USPTO).¹⁰ Patent grant information is drawn from two sources, bibliographic information drawn from the front page of US patents,¹¹ and a customized extract of cleaned and standardized assignee names available from the USPTO.¹² We find that 28% of our sample startups were granted at least one patent, and 19% were granted more than one patent, by December 31, 2008.

III. Econometric Methodology

As mentioned earlier, the first research question we address is whether the involvement of prominent investors affects the likelihood that a startup’s CEO is replaced. To examine this question, one possibility would be to estimate the following model:

$$\Pr(CEOReplacement_i) = f(ProminentInvestor_i, \mathbf{F}_i; \epsilon_i) \quad (1)$$

where $CEOReplacement_i$ is an indicator that equals 1 if startup i had its CEO replaced. $ProminentInvestor_i$, our treatment, is an indicator that takes on the value of 1 if startup i had received funds from at least one investor whose eigenvector value is in the 95th percentile of the distribution of eigenvector values computed for the population of investors who were active during 2006-2008. The reference category of $ProminentInvestor_i$ is represented by startups that reported a financing round in 2006, 2007, or 2008 but which did not receive funds from prominent investors. \mathbf{F}_i is a vector of relevant startup characteristics.

The problem with estimating equation (1) is that the probability that a startup receives financing from prominent investors is likely to be endogenous (Sørensen, 2007). Indeed, it is possible that startups with a high *ex-ante* probability of having their CEO replaced more frequently attract prominent investors than startups with a low such probability (sorting effect). Descriptive

⁹ As we will show in the next sections, results are qualitative the same with the two eigenvector indicators.

¹⁰ In the United States prior to 2012, patents were granted only to human beings, and so ownership in a firm occurs through the recording of an “assignment” to the firm, generally the individual’s employer.

¹¹ Available at <https://eipweb.uspto.gov/TOC/>.

¹² Available at http://www.uspto.gov/web/offices/ac/ido/oeip/taf/data/misc/data_cd.doc/custom_extract_dvd/.

statistics on a number of pertinent startup characteristics we present in Table 1 suggest that the participation of prominent investors in a given round is unlikely to be random. As shown, prominent investors – as compared to less prominent ones – tend to invest more frequently in startups that: are mature; had received comparatively large amounts of previous funding; have a prior US patent grant; possessed a comparatively large number of top executives (other than a CEO) and board members; included a “marketing or sales” executive on the top management team (TMT) (our proxy for how close the startup is to experiencing sales, and hence revenues, in product markets); employed a chief technology or science officer; and were founded by serial entrepreneurs. It is notable that we observe, contingent on receiving funding from prominent investors, startups are more likely to have experienced either an IPO or an acquisition by 2015, relative to startups with no prominent investor funds.

< Insert Table 1 about here >

Implementing the CEM Algorithm to Address Endogeneity Concerns. To separate the sorting effect from the *ex-post* influence that a prominent investor may exert on a startup we implement a CEM algorithm. This algorithm ensures that treated startups are compared to a valid group of counterfactuals by balancing treatment and control observations based on exogenous regressors. A number of finance studies have estimated matching models to address endogeneity issues (see, for instance, Drunken and Puri, 2005 and Hellmann et al., 2008).

Relative to matching algorithms researchers most commonly employ (such as propensity score matching), CEM offers fundamental advantages. First, CEM allows the researcher to guarantee the degree of covariate balance *ex-ante* rather than requiring both an *ex-post* check for balance and a re-specification of the matching model when that balance is unsatisfactory (Iacus *et al.*, 2011). Second, CEM does not extrapolate counterfactual observations from regions of the parameters where data on controls are missing (Simcoe and Toffel, 2013). Third, given that CEM is a nonparametric method, we do not incur the problem that a mis-specified model of selection will generate greater imbalance in variables not included in the matching. Finally, the CEM is advantaged in that the counterfactual observations match the means as well as all other sample moments of the treated observations.

To select control observations we applied the following procedure. We carefully identified a set of startups’ characteristics that affect their propensity to receive prominent investor financing.

Next, we created a large number of strata to cover the entire support of the joint distribution exhibited by the startup characteristics previously selected. Successively, each observation was allocated to a unique stratum. Finally, we retained all strata that had at least one control and one treatment observation. Because the described procedure delivers one-to-many matches, each observation was assigned an appropriate weight.

We opted for the following exogenous variables to balance treated and control observations. The first is the predetermined likelihood that a startup attracts funds from prominent investors, measured over the 2004-2006 period. The second is the cumulative amount of funds that a startup had received through 2006 (in thousands of constant USD). We followed the convention and partitioned this continuous variable into separate bins with cutoff values at the 50th, 75th, 90th, 95th, and 99th percentiles, determined at the startups' activity sector level. The third variable we chose is an indicator that captures the complexity of a startup's organization by flagging those companies that, in 2008, listed among their executives a President, Co-President, or a Co-CEO, in addition to a CEO.¹³ Similarly, we created a variable capturing the size or importance of a startup's board of directors by examining the number of board members listed in the executives provided by Venture Economics (hereafter, "board size"). The resulting indicator takes the value 0 if a startup reported no board members in 2008, 1 if the startup reported at least one board member, and 2 if the startup reported such board members at or above the median (=3) of all firms in our sample. We also include an indicator for whether the CEO has prior experience managing an investor-backed startup, and a second indicator that takes the value of 1 if a startup was granted at least one US patent (and zero otherwise) during the pre-treatment period¹⁴. Because Venture Economics reports on the characteristics of investors – including in what sectors they prefer to invest – we were able to construct an indicator that we allow to take a value 1 if we observe a startup having at least one round investor specialized in the startup's operating sector, to account for investor knowledge of a given sector. Finally, we used sector, foundation-period, and region dummies. We considered two foundation time intervals: the first from 1999 to 2003 and the second from 2004 to 2008.¹⁵ We also generated an indicator that equals one if a startup was either

¹³ We chose this formulation on the theory that these positions suggest a more complex structure in the startup.

¹⁴ In an alternative specification, we used an indicator that takes on the value of 1 if a startup was granted one, and 2 if it was granted more than one, US patent in the pre-treatment period. The results remain qualitatively the same.

¹⁵ We adjust for the remaining imbalance by including in our model foundation-year fixed effects.

located in California or Massachusetts and zero otherwise¹⁶. To adjust for possible, remaining imbalance we include in our weighted regressions foundation-year fixed effects and a more fine-grained set of region dummies. Specifically, we identify three regions based on our analysis of total venture funds invested in each US state, per capita. Using figures from the National Venture Capital Association 2008-2013,¹⁷ we compared states' deal stock to population statistics from the 2010 US Census. Weighting so the median performing state takes a value equal to 1.0, we find California and Massachusetts are clear outliers (taking values 12.7 and 8.7, respectively), followed in rank by a second small grouping (District of Columbia, Colorado, Washington, and New York, each well above 3.0).¹⁸ We consequently create a ranked variable taking values 2 if the startup resides in CA or MA, 1 if in DC, CO, WA, or NY, and 0 otherwise.¹⁹

With these covariates we feel confident that we capture the main relevant characteristics of a startup, including the funds it received, the complexity of its organization, the quality of its executives, and the characteristics of its technology (Gompers and Lerner, 2004). Having started with 1,763 treated observations (i.e., startups that received funds from prominent investors), after processing we find at least one control observation in 814 cases (46%). This rate is a consequence of using non-parametric matching algorithms, since the percentage of matched observations decreases steeply with the number of strata. Descriptive statistics are presented in Table 2 confirm that our CEM procedure resulted in a balanced match of treated and control startups. In fact, we confirm that there is no significant difference between the sample means of the two groups, both in terms of the variables that we employ in the matching and also when considering all other observables, including importantly the startups' exit outcomes.

< Insert Table 2 about here >

Analyses Relating Investor Prominence and CEO Replacement to Outcomes of Interest. Having implemented the CEM algorithm to address endogeneity concerns, we are able to estimate a weighted probit model to assess the effect of prominent investors on the replacement of a CEO.

¹⁶ A number of studies, including Lindsey (2008), have adopted this partition of US regions.

¹⁷ Venture Capital Dollars and Deals by State, 2009-2014, available at <http://ssti.org/blog/useful-stats-venture-capital-investment-dollars-deals-state-2009-2014>.

¹⁸ Various different constructions, across different times and different methods, resulted in no meaningful changes in the rankings.

¹⁹ For robustness, we follow an additional formulation and assign states to 8 regions as proposed by the Bureau of Economic Analysis (2004). The results do not change.

To qualify the effects of prominent investor involvement, we propose a number of additional analyses in which we condition the sample to those 1,496 startups that had their CEO replaced and distinguish between insider and outsider CEOs and, within the latter category, between CEOs with and without prior startup executive experience. To account for the endogeneity of prominent investor involvement in a startup's round, we implement the just-described CEM algorithm. Additionally, we examine how the effect of prominent investor performance varies, conditional on a number of startup characteristics we code as dichotomous variables. These include: the startup's *ex-ante* funding stock (cumulative) through 2006 (zero funding as against "greater than zero" funding); the size of the startup's non-CEO top management team (zero as against greater than zero executives); the size of the startup's board (below as against above the median); and whether or not the startup included a "marketing or sales" executive in the TMT. Our approach consists of partitioning the initial sample of startups into sub-samples along these characteristics and comparing the effect of investor prominence across sub-samples.

Assessing the Effect of a CEO Replacement on Startups' Attracting Follow-on Funds. Whether or not the replacement of an existing CEO contributes to the performance of a startup remains an open question. It is possible, for instance, that prominent investors participate in the replacement of a startup's CEO in order to exert bargaining power and claim a larger "share of the pie," but that the new executive does not actually improve the startup's performance (i.e., it does not increase the size of the pie). To examine this question, our equation of interest is:

$$StartupPerformance_i = f(CEOReplacement_i, \theta_i; u_i) \quad (2)$$

where startup i 's performance is measured as the amount that the startup secured during the 2009-2015 period and θ_i is a vector of covariates. Our independent variable of interest, the indicator for whether a startup had its CEO replaced, is likely to be endogenous to funding since startups may undergo a re-organization of their top management with the aim of attracting external funds. We address this endogeneity concern by implementing the CEM algorithm and balancing treatment and control observations with the controls listed previously, in this instance adding an indicator for whether the startup employed a chief science or technology officer in its TMT to achieve balance on all observables. Given an initial number of 1,496 treated observations, after processing we find at least one control observation in 683 cases (46%). As shown in Table 3, our CEM procedure eliminates any significant difference in the means of all observables.

After implementing the CEM, we estimate two weighted probit models for the impact of replacing a startup's CEO on startup performance. In the first model, we use an indicator for whether a startup had received any follow-on financing after 2009. In the second model, we use an indicator for whether the startup was in the top quartile of the follow-on financing distribution among startups in its activity sector. We also estimated models using as a dependent variable the natural logarithm of the amount of funds a startup had received during 2009-2015, and while results are very similar to those obtained using the weighted probit models, we prefer to discretize our dependent variable to mitigate possible outlier problems²⁰.

< Insert Table 3 about here >

Implementing an IV Weighted Probit Model. We remain interested in the relationship between prominent investors and CEO replacement. Accordingly, we assess the impact on startup performance of a prominent-investor-induced CEO replacement. For this purpose, we estimate an IV weighted probit model that 1) relates the probability of CEO turnover to the prominence of an investor (first-stage) and 2) the probability of CEO turnover to a startup's follow-on financing (second-stage). We measure a startup's follow-on financing using two aforementioned indicators, one for whether the startup received any financing and the other for whether the financing amount placed the startup in the top quartile of the distribution in its sector. In order for investor prominence to be a valid instrument of a startup's CEO replacement, it must have no direct effect on startup performance beyond the replacement of a CEO. To fulfill this exclusion restriction, we implement the CEM algorithm to assign appropriate control observations to those startups receiving prominent-investor funding. Given the richness of the startup characteristics that we employ to balance treatment and control observations, the implementation of CEM ensures, as much as possible, that the investor prominence instrument is as good as if it were randomly assigned. With this methodology, the IV estimates the effect of CEO replacement on a startup's performance for the subpopulation that experienced a CEO turnover due to prominent investor participation (Imbens and Angrist, 1994).

IV. Results

A. Prominent investor effect on startup professionalization

²⁰ Model results of this alternative procedure are available from the authors upon request.

Table 4 presents the baseline results from estimating the effect prominent investors participating in a startup's round has on the likelihood that the startup's CEO is replaced. Reported coefficients are marginal effects and standard errors are clustered around the strata identified with the CEM algorithm. As shown, receiving funds from prominent investors increases a startup's likelihood that its CEO is replaced by 8.8% (column I). The coefficient is significant at the 1% confidence level. Because in implementing our CEM algorithm we used *ex-ante* information about the prominence of startup investors, the coefficient we report in Table 4 captures the effect of the incremental measure of investor prominence relative to the pre-treatment period. As a robustness check, we re-define the sample to focus only on startups in which we observe literally a "CEO" (and its variations), excluding those 263 startups that had listed as the top manager only a "President." The results are reported in column II. Consistent with the results in column I, we find that receiving funds from prominent investors increases a startup's likelihood that its CEO will be replaced by 8%.

While Venture Economics primarily covers information about financing rounds led by (non-corporate) venture capitalists, we identified 241 instances in which round investors included only individuals, corporate venture capitalists, and real estate investors. Noting that Hellmann and Puri (2002) focus only on venture capital investors, we sought to verify that our prominent-investor effect is not led by whether or not a startup had received venture capital investment. We therefore estimate a model in which the dependent variable is an indicator that equals 1 if a startup had received venture capital financing, and 0 otherwise. To implement the CEM algorithm, we use the same exogenous regressors that we listed in the econometric methodology section above. The results are reported in columns III and IV. Regardless of whether we use the entire sample (column III of Table 4) or those startups listing only a "CEO" in 2008 (column IV), the coefficient for venture capital investment is not significantly different from zero. This result suggests that comparing the more-prominent to less-prominent investor effect on startup professionalization is stronger than comparing the impact of venture capital investors on professionalization as against other types of investors (Hellmann and Puri, 2002)

< Insert Table 4 about here >

Replacement characteristics. Having found that the participation of prominent investors is more likely to result in startup CEO turnover, we are interested in understanding the conditions under

which replacement occurs. As a first question, we ask whether an incumbent CEO is more likely to be replaced with executives currently on the management team (insiders) or with others (outsiders).²¹ In order to explore this question, we restrict the sample to those 1,496 startups in which we observe a CEO replacement between 2008 and 2015, and create an indicator that takes value 1 if a startup’s CEO was replaced with an outsider and zero otherwise. We implement our CEM algorithm using all exogenous regressors listed in the previous section, and by so doing are able to find a match to 47% of the startups that had received funds from prominent investors. We report the outcome of our investigation in Table 5. Our results show that prominent investors are no more likely than non-prominent investors to bring outsiders.²²

That finding leads us to investigate another question related to managerial experience. We are able to examine in the Venture Economics data whether a superseding CEO appears in any management position across all firms listed in the dataset, in both 2008 and 2015. For those individuals we identify as having a prior executive position in one of the investor-funded startups, we flag them as being “experienced.” This enables us to examine whether the involvement of prominent investors makes it more likely that superseding CEOs are outsiders with managerial experience. To this scope, we redefine our initial indicator as a dummy that equals 1 if a startup’s CEO was replaced with an “experienced outsider” and 0 otherwise. The results are reported in column II. They clearly show that the participation of prominent investors affects the character of startup professionalization, since replacement CEOs are more likely to be outsiders with prior experience managing an investor-backed startup.

< Insert Table 5 about here >

Startup firm characteristics. To further qualify the effect of investor prominence, we identify a number of situations in which the marginal impact of prominent investors is likely to be strongest. These are situations in which there is a large uncertainty about a startup’s future performance and, for this reason, it may be costly to attract new CEOs. Given that prominent investors likely have strong(er) bargaining power, they can induce a CEO turnover at relatively low costs. Additionally, while it is difficult to make accurate forecasts about future performance when the startup has not

²¹ As explained previously, we are able to compare the names (first name, last name, title, and suffixes) of CEOs with information on the startup’s executives in 2008 to determine if the replacement was an “insider” or not.

²² The analyses presented in Tables 5 and 6 hold when we re-define the sample and exclude those 263 startups that had listed in their top of hierarchy a President but not a CEO

yet proven its viability, prominent investors may be better at making these forecasts than non-prominent investors, and these forecasts may require changes in management and organization that new CEOs can better accomplish. In order to investigate these hypotheses, we select three different indicators to proxy for poor performance. Similar to a method used by Hellmann and Puri (2002), we partition the sample of startups according to whether or not, as of 2006 (the predetermined period), they had received positive cumulative investment. Additionally, we generate dichotomous variables to identify startups that in 2008 did (and did not) employ non-CEO executives on their TMT and have a comparatively small board size. Finally, we identify startups that did (and did not) employ in 2008 a marketing or sales executive.

We report our results on these analyses in Table 6, panels A, B, C, and D. Investor prominence exhibits the largest positive effect on the likelihood of CEO replacement when the startup i) did not receive investment as of 2006, ii) did not employ any non-CEO top executives, iii) had a relatively small board size, iv) and did not employ a TMT marketing executive. Findings (ii) to (iv) complement and provide a more nuanced window into finding (i) showing the effect of prominent investors is strongest during a startup's earliest stages. In fact, these added results suggest that the participation of prominent investors contributes to startup professionalization in a very specific set of circumstances.²³

The effects indicated by the coefficients are instructive in this regard. When the startup has no investment prior to 2006, the increased likelihood of CEO replacement from the participation of prominent investors is 11%. In those startups for which the only executive listed is a CEO, the involvement of prominent investors increases the likelihood of that CEO being replaced by 9%. When a startup's board is relatively small (below the median), the involvement of prominent investors increases the likelihood of the CEO being replaced by 12%. And finally, when the startup is more distant from the product market (i.e., not having a marketing executive on the TMT), the increased likelihood of CEO replacement from the participation of prominent investors is 12%.

< Insert Table 6 about here >

²³ The results we reported are not driven by the fact that CEO replacements occur only in a startup's earliest stages. In fact, these CEO replacements are observed both in the early and late funding stages.

B. Startup professionalization effect on performance

While the relationship of prominent investors to startup professionalization is interesting, the phenomenon would yield much more important insights if tied to startups' *ex-post* financial performance. The replacement of incumbent CEOs appurtenant to the involvement of professional investors could be a result of matching new skills to new demands in the later development stages of the startup: Research has shown that the organizational skills needed to prototype a product may be quite different from those needed to scale up production and take product to market, let alone those required to manage a successful exit event such as an initial public offering (Gompers, 1995). So, while prominent investors may be interested in replacing incumbent CEOs not well suited to the managerial tasks required in later stages, it remains an empirical question whether superseding CEOs are better at fulfilling those tasks. As measures of performance, we consider whether a startup received any follow-on financing after 2008, and alternatively whether the startup is in the last quartile of its sectorial follow-on financing amount distribution. We thus estimate two weighted probit models that relate each of our outcome variables to an indicator that equals 1 if a startup's CEO was replaced and zero otherwise. To address the endogeneity of this indicator, we compare the treated startups to a valid group of counterfactuals, which we find by implementing the CEM algorithm. The baseline results are reported in Table 7. Coefficients are marginal effects and standard errors are clustered around the strata identified by CEM. As shown, startups in which we observe a CEO replacement are 23 to 25% more likely to receive follow-on financing after 2008, depending on whether we exclude or not those 263 startups that had listed in their top of hierarchy a President but not a CEO. Additionally, we see that a CEO replacement induces a 17% increase in the probability that a startup is in the top quartile of the follow-on investment distribution in its sector, regardless of the sample the definition.

< Insert Table 7 about here >

Since we have shown previously that conditions under which replacement occur are relevant, it is natural to inquire into whether the superior performance we observe is moderated by these conditions. In Table 8, column I, we further disentangle the effect of CEO turnover by first distinguishing between “outsider” and “insider” superseding CEOs. This analysis implies that there are two distinct treatments. The first corresponds to replacing a CEO with an insider, and the second to bringing an outsider in the CEO position. To address endogeneity concerns, we again

apply the CEM algorithm to find for each CEO replacement type a valid counterfactual from the set of startups that did not experience a CEO replacement. We then estimate two weighted probit models, one for the probability that a startup receives any follow-on financing during 2009-2015, and the other for whether the amount received places the startup in the top quartile of its sector investment distribution. The regressors of interest are a dichotomous indicator for whether a CEO is replaced with an insider, another for whether the CEO is replaced with an outsider, and the reference dummy indicator taking value 1 if the startup did not experience a CEO turnover and zero otherwise. As shown in Table 8, an outsider CEO replacement is more likely to show superior funding, regardless of the outcome variable examined. A test of the equality of the indicators' coefficients rejects the null hypothesis that these are the same, with a p-value of 0.00. In line with the other condition we identified in replacement – prior experience managing an investor-backed startup – in column II we generate a more fine-grained taxonomy of outsider CEOs and distinguish between those with and without such managerial experience. Meaningfully, the results of our tests of coefficients' equality demonstrate that outsider CEOs with prior investor-funded startup management experience are associated with greater performance than outsider CEOs without such experience, regardless of the outcome considered.

< Insert Table 8 about here >

C. Prominent investors, startup professionalization, and the effect on startup performance

While this paper has shown how prominent investors affect CEO replacement, and how CEO replacement relates to performance, an important question remains: Are the performance results we demonstrate a consequence of the involvement of prominent investors in CEO replacement? In this section, we examine that important question by estimating the effect of a CEO turnover, induced by prominent investors, on startups follow-on funds. We demonstrated earlier that prominent investors are more likely to bring outsider CEOs with managerial experience. We also showed that these CEOs are more successful in securing follow-on funds to their startups. We should thus expect the effect of a prominent-investor-induced CEO replacement to be larger than that of CEO replacement generally.

In order to implement a test of this proposition, we estimate an IV weighted probit model, relating the probability of CEO turnover to investor prominence (first-stage), and the probability of CEO replacement to a startup's follow-on financing (second-stage). Again, we use as measures

of startup performance in the post-2008 period an indicator for whether the startups received any financing, and as an alternative whether the financing amount placed the startup in the top quartile of its sector distribution. As we mentioned in the Econometric Methodology Section, we implement the CEM algorithm to assign a valid control to those startups that received prominent investor funds, and ensure that our instrument fulfils the exclusion restriction.

We report results in Table 9, presenting marginal effects only for the second-stage equation given that the result of the first-stage were previously displayed in Table 4. We reiterate that these effects are for the subpopulation that experienced a prominent-investor induced CEO turnover. Standard errors are clustered around the strata identified by the CEM algorithm in the first-stage. For the sake of brevity, we report in Table 9 only the coefficient associated with CEO replacement, although we control in the model for all the other startup characteristics we identified earlier in order to eliminate as much as possible any residual bias. Our findings are dramatic: A prominent-investor-induced CEO replacement increases the probability that a startup receives any funds by 51%, and the probability that the startup is in the top quartile of the fund distribution by 48%. These effects are considerably larger than those reported in the last section using the entire sample (25% and 17%, respectively), and the large t-statistics suggest these effects are strong and robust.

< Insert Table 9 about here >

V. Robustness Checks

We conducted a number of robustness checks to ensure that our results on prominent investors are not driven by the fact that we are comparing heterogeneous investors (VCs as opposed to other types of investors) and are not dependent on the way we built our prominent-investor indicator. To address the first concern, we restricted the sample to those 3,454 startups that had received funds from venture capitalists during the 2006-2008 period, and built an alternative eigenvector measure taking into account only the investments of VCs leading the startups' rounds. Startups that received funds from prominent VCs comprise 44.5% of the newly defined sample. To address the second concern, we first built our prominent-investor indicator using as a reference those investors who participated in the financing rounds of our sample startups, rather than in the rounds of all startups in the population. As mentioned earlier, using this criterion, the percentage of treated startups decreases from 47.7% to 40.7%. Second, we built our treated indicator only for those

“lead” investors that had invested the largest amount in a given startup relative to all other investors participating in a same round. Using this criterion, the share of treated startups decreases to 36.2%.

The results of these robustness checks are presented in Tables 10 to 27. Regardless of the analysis considered, we still find that the involvement of prominent investors in a startup’s round positively affects the likelihood that the startup’s CEO is replaced (Tables 10, 16, and 22). We continue to find, too, that prominent investors are more likely to replace existing CEOs with experienced outsiders (Tables 11, 17, and 23). We also find additional support (Tables 12, 18, and 24) for our findings that the marginal contribution of prominent investors is strongest when startups list no non-CEO executives, have a comparatively small board of directors, and employ no sales or marketing executive. Moreover, the results support our other findings by continuing to show that replacing an existing CEO has a positive impact on a startup’s ability to secure follow-on financing (Tables 13, 19, and 25), with the effect being strongest when existing CEOs are replaced with experienced outsiders (Tables 14, 20, and 26). Finally, our alternative tests are again confirmatory, demonstrating that the effect on a startup’s follow-on financing of a CEO replacement is strongest when induced by prominent investor involvement (Tables 16, 21, and 27).

< Insert Tables 10-27 about here >

VI. Concluding remarks

In this paper, we have been primarily concerned with the effect that the participation of prominent startup investors has on one of the main mechanisms through which investors exercise their monitoring role in the enterprises in which they invest: The replacement of top managers. Recognizing the difficulty of producing meaningful results given the endogeneity inherent in the investment and CEO replacement actions we examine, we implement an innovative CEM matching procedure to overcome this limitation and produce a set of novel findings. Our results demonstrate that prominent investor involvement in startups explains increased incidence of CEO replacement, and we uncover that such replacements are overwhelmingly outsiders with previous management experience at investor-funded startups. Importantly, we relate CEO turnover to increased startup firm financial performance, and show that incrementally better performance is explained by characteristics of the superseding CEO, with outsiders performing better than insiders, and those outsiders with prior startup management experience leading even better performance still. To bring our findings full circle, we finish our investigation by relating investor

involvement to performance, employing CEM in an instrumental-variable system of equations. In so doing, we are able to show that the participation of prominent investors results in the superior performance of startups produced – specifically – by prominent-investor led CEO replacement. This prominent-investor effect is substantial, producing a roughly 50% boost in startup financial performance due to CEO replacement.

Our results contribute to a broader set of investigations in the finance literature concerning the role of investors beyond mere financial stewardship, examining most commonly how VCs employ various mechanisms to implement screening and monitoring of their startup investments. Given the increasing evidence that young firms propel economic development (Decker, et al. 2014), it is desirable to increase our understanding of how the involvement and actions of financial intermediaries – even when acting in their narrow self-interest – can increase the likelihood of their long-term success. By investigating heretofore unexamined questions, and using appropriate methods to overcome endogeneity concerns, we contribute to the field’s understanding of the implications associated with variation among startup investors, not only in terms of investor prominence, but also extending focus to investors other than VCs. We believe we are the first to document empirically the set of startup firm conditions under which investor-led CEO turnover occurs, and the characteristics of the CEOs chosen to succeed incumbents. We also believe we are the first to demonstrate how the participation of prominent investors drives CEO turnover and concomitant superior firm performance of firms, thereby providing insights to not only finance scholars, but also to researchers interested in the economic implications of organizations and management more broadly.

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VIII. Tables

Table 1: Descriptive statistics on a number of relevant startup characteristics, distinguishing between startups that did and did not receive funds from prominent investors

	Startups with funds from prominent investors		Startups without funds from prominent investors		Absolute difference of means
	Mean	Standard Dev.	Mean	Standard Dev.	
Age	12.090	2.503	11.850	2.600	0.238***
Cumulative funding stock by 2006 (mill. constant USD)	24.224	34.999	10.512	32.946	13.712***
Had received funding from prominent investors by 2006	0.403	0.491	0.045	0.207	0.358***
Founded by serial entrepreneurs	0.275	0.447	0.204	0.403	0.071***
Had a US patent granted by 2008	0.352	0.478	0.212	0.409	0.141***
Listed more than one top executive officer in 2008	0.112	0.316	0.147	0.354	0.035***
Number of high-level executives other than a CEO or a President	0.789	0.891	0.659	0.852	0.130***
Board size	4.223	2.126	2.851	2.203	1.372***
Number of external board members	3.987	2.076	2.654	2.128	1.333***
Had employed a Chief Technical Officer	0.711	0.454	0.515	0.500	0.196***
Had employed marketing executives	0.466	0.499	0.300	0.458	0.166***
Achieved a successful exit (either IPO or acquisition)	0.544	0.498	0.391	0.488	0.153***
Had ceased operations	0.004	0.063	0.004	0.064	0.000
Still active	0.452	0.498	0.605	0.489	0.153***
Observations	1,763		1,932		

Note: *p<0.1; **p<0.05; ***p<0.01.

Table 2: Descriptive statistics on a number of relevant startup characteristics, distinguishing between startups that did and did not receive funds from prominent investors (conditional on applying our CEM algorithm)

	Startups with funds from prominent investors		Startups without funds from prominent investors		Absolute difference of means
	Weighted Mean	Standard Dev.	Weighted Mean	Standard Dev.	
Age	11.410	2.580	11.510	14.000	0.100
Cumulative funding stock by 2006 (mill. constant USD)	11351.450	16104.610	10769.250	34659.700	582.200
Had received funding from prominent investors by 2006	0.170	0.370	0.170	0.890	0.000
Founded by serial entrepreneurs	0.180	0.380	0.180	0.680	0.000
Granted US patents by 2008	0.240	0.430	0.240	0.800	0.000
Number of top executive officers in 2008	1.000	0.040	1.000	1.120	0.000
Number of high-level executives other than a CEO or a President	0.670	0.840	0.680	1.540	0.010
Board size	3.680	2.030	3.510	5.580	0.170
Number of external board members	3.470	1.990	3.270	5.360	0.200
CEO is a board member	0.550	0.500	0.520	1.030	0.030
Had employed a Chief Technical Officer	0.660	0.470	0.610	1.110	0.050
Had employed marketing executives	0.400	0.490	0.360	0.940	0.040
Achieved a successful exit (either IPO or acquisition)	0.490	0.500	0.430	0.900	0.060
Had ceased operations	0.000	0.040	0.000	0.080	0.000
Still active	0.510	0.500	0.570	0.960	0.060
<i>Observations</i>	814		912		

Note: None of the differences are statistically significant at conventional levels.

Table 3: Descriptive statistics on a number of relevant startup characteristics, distinguishing between startups that did and did not experience a CEO replacement (conditional on applying our CEM algorithm)

	Startups that experienced a CEO replacement		Startups that did not experience a CEO replacement		Absolute difference of means
	Weighted Mean	Standard Dev.	Weighted Mean	Standard Dev.	
Age	11.770	2.620	11.690	9.160	0.080
Cumulative funding stock by 2006 (mill. constant USD)	14541.190	27436.640	13660.460	29065.300	880.730
Had received funding from prominent investors by 2006	0.250	0.430	0.240	0.560	0.010
Founded by serial entrepreneurs	0.130	0.340	0.130	0.420	0.000
Granted US patents by 2008	0.240	0.430	0.240	0.560	0.000
Number of top executive officers in 2008	1.000	0.000	1.000	0.760	0.000
Number of high-level executives other than a CEO or a President	0.720	0.870	0.680	1.170	0.040
Board size	3.770	2.150	3.570	3.690	0.200
Number of external board members	3.540	2.080	3.330	3.490	0.210
CEO is a board member	0.520	0.500	0.530	0.770	0.010
Had employed a Chief Technical Officer	0.680	0.470	0.680	0.800	0.000
Had employed marketing executives	0.420	0.490	0.370	0.640	0.050
Achieved a successful exit (either IPO or acquisition)	0.430	0.500	0.480	0.720	0.050
Had ceased operations	0.000	0.050	0.000	0.040	0.000
Still active	0.560	0.500	0.520	0.750	0.040
Observations	683		833		

Note: None of the differences are statistically significant at conventional levels.

Table 4: Prominent investor effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced			
	Marginal Effects			
	I	II	III	IV
Prominent Investor	0.088*** (0.029)	0.080*** (0.030)		
Venture Capital Investor			0.106 (0.078)	0.088 (0.082)
Region FE	YES	YES	YES	YES
Foundation Year FE	YES	YES	YES	YES
Observations	1,726	1,578	618	546

Notes: *p<0.1; **p<0.05. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. In columns I and II, we report the marginal effects of prominent investor involvement in a startup's round. In columns I and II, we report the marginal effects of venture capital involvement in a startup's round. In columns I and III, the sample includes startups that listed a CEO or a President as a top executive. In columns II and IV, the sample includes startups that listed a CEO only. Regardless of the treatment (prominent investor or venture capital involvement) and the sample definition, we balance treatment and control observations by adopting the CEM algorithm described in the text.

Table 5: Prominent investor effect on the hiring of an outside CEO

	Weighted probit regressions	
	Likelihood that a superseding CEO is an outsider	Likelihood that a superseding CEO is an "experienced outsider"
	Marginal Effects	
	I	II
Prominent Investor	0.06 (0.045)	0.075** (0.030)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	704	

Notes: See Table 4. The sample includes only those startups that had experienced a CEO replacement by 2015. In column I, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an outsider. In column II, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an "experienced outsider". An "experienced outsider" is defined as an outsider having a prior executive position in an investor-funded startup. Regardless of the outcome examined, we balance treatment and control observations by adopting the CEM algorithm.

Table 6: Startup characteristics and prominent investor effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced (Marginal effects)	
	Panel A	
	Startups that had not received a positive investment amount in the pre-period	Startups that had received a positive investment amount in the pre-period
	I	II
Prominent Investor	0.110** (0.122)	0.081** (0.035)
Observations	743	982
	Panel B	
	Number of high-level executives other than a CEO or a President =0	Number of high-level executives other than a CEO or a President >0
	I	II
Prominent Investor	0.094** (0.036)	0.083 (0.046)
Observations	940	786
	Panel C	
	Board size below or equal the median value	Board size above the median value
	I	II
Prominent Investor	0.123*** (0.033)	0.039 (0.046)
Observations	946	780
	Panel D	
	Had not employed marketing personnel	Had employed marketing personnel
	I	II
Prominent Investor	0.120*** (0.033)	0.015 (0.051)
Observations	1,119	607

Notes: See Table 4. *p<0.1; **p<0.05; ***p<0.01. In Panel A, we partition the sample of startups according to whether or not, as of 2006 (predetermined period), they had received a positive investment amount in the pre-period. In Panel B, we divide the sample according to whether or not startups had listed an high-level executive other than a CEO or a President. In Panel C, we divide the sample according to whether or not a startup's board size is greater than the median. In Panel D, we partition the sample according to whether or not startups had employed marketing personnel. In all models, we control for foundation-year and region fixed effects.

Table 7: Startup professionalization effect on performance

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
CEO replacement	0.246*** (0.024)	0.230*** (0.026)	0.169*** (0.023)	0.171*** (0.025)
Region FE	YES	YES	YES	YES
Foundation Year FE	YES	YES	YES	YES
Observations	1,516	1,391	1,516	1,391

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. In columns I and II, we report the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, we report the marginal effects of CEO replacement on the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III we apply the CEM algorithm to the entire sample. In columns II and IV, the sample includes only those startups that listed a CEO but not a President as top executive.

Table 8: Startup professionalization effect on performance - Distinguishing between different types of superseding CEOs

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
Superseding CEO is an insider	0.099*** (0.031)		0.052* (0.030)	
Superseding CEO is an outsider	0.340*** (0.027)		0.229*** (0.024)	
Superseding CEO is an insider		0.099*** (0.031)		0.053* (0.030)
Superseding CEO is an "inexperienced outsider"		0.308*** (0.029)		0.204*** (0.026)
Superseding CEO is an "experienced outsider"		0.435*** (0.053)		0.291*** (0.038)
Observations	1,516	1,516	1,516	1,516

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach described in the text. In columns I and II, the outcome is represented by the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, the outcome is represented by the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III, the regressors of interest are a dichotomous indicator for whether a CEO is replaced with an insider, another for whether the CEO is replaced with an outsider, and the reference dummy indicator taking value 1 if the startup did not experience a CEO turnover and zero otherwise. In columns II and IV, we consider a more fine-grained taxonomy of outsider CEOs and distinguish between those with and without managerial experience. In all models, we control for foundation-year and region fixed effects.

Table 9: Prominent investors, startup professionalization, and the effect on startup performance

	IV weighted probit models (second-stage results)	
	Likelihood that a startup received any follow-on financing	Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution
	Marginal Effects	
	I	II
CEO replacement	0.507*** (0.004)	0.483*** (0.008)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,716	1,716

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to balance startups with and without prominent investor funds. First-stage results are reported in Table 4. Given that our instrument is the indicator for whether a startup had received funds from prominent investors, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to prominent investor participation.

Table 10: Prominent venture capitalist effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced	
	Marginal Effects	
	I	II
Prominent Venture Capitalist	0.069** (0.030)	0.061* (0.031)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,630	1,497

Notes: *p<0.1; **p<0.05. We balance treatment and control observations by adopting the CEM algorithm described in the text. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. We report the marginal effects of prominent venture capital involvement in a startup's round. In column I, the sample includes startups that listed a CEO or a President as a top executive. In column II, the sample includes startups that listed a CEO only.

Table 11: Prominent venture capitalist effect on the hiring of an outside CEO

	Weighted probit regressions	
	Likelihood that a superseding CEO is an outsider	Likelihood that a superseding CEO is an "experienced outsider"
	Marginal Effects	
	I	II
Prominent Venture Capitalist	0.094** (0.043)	0.052* (0.029)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	671	

Notes: See Table 10. The sample includes only those startups that had experienced a CEO replacement by 2015. In column I, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an outsider. In column II, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an "experienced outsider". An "experienced outsider" is defined as an outsider having a prior executive position in an investor-funded startup. We balance treatment and control observations by adopting the CEM algorithm described in the text.

Table 12: Startup characteristics and prominent venture capitalist effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced (Marginal effects)	
	Panel A	
	Startups that had not received a positive investment amount in the pre-period	Startups that had received a positive investment amount in the pre-period
	I	II
Prominent Venture Capitalist	0.092* (0.052)	0.059 (0.037)
Observations	651	978
	Panel B	
	Number of high-level executives other than a CEO or a President =0	Number of high-level executives other than a CEO or a President >0
	I	II
Prominent Venture Capitalist	0.084** (0.040)	0.046 (0.045)
Observations	1,119	511
	Panel C	
	Board size below or equal the median value	Board size above the median value
	I	II
Prominent Venture Capitalist	0.099*** (0.035)	0.023 (0.046)
Observations	847	783
	Panel D	
	Had not employed marketing personnel	Had employed marketing personnel
	I	II
Prominent Venture Capitalist	0.108*** (0.037)	0.002 (0.045)
Observations	1,021	609

Notes: See Table 4. *p<0.1; **p<0.05; ***p<0.01. In Panel A, we partition the sample of startups according to whether or not, as of 2006 (predetermined period), they had received a positive investment amount in the pre-period. In Panel B, we divide the sample according to whether or not startups had listed an high-level executive other than a CEO or a President. In Panel C, we divide the sample according to whether or not a startup's board size is greater than the median. In Panel D, we partition the sample according to whether or not startups had employed marketing personnel. In all models, we control for foundation-year and region fixed effects.

Table 13: Startup professionalization effect on performance

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
CEO replacement	0.258*** (0.025)	0.239*** (0.026)	0.175*** (0.024)	0.177*** (0.025)
Region FE	YES	YES	YES	YES
Foundation Year FE	YES	YES	YES	YES
Observations	1,404	1,288	1,404	1,288

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. In columns I and II, we report the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, we report the marginal effects of CEO replacement on the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III we apply the CEM algorithm to the entire sample. In columns II and IV, the sample includes only those startups that listed a CEO but not a President as top executive.

Table 14: Startup professionalization effect on performance - Distinguishing between different types of superseding CEOs

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
Superseding CEO is an insider	0.112*** (0.033)		0.063* (0.033)	
Superseding CEO is an outsider	0.352*** (0.027)		0.232*** (0.024)	
Superseding CEO is an insider		0.112*** (0.033)		0.063* (0.032)
Superseding CEO is an "inexperienced outsider"		0.313*** (0.030)		0.198*** (0.027)
Superseding CEO is an "experienced outsider"		0.487*** (0.056)		0.328*** (0.041)
Observations	1,404	1,404	1,404	1,404

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach described in the text. In columns I and II, the outcome is represented by the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, the outcome is represented by the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III, the regressors of interest are a dichotomous indicator for whether a CEO is replaced with an insider, another for whether the CEO is replaced with an outsider, and the reference dummy indicator taking value 1 if the startup did not experience a CEO turnover and zero otherwise. In columns II and IV, we consider a more fine-grained taxonomy of outsider CEOs and distinguish between those with and without managerial experience. In all models, we control for foundation-year and region fixed effects.

Table 15: Prominent venture capitalists, startup professionalization, and the effect on startup performance

	IV weighted probit models (second-stage results)	
	Likelihood that a startup received any follow-on financing	Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution
	Marginal Effects	
	I	II
CEO replacement	0.507*** (0.005)	0.493*** (0.009)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,627	1,627

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to balance startups with and without prominent investor funds. First-stage results are reported in Table 10. Given that our instrument is the indicator for whether a startup had received funds from prominent venture capitalists, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to prominent venture capitalist participation.

Table 16: Prominent investor effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced	
	Marginal Effects	
	I	II
Prominent Investor	0.065** (0.028)	0.565* (0.030)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,772	1,629

Notes: *p<0.1; **p<0.05. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. Our treated indicator, *Prominent Investor*, is now constructed using as a reference those investors who participated in the financing rounds of our sample startups, rather than in the rounds of all startups in the population. In column I, we report the marginal effects of prominent investor involvement in a startup's round, using the entire sample of startups. In column II, the sample includes only those startups that listed a CEO or a President as a top executive. We balance treatment and control observations by adopting the CEM algorithm described in the text.

Table 17: Prominent investor effect on the hiring of an outside CEO

	Weighted probit regressions	
	Likelihood that a superseding CEO is an outsider	Likelihood that a superseding CEO is an "experienced outsider"
	Marginal Effects	
	I	II
Prominent Investor	0.086** (0.041)	0.056* (0.029)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	722	

Notes: See Table 16. The sample includes only those startups that had experienced a CEO replacement by 2015. In column I, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an outsider. In column II, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an "experienced outsider". An "experienced outsider" is defined as an outsider having a prior executive position in an investor-funded startup. Regardless of the outcome examined, we balance treatment and control observations by adopting the CEM algorithm.

Table 18: Startup characteristics and prominent investor effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced (Marginal effects)	
	Panel A	
	Startups that had not received a positive investment amount in the pre-period	Startups that had received a positive investment amount in the pre-period
	I	II
Prominent Investor	0.107** (0.046)	0.049 (0.035)
Observations	709	1062
	Panel B	
	Number of high-level executives other than a CEO or a President =0	Number of high-level executives other than a CEO or a President >0
	I	II
Prominent Investor	0.115*** (0.036)	0.010 (0.044)
Observations	946	826
	Panel C	
	Board size below or equal the median	Board size above the median
	I	II
Prominent Investor	0.112*** (0.033)	0.008 (0.042)
Observations	915	857
	Panel D	
	Had not employed marketing personnel	Had employed marketing personnel
	I	II
Prominent Investor	0.103*** (0.034)	0.001 (0.045)
Observations	1,112	660

Notes: See Table 4. *p<0.1; **p<0.05; ***p<0.01. In Panel A, we partition the sample of startups according to whether or not, as of 2006 (predetermined period), they had received a positive investment amount in the pre-period. In Panel B, we divide the sample according to whether or not startups had listed an high-level executive other than a CEO or a President. In Panel C, we divide the sample according to whether or not a startup's board size is greater than the median. In Panel D, we partition the sample according to whether or not startups had employed marketing personnel. In all models, we control for foundation-year and region fixed effects.

Table 19: Startup professionalization effect on performance

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
CEO replacement	I	II	III	IV
	0.260*** (0.024)	0.243*** (0.026)	0.167*** (0.023)	0.169*** (0.024)
Region FE	YES	YES	YES	YES
Foundation Year FE	YES	YES	YES	YES
Observations	1,510	1,377	1,510	1,377

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. In columns I and II, we report the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, we report the marginal effects of CEO replacement on the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III we apply the CEM algorithm to the entire sample. In columns II and IV, the sample includes only those startups that listed a CEO but not a President as top executive.

Table 20: Startup professionalization effect on performance - Distinguishing between different types of superseding CEOs

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
Superseding CEO is an insider	0.131*** (0.032)		0.067** (0.031)	
Superseding CEO is an outsider	0.341*** (0.026)		0.218*** (0.023)	
Superseding CEO is an insider		0.131*** (0.032)		0.067** (0.031)
Superseding CEO is an "inexperienced outsider"		0.302*** (0.029)		0.183*** (0.025)
Superseding CEO is an "experienced outsider"		0.477*** (0.054)		0.321*** (0.041)
Observations	1,510	1,510	1,510	1,510

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach described in the text. In columns I and II, the outcome is represented by the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, the outcome is represented by the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III, the regressors of interest are a dichotomous indicator for whether a CEO is replaced with an insider, another for whether the CEO is replaced with an outsider, and the reference dummy indicator taking value 1 if the startup did not experience a CEO turnover and zero otherwise. In columns II and IV, we consider a more fine-grained taxonomy of outsider CEOs and distinguish between those with and without managerial experience. In all models, we control for foundation-year and region fixed effects.

Table 21: Prominent investors, startup professionalization, and the effect on startup performance

	IV weighted probit regressions models (second-stage results)	
	Likelihood that a startup received any follow-on financing	Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution
	Marginal Effects	
	I	II
CEO replacement	0.507*** (0.005)	0.489*** (0.010)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,762	1,762

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to balance startups with and without prominent investor funds. First-stage results are reported in Table 16. Given that our instrument is the indicator for whether a startup had received funds from prominent investors, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to prominent investor participation.

Table 22 Prominent lead investor effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced	
	Marginal Effects	
	I	II
Prominent Lead Investor	0.056** (0.026)	0.513* (0.026)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,772	1,696

Notes: *p<0.1; **p<0.05. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. Our treated indicator, *Prominent Lead Investor*, is now constructed only for those investors that invested the largest amount in a given startup relative to all other investors participating in a same round. In column I, we report the marginal effects of prominent lead investor involvement in a startup's round, using the entire sample of startups. In column II, the sample includes only those startups that listed a CEO or a President as a top executive. We balance treatment and control observations by adopting the CEM algorithm described in the text.

Table 23: Prominent lead investor effect on the hiring of an outside CEO

	Weighted probit regressions	
	Likelihood that a superseding CEO is an outsider	Likelihood that a superseding CEO is an "experienced outsider"
	Marginal Effects	
	I	II
Prominent Lead Investor	0.051 (0.041)	0.101*** (0.026)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	758	

Notes: See Table 22. The sample includes only those startups that had experienced a CEO replacement by 2015. In column I, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an outsider. In column II, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an "experienced outsider". An "experienced outsider" is defined as an outsider having a prior executive position in an investor-funded startup. We balance treatment and control observations by adopting the CEM algorithm.

Table 24: Startup characteristics and prominent lead investor effect on startup professionalization

	Weighted probit regressions for the likelihood that a startup's CEO is replaced (Marginal effects)	
	Panel A	
	Startups that had not received a positive investment amount in the pre-period	Startups that had received a positive investment amount in the pre-period
	I	II
Prominent Lead Investor	0.030 (0.050)	0.074** (0.034)
Observations	716	1,120
	Panel B	
	Number of high-level executives other than a CEO or a President =0	Number of high-level executives other than a CEO or a President >0
	I	II
Prominent Lead Investor	0.064** (0.034)	0.057 (0.036)
Observations	984	853
	Panel C	
	Board size below or equal the median	Board size above the median
	I	II
Prominent Lead Investor	0.086** (0.034)	0.022 (0.037)
Observations	961	876
	Panel D	
	Had not employed marketing personnel	Had employed marketing personnel
	I	II
Prominent Lead Investor	0.083** (0.032)	0.008 (0.041)
Observations	1,144	693

Notes: See Table 4. *p<0.1; **p<0.05; ***p<0.01. In Panel A, we partition the sample of startups according to whether or not, as of 2006 (predetermined period), they had received a positive investment amount in the pre-period. In Panel B, we divide the sample according to whether or not startups had listed an high-level executive other than a CEO or a President. In Panel C, we divide the sample according to whether or not a startup's board size is greater than the median. In Panel D, we partition the sample according to whether or not startups had employed marketing personnel. In all models, we control for foundation-year and region fixed effects.

Table 25: Startup professionalization effect on performance

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
CEO replacement	0.272*** (0.023)	0.259*** (0.025)	0.189*** (0.022)	0.192*** (0.023)
Region FE	YES	YES	YES	YES
Foundation Year FE	YES	YES	YES	YES
Observations	1,524	1,392	1,524	1,392

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach. In columns I and II, we report the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, we report the marginal effects of CEO replacement on the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III we apply the CEM algorithm to the entire sample. In columns II and IV, the sample includes only those startups that listed a CEO but not a President as top executive.

Table 26: Startup professionalization effect on performance - Distinguishing between different types of superseding CEOs

	Weighted probit regressions			
	Likelihood that a startup received any follow-on financing		Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution	
	Marginal Effects			
	I	II	III	IV
Superseding CEO is an insider	0.128*** (0.031)		0.080*** (0.029)	
Superseding CEO is an outsider	0.365*** (0.026)		0.246*** (0.023)	
Superseding CEO is an insider		0.128*** (0.031)		0.080*** (0.029)
Superseding CEO is an "inexperienced outsider"		0.335*** (0.029)		0.222*** (0.025)
Superseding CEO is an "experienced outsider"		0.462*** (0.052)		0.311*** (0.037)
Observations	1,524	1,524	1,524	1,524

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach described in the text. In columns I and II, the outcome is represented by the likelihood that a startup received any follow-on financing during 2009-2015. In columns III and IV, the outcome is represented by the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. In columns I and III, the regressors of interest are a dichotomous indicator for whether a CEO is replaced with an insider, another for whether the CEO is replaced with an outsider, and the reference dummy indicator taking value 1 if the startup did not experience a CEO turnover and zero otherwise. In columns II and IV, we consider a more fine-grained taxonomy of outsider CEOs and distinguish between those with and without managerial experience. In all models, we control for foundation-year and region fixed effects.

Table 27: Prominent investors, startup professionalization, and the effect on startup performance

	IV weighted probit regressions models (second-stage results)	
	Likelihood that a startup received any follow-on financing	Likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution
	Marginal Effects	
	I	II
CEO replacement	0.506*** (0.012)	0.483*** (0.016)
Region FE	YES	YES
Foundation Year FE	YES	YES
Observations	1,827	1,827

Notes: ***p<0.01. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to balance startups with and without prominent investor funds. First-stage results are reported in Table 16. Given that our instrument is the indicator for whether a startup had received funds from prominent investors, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to prominent investor participation.