# Prominent Investor Influence on Startup CEO Replacement and Performance

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**Abstract**

This paper empirically examines how CEO replacement and *ex post* performance in startups are influenced by prominent-investor involvement. We employ Coarsened Exact Matching to generate causal evidence showing that CEO-replacement effects increase with prominent-investor participation, and intensify when startups are early-stage, or exhibit weak governance. Replacement CEOs succeeding from prominent-investor involvement are primarily non-internal hires ("outsiders") with prior startup-CEO background ("experienced"). These CEO replacements boost startup performance, with "outsider" CEOs – and more so "experienced outsiders" – intensifying these gains. Finally, we specifically show that prominent-investor involvement produces an independent, large and robust amplification of the replacement CEO-led performance increases in startups.

Keywords: Startups; Investors; Venture capital; CEO turnover; Firm performance; Entrepreneurship.

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

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## I. Introduction

This paper empirically examines CEO turnover in startup companies, providing evidence on the cause-and-effect relationships among prominent investors' participation, CEO replacements, and their *ex post* firm performance implications. Using a large dataset of investors, startups, executives and their characteristics, we focus on how the participation of more prominent investors affects CEO replacement in startup companies, identifying the conditions associated with these leadership transitions, and relating CEO replacement to *ex post* financial and innovative performance in startups. We demonstrate that prominent-investor participation increases the incidence of CEO replacement in startups, and that the CEO-replacement effect of prominent investors is stronger when startups are relatively early stage, and when they exhibit weak governance. Notably, we find that the prominent investor-led replacement CEOs are drawn overwhelmingly from one pool: non-internal, outside candidates with prior CEO experience at other investor-backed startups (so-called "experienced outsiders"). We provide additional causal evidence demonstrating that CEO replacement produces superior company performance *ex post*, and that this performance effect is increased when the new CEO comes from outside the company, and boosted even more when the individual is an "experienced outsider." Additionally, our analysis demonstrates that these performance-increasing effects are driven specifically by CEO replacements caused by prominent-investor participation, and that the independent effect of prominent investors in CEO replacement is responsible for an independent, large and robust performance boost in startups.

Finance theory generally employs information explanations to model financial intermediaries, examining the principal-agent relationship, adverse selection and moral hazard (Fama, 1985; Stiglitz, 1985; Bernanke *et al*., 1994). In the startup context, the prior literature has modeled investors – typically venture capitalists (VCs) – to engage in both screening and monitoring, focusing on specific mechanisms such as contractual agreements and convertible securities (Hellmann, 1998; Kaplan and Strömberg, 2004; Casamatta, 2003; Schmidt, 2003). VCs have been shown to participate in major decisions affecting startup

management (Sahlman, 1990; Gompers and Lerner, 2004), even altering their board representation during startup CEO turnover (Lerner, 1995).

A direct effect relating investor participation to startup CEO turnover is reported by Hellmann and Puri (2002) who empirically investigate the influence of VCs in replacing startup management. Using a dataset of 170 California-based startup companies, the authors collected detailed information on the arrival of VC funding 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 startup 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 management structure of startups in which they invested. While these findings are provocative, it is not obvious how to interpret the authors' correlations. Due to endogeneity, their findings may result either from VC target selection (screening) or the ongoing influence of VCs in the startup (monitoring).

We contribute to this discussion by constructing a research design that specifically addresses these endogeneity concerns, and combine disparate elements from prior literature to investigate unanswered questions related to prominent-investor participation in startups, the incidence and character of startup CEO replacement, and – critically – whether these factors, and the relationships between them, affect the *ex post* performance of startup firms. Because our principal interest lies in exploring differences among investors in terms of their quality, we focus on prominent-investor participation in startup funding, examining a specific monitoring mechanism: startup CEO replacement. Our findings fill a gap in the literature by providing causal evidence about the circumstances and conditions of prominent investor-led CEO replacement, and the resulting *ex post* performance effects on funded startups.

Research into these questions is economically relevant because while startup companies drive disproportionate economic growth (Haltiwanger *et al.*, 2013), investor-led CEO replacement and its performance implications have not been adequately studied, and remain controversial in the investing

community. In fact, there exists no consistent set of opinions among investors regarding whether, let alone the timing or conditions under which, CEO replacement creates value. Describing the VC financing model, a *Beta Group* founding partner and investor observed:

> "The person who starts the business is seldom the person who can grow it, and that person is seldom the one who can lead a much larger company. Thus it is unlikely that the founder will be the same person who takes the company public." (Zider, 1998).

Marc Andreessen expressed a contrary view in 2009, stating that the *Adreessen Horowitz* investment firm was "hugely in favor of the founder who intends to be CEO."[1] Explaining further, his partner Ben Horowitz noted that the:

> "most controversial component of our investment strategy [is] our preference for founding CEOs. The conventional wisdom says a startup CEO should make way for a professional CEO once the company has achieved product-market fit [but] we prefer to fund companies whose founder will run the company as its CEO."[2]

This suggestion that *Andreessen Horowitz* screens their investments accompanies an acknowledgement by Andreessen of a monitoring role: "We cannot guarantee that a founder can be a great CEO, but we can help that founder develop the skills necessary to reach his or her full CEO potential."[3] A general partner at *Khosla Ventures* offered a succinct opinion: "Great VCs do not want to replace a founder as CEO. Period."[4]

While there is no consensus view to guide researchers, this last comment – by distinguishing "great" VCs from others – suggests that differences in investor quality may be a relevant factor when

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[1] Marc Andreessen. "Introducing our new venture capital firm Andreessen Horowitz." http://blog.pmarca.com/2009/07/06/introducing-our-new-venture-capital-firm-andreessen-horowitz (7/6/09).
[2] Ben Horowitz. "Why We Prefer Founding CEOs." http://www.bhorowitz.com/why_we_prefer_founding_ceos (4/29/10).
[3] Andreessen, footnote 2.
[4] Keith Rabois, Comment. https://www.quora.com/How-do-VCs-eventually-come-to-the-conclusion-that-they-need-to-replace-the-CEO/answer/Keith-Rabois (7/15/10).

investigating CEO replacements in startups. The prior entrepreneurial-finance literature has generally focused, not on investor quality directly, but on the involvement (or not) of one specific type of startup investor: the VC (Hellmann and Puri, 2002; Lindsey, 2008; Chemmanur *et al.*, 2011). Only recently have a few studies begun to explore how heterogeneity in VC quality relates to investment outcomes. Kaplan and Schoar (2005) for instance observe persistent returns among only a subset of VCs, speculating that variation in VC screening and monitoring skills may be an explanation. Hochberg, Ljundqvist and Lu (2007) find a positive correlation between the prominence of participating VCs and the likelihood of startup survival, and Sørensen (2007) provides causal evidence that variance in VC investing experience predicts superior financial performance of funded startups. While these studies differentiate quality, they still focus only on VCs, omitting from their analysis non-VC investors that have been shown in other studies to be important intermediaries in startup finance (Ueda, 2004; Kerr *et al*., 2014).

We contribute to this evolving stream of literature by exploring how the participation of prominent investors in startups affects CEO replacement and *ex post* performance, focusing on both VC and non-VC investors. In a series of qualitative interviews with professional financiers, we investigated what affected the propensity and character of CEO replacement in portfolio companies, discovering a likely set of explanatory investor attributes, including: longer investing experience, superior reputation, and deeper sector-specific relationships in finance and startup industries. Our "prominence" measure is accordingly relevant to the phenomenon we are studying, since it reflects prior investing relationships with other financiers and captures participation in prior startup-financing deals. While our measure represents investing experience and position in industry networks (Hochberg *et al.*, 2007), unlike other research we extend our framework to include both VC and non-VC investors. Our prominence measure thereby becomes a quality differentiator among financial intermediaries of varying types.

Akin to Sørensen (2007), our research design is constructed to generate causal evidence on the relationships we investigate. Accordingly, we implement an innovative non-parametric matching approach

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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, 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 and executive composition.

By implementing the CEM, we generate causal evidence showing that prominent-investor participation in startups induces an increased likelihood of CEO replacement. Additionally, we are able to show that contrary to suggestions in earlier scholarship (Hellmann and Puri, 2002), VC involvement does not influence CEO replacement in startups: replacement is instead produced by the participation of prominent investors, whether VCs or otherwise. This finding is provocative, especially considering the exclusive focus on VCs in much of the entrepreneurial finance literature.

Because startups are often founded and initially led by technologists who lack business experience and management training, we also investigate the relationship between prominent investor-led CEO replacement in startups and the characteristics of the individuals chosen to supplant incumbent CEOs. Since investor motives for replacing a CEO may differ from case to case (Gompers and Lerner, 2004), it is not *a priori* evident which individual traits may matter. Using prior literature as a guide, we examine characteristics related to managerial skill and experience and, alternatively, whether the successor was promoted from inside the firm (Furtado and Rozeff, 1987; Hellmann and Puri, 2002). Specifically, we determine whether the successor CEO (i) was promoted internally, or hired in from outside the firm (was an "insider" or "outsider") and (ii) had previously managed another investor-funded startup (was "experienced"). We find the participation of prominent investors in startups is most likely to produce successor CEOs who combine both characteristics, whom we call "experienced outsiders."

Our research design also allows us to explore whether prominent investor-led CEO turnover in portfolio companies is related to differing startup-firm characteristics. Prior research (Fulghieri and Sevilir, 2009) suggests that prominent investors could capture bargaining advantage by inducing CEO turnovers in more mature startups, although asymmetric information and uncertainty explanations may cut the other way, implying a stronger value-creating opportunity for prominent investors in younger startups. After generating several proxies for the earlier stages of startup development, we apply our CEM procedure to investigate how prominent investor-led CEO replacement relates to these characteristics. Our results provide causal evidence that the involvement of prominent investors is more likely to induce a CEO replacement in relatively immature startups, implying that prominent investors may have monitoring advantages in the earlier stages of their portfolio companies' development.

Similarly, we examine startup characteristics related to the quality of firm governance. Relying on prior research studying the relationship of strong governance to investor outcomes (Fama, 1980; Jensen, 1993; Gompers and Lerner, 2004; Hermalin, 2005), we generate predictions relating prominent investors to CEO replacement in startups characterized by weak governance. After generating a proxy for weak governance in startups, we again apply our CEM procedure to investigate how prominent investor-led CEO replacement relates to this characteristic. Our results provide causal evidence that the involvement of prominent investors is more likely to induce a CEO replacement in startups exhibiting relatively poor governance. This result implies that prominent investors may have advantages in monitoring when startups have weak governance structures in place.

Given these findings, the last questions we investigate are fundamental ones: Does startup CEO replacement contribute to *ex post* financial and innovative performance, and does the participation of prominent investors independently induce a performance premium? Again, in light of the disparate motives prominent investors may have for replacing existing CEOs, it is not clear *a priori* that hiring new management would necessarily result in better startup outcomes. After applying the CEM approach to

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address endeogeneity concerns, our empirical results provide causal evidence that CEO replacement does produce superior *ex post* performance in startups, and that these dividends are strongly driven by "experienced outsider" CEOs. Finally, by using the CEM procedure in an instrumental variable (IV) model, we find strong support for the positive, distinct role played by prominent investors: our results provide causal evidence of large increased performance effects produced by CEO replacements that are directly induced by prominent-investor participation in the startup.

We organize the remainder of the paper as follows. Section II describes the dataset. In Section III we present our exploration of how the participation of prominent investors in startup funding relates to CEO turnover, and the conditions under which such CEO replacement occurs. Section IV presents causal evidence demonstrating the positive effect CEO replacement has on startup performance, and shows that individual characteristics of successor CEOs enhance this positive effect. Section V provides additional causal evidence showing that these CEO replacement effects are induced by the participation of prominent investors in startup funding, and that this prominent-investor involvement produces a large independent performance premium in the startup. Section VI presents a number of robustness checks. Section VII concludes by offering some closing remarks.

**II. Data**

To assess the effect of investor prominence on startup CEO replacement, we use data on startups' financing rounds and the identity of their executives from Thomson's Venture Economics. While Venture Economics reports only a cross-section of the most recent information available, we retrieved this information at two distinct points in time: in October 2008, and again in April 2015.[5] Because we have access to a complete 2008 cross section, we are in a privileged position to examine the impact of investor prominence on the

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[5] Venture Economics includes information on "Executives." Average executive counts for our sample companies equal 7.8 in 2008 (median=7) and 6.7 in 2015 (median=5).

probability that startups' 2008 CEOs are replaced as of 2015, and to assess the effect prominent investor-led CEO replacement has on startups' *ex post* performance.

To construct our sample, we begin from the population of 26,071 US-based startup firms listed in the 2008 Thomson's Venture Economics dataset with at least one financing round. We then retain records on companies still listed in the April 2015 data, eliminating any record with incomplete information on founding date, financing rounds, or the first and last name (including title and suffix) of the company's top executive.[6] To better identify active portfolio companies, we retain only those records showing a financing round in 2006, 2007, or 2008. Because startup funding tends to arrive soon after founding (Gompers, 1995) we exclude those with founding dates before 1999. After applying these filters, our final sample includes 3,695 startups, representing 70% of companies listed in the October 2008 Venture Economics dataset with at least one financing round during 2006-2008.

Descriptively, our sample companies operate in many sectors: 272 in biotechnology, 490 in the medical sector, 304 in communications, 109 in computer hardware, 801 in computer software, 814 in the Internet, 314 in semiconductors, 125 in consumer-related sectors, 77 in financial services, 89 in business services, 203 in energy, and the remaining in miscellaneous sectors. Company age since founding was in April 2015 on average 12 years (median=12). By April 2015 they received on average 3.5 rounds of financing (median=3) and a cumulative, constant USD funding stock by 2006 of 17 million (median=5 million).

In order to determine whether a CEO was replaced in the period between October 2008 and April 2015, we compare both by machine and by hand the names and job titles of executives listed in the 2008 and 2015 data images. We verify and complement the Venture Economics information by manually

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[6] This paper uses "CEO" to denote the startup's top manager, even though some firms list a "President" but no CEO. We hand-checked Venture Economics against online sources (LinkedIn and company websites), and excluded those few CEO replacement records we could not verify. All results reported in this paper are robust to us excluding the 263 records that list a "President" only but no "CEO" (7.1% of the sample).

searching (in LinkedIn, and on company websites) for all CEOs employed by our sample startups during 2008-2015. Among the 3,695 startups in our sample, we find 30% (1,107) experienced a CEO replacement during the period. We are able to identify whether the replacement CEO originated from inside the startup or from outside, or had previously been a CEO or President at another investor-funded startup (based on executive rosters in Venture Economics' 2008 data for all 26,071 startups, and our hand-collected information from LinkedIn and company website searches). For those 1,017 startups in our sample showing a CEO replacement, the new CEO in 59% of the cases was not listed on the focal company's 2008 executive roster (was an "outsider"), and in 37% was listed as having previously been the top manager in another investor-backed startup (had "experience").

***Investor prominence.*** To investigate our research questions, we create an indicator for the prominence of participating investors, using an eigenvector centrality measure (Bonacich, 1972), which weights an investor's ties to other investors by the importance of the investors to which the former is related through its startup investing. 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.[7]

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, computed for the entire population of investors who were active in 2008 according to Venture Economics. If a startup shows no financing rounds in 2008, we use the 2007 round to compute our measure, and similarly the 2006 round if we observe no 2007 financing.

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[7] Several studies in entrepreneurial finance have used eigenvector centrality measures to proxy for investor prominence. See for instance Hochberg *et al.* (2007) and Hsu and Ziedonis (2013).

After calculating this measure, we find 47.7% of the startups in our sample received funds from "prominent investors" during 2006-2008.

The results we report are robust to several alternative methods of building our main variables of interest. Alternatively constructing our treated indicator using as a reference those investors who participated in the financing rounds of only our sample startups, rather than in all startups, we find the share of treated startups decreases to 40.7%. After building our treated indicator only for those "lead" investors who had invested the largest amount in a given startup relative to all other investors participating in a same round, we find the share of treated startups falls to 36.2%. To define prominent investors, we also considered a different eigenvector distribution cutoff (90th percentile) and an alternative measure based on the number of investment rounds undertaken in a 3-years window. Finally, to reduce concerns that we do not compare startups funded by similar types of investors, we built the treatment indicator for only those 3,454 startup that had received funds from venture capitalists, during the 2006-2008 period. We find that, regardless of the cutoff or definition we use to construct our treatment or treated indicator, our results hold.

To generate performance metrics, we complement our dataset with information on US patents awarded to our sample startups prior to 2008. We machine and hand match the company names from Venture Economics to "assignee" information available from the US Patent & Trademark Office (USPTO). Granted patent information is drawn from three sources; public bibliographic information drawn from the front page of US patents, a customized extract of cleaned and standardized assignee names available from the USPTO, and the Thomson-Reuters patent database. We find that 28% of our sample startups were awarded at least one US patent grant by December 31, 2008, with 19% receiving more than one.

**III. Analyzing the influence of prominent-investor participation on CEO replacement**

**A. Econometric methodology**

The first research question we address is whether prominent-investor participation affects the likelihood that we observe a startup CEO replacement. To examine this question, one possibility would be to estimate the following model:

$$\Pr(CEOReplacement_i) = f(ProminentInvestor_i, \pmb{\Gamma}_i; \epsilon_i) \tag{1}$$

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 95$^{th}$ 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. $\pmb{\Gamma}_i$ 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 endogenous (Sørensen, 2007). It is possible that a particular class of startups with a high *ex ante* probability of having their CEO replaced will attract prominent investors less frequently compared to other startups having a low *ex ante* likelihood of experiencing a CEO replacement (a sorting effect). Descriptive statistics on a number of pertinent startup characteristics we present in Table 1, Panel A show that prominent-investor participation in a given round is not likely 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 been awarded at least one US patent, have comparatively more top executives (other than CEO) and board members; list a "marketing or sales" executive (a proxy for the startup's proximity to showing sales and revenues), list a chief technology or science officer, and have an "experienced outsider" CEO. Consistent with a selection effect,

we are more likely to observe for startups receiving funds from prominent investors either an IPO or an acquisition by 2015, relative to startups with no prominent-investor funding.

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. While a number of finance studies have estimated matching models to address endogeneity issues (Drucker and Puri, 2005 and Hellmann *et al.*, 2008), none to our knowledge have yet implemented the CEM procedure.

Empirical strategies that use matching methods help researchers sort out cause-and-effect when the ideal experiment is otherwise not observable. When considering our research question, an ideal experiment would be to randomly assign prominent investor funding among startups, and observe how this treatment influences CEO replacement and, ultimately, startup performance. However, in the real world, investors do not make their selections randomly.

While propensity score matching is commonly used in finance and economics scholarship, the CEM procedure we implement in this paper offers real advantages to researchers. 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 provides an advantage because the counterfactual observations match the means as well as all other sample moments of the treated observations.

To select control observations we apply the following procedure. We carefully identify a set of startup characteristics that affect their propensity to receive prominent investor financing. Next, we create

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

We next generate a set of exogenous variables to balance treated and control observations. To capture financing, our variables include the predetermined likelihood that a startup attracts funds from prominent investors, measured during the 2004-2006 period.[8] We also include cumulative funding received through 2006 (in thousands of constant USD), and follow convention by partitioning this continuous variable into separate bins with cutoff values at the 50th, 75th, 90th, 95th, and 99th percentiles, determined at the startup activity-sector level. To capture technology concentration, we create a dichotomous variable flagging those startups listing a chief technology or science officer in 2008, and another flagging those startups that received at least one US patent grant during the pre-treatment period.

To control for companies' organizational structure, we examine in Venture Economics the number of board members (hereafter, "board size"), and build an indicator based on startup board size in 2008, taking value 0 for board size zero, 1 if board size was at least one, and 2 if board size was at or above the median (=3) for all startups in our sample. Using our 2008 data as well as LinkedIn and company web site searches, we also create an indicator for 2008 startup CEO "experience" taking value 1 if the individual held another startup CEO position prior to 2008, and 0 otherwise. To control for investors' specialization and expertise, we employed Venture Economics data on investors' preferred investment sectors to construct an indicator based on the focal startup's prior financing rounds, taking value 1 if any investor's sector preference matched the startup's operating sector, and 0 otherwise. We also constructed several different

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[8] Our results hold when we exclude this variable from the set of predetermined regressors used in the implementation of the CEM algorithm. Our results also hold if we include the cumulative funding received through 2008 rather than through 2006. Finally, our results hold if we use the natural logarithm of the cumulative funding received through 2006 instead of the ordinal indicator described in the text.

geography-based controls, and after finding no difference in their effects, chose to include an indicator taking value 1 if a startup was located in California or Massachusetts, and zero otherwise. We also consider two startup founding periods, one during 1999-2003 and another from 2004-2008, and use founding-period, sector, and region dummies.

To adjust for possible remaining imbalance, we include in our weighted regressions founding-year fixed effects and a more fined-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, we compare 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). We consequently create a ranked variable taking value 2 if the startup was located in CA or MA, value 1 if in DC, CO, WA, or NY, and 0 otherwise. Reassuringly, we find that point estimates do not change when we exclude these controls, confirming that our implementation of CEM achieves a satisfactory covariate balance.

We are satisfied these covariates capture first order startup characteristics, including funding, organizational complexity, the quality of its executives, and technology characteristics (Gompers and Lerner, 2004). The relevant treatment for startups is receiving funding from prominent investors: among 1,763 treated observations, after processing we are able to identify at least one control observation in 823 cases (47%). This percentage is expected since, being a product of using a non-parametric matching algorithm, the share of matched observations decreases steeply with the number of strata. We present descriptive statistics in Table 1, Panel B confirming that our CEM procedure produces a balanced match of treated and control startups. In fact, there are no meaningful statistical differences between the sample means of the two groups, both in terms of variables used in the matching, and among all other observables.

Having implemented the CEM algorithm, we estimate a set of probit equation specifications. First, we estimate equation (1) in a simple descriptive fashion to generate baseline results. Next, we employ the CEM algorithm, estimating a weighted probit model to assess the causal effect of prominent-investor involvement on the likelihood of startup CEO replacement. For robustness, we also estimated weighted logit equation and weighted conditional logit models, each of which produced qualitatively similar results.[9]

< Insert Table 1 about here>

**B. Baseline results**

We report in Table 2 correlations derived from estimating equation (1) in a probit model (controlling for the set of predetermined regressors we employ when later implementing the CEM algorithm). Reported coefficients are marginal effects, with standard errors clustered around the startups' activity sector. Table 2 demonstrates that all else equal, prominent-investor involvement in funding is positively and significantly associated with a startup's CEO being replaced. It is noteworthy that CEO replacement is negatively associated with a set of predetermined performance measures, namely whether a startup was led by an "experienced outsider" CEO, had received a relatively large funding amount in the pre-period (to 2006), and had received at least one US patent grant by 2008.

< Insert Table 2 about here>

We now turn to the results derived from estimating the weighted probit model, which follows our implementation of the CEM algorithm to address endogeneity concerns. Table 3 reports coefficients as marginal effects, with standard errors clustered around the strata identified using the CEM algorithm. We find that prominent-investor participation increases the likelihood that a startup's CEO is replaced by 7.7

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[9] Because the conditional logit model addresses possible remaining unobserved heterogeneity (by computing the likelihood relative to each group identified with the CEM algorithm), we devote additional discussion to those results in our Robustness Checks section below.

percentage points (column I), with the coefficient 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 captures the effect of the incremental measure of investor prominence, relative to the pre-treatment period. It is noteworthy that the magnitude of the coefficient associated with investor prominence is larger than the analogous coefficient we reported previously in Table 2 (6.7 percentage points). This difference in coefficients is the result of the CEM excluding from the sample those un-matched startups in the upper tail of the performance distribution. We interpret these results as evidence that these high performers are least likely to benefit from prominent-investor involvement at the margin, since they have less room for improvement in their organizational structure compared to other startups.

## C. Venture-capital investor effects

In prior research, Hellmann and Puri (2002) showed a positive correlation between VC involvement and CEO turnover in startups, attributing the CEO replacement effect to VCs specifically. Our research design allows us to provide causal evidence on a question left unresolved in the literature: Is CEO turnover in startups influenced primarily by VCs in particular, or is the prominence of participating investors the more important influence on startup CEO replacement? The answer to this question is *a priori* ambiguous: while investor prominence and experience has been shown to predict startup outcomes within VCs (Hochberg *et al.*, 2007; Sørensen, 2007), it is possible that characteristics specific to VCs may dominate across different investor types, since VC firms have developed distinctive organizational forms and employ particular contract and equity devices when structuring their deals (Kaplan *et al*., 2002).

To explore this open question, we test whether the prominent-investor effect we find on CEO replacement is dominated by VC involvement. While Venture Economics primarily covers information about financing rounds led by (non-corporate) VCs, we were able to identify 241 instances in which round investors included only individuals, corporate VCs, and real estate investors, allowing us to estimate a

model in which the dependent variable is an indicator that takes value 1 if a startup had received venture capital financing, and 0 otherwise. In implementing the CEM algorithm to address endogeneity concerns, we use the same exogenous regressors that we listed in the econometric methodology section previously.

The results, reported in column II of Table 3, show a coefficient for VC involvement that is not significantly different from zero. This result is meaningful and has implications for research: it demonstrates that when examining CEO replacement, the relevant comparison is between more-prominent and less-prominent investors, not between VCs and other types of investors. Our finding is provocative, especially considering the extensive focus on VCs in prior literature. We are mindful nevertheless that without additional research, this result is not generalizable beyond the context of CEO replacement to other outcomes on this evidence alone.

< Insert Table 3 about here>

**D. The influence of CEO characteristics**

Having found that the participation of prominent investors results in increased CEO turnover in startups, we are interested in understanding the conditions under which replacement occurs. By comparing the identities (first name, last name, title, and suffixes) of our sample startups' CEOs in 2015 with its list of 2008 executives, we are able to identify "insider" successor CEOs who were promoted internally. This designation enables us to empirically explore whether prior CEOs are more likely to be replaced with incumbent company executives (insiders) or with others (outsiders). To investigate, we restrict the sample to those 1,107 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. The

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results of our investigations are reported in Table 4, Column I, showing that the involvement of prominent investors in a startup is not more likely to produce an "outsider" replacement CEO.

That finding leads us to investigate whether the management experience of replacement CEOs is relevant. We flag successor CEOs as being "experienced" if we observe them having occupied a prior CEO or President position in another investor-funded startup. This indicator enables us to examine whether prominent-investor involvement leads to a higher incidence of successor CEOs having prior startup management experience. Our results, reported in Table 4, Columns II and III, show that the participation of prominent investors influences the characteristics of startup CEO replacements. Our exploration suggests that prominent-investor participation in a startup results in a specific type of outsider succeeding to the CEO position: the "experienced outsider." This finding holds true when we compare experienced outsiders to all other CEO replacement types (column II) and when we specifically compare experienced to inexperienced outsider CEOs (column III).

< Insert Table 4 about here>

**E. The influence of startup firm characteristics**

***CEO replacements in early versus late stage startups.*** A fundamental question relates to what mechanisms may be driving our results. Are prominent investors advantaged in their ability to deal with uncertainty, do they have information advantages, or are they better able to exploit bargaining advantages relative to founders and managers? Prior literature has investigated how differences in investor characteristics relate to the marginal startup investment they make, examining why investors participate in more or fewer startups. In modeling VC investment strategies, Fulghieri and Sevilir (2009) show that experienced VCs (as defined by their number of investments) are able to induce greater competition among portfolio companies, leading experienced VCs to have more bargaining power than their startups relative to less-experienced VCs. Furthermore, this advantage relative to non-experienced VCs increases with the maturity

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of portfolio companies. The implication for our research is that if bargaining power is a primary explanation for our results, we would expect the participation of more experienced investors to produce larger effects as startups become more mature.

To investigate, we qualify the investor prominence effect by identifying a number of situations likely to characterize relatively early stages in the startup's lifecycle. First, following Hellmann and Puri (2002), we partition our sample according to whether or not the startup received an amount of funds below or equal to the sector median by 2006. Likewise, we construct an indicator for whether or not the startup received funds from prominent investors during the 2004-2006 period. We also generate a dichotomous variable to identify startups that in 2008 had a comparatively small board size, since this situation should relate to less complex organizations. Additionally, we identify whether 2008 startups listed a marketing or sales executive, on the theory that employing such an executive will correspond to the beginning of product sales (later in the startup's lifecycle). Finally, we identify whether a chief technology officer or a chief scientist was listed in 2008, to proxy for startups focused more on science-based technologies, typically viewed as being more embryonic and more distant from the marketplace (Gompers and Lerner, 2004).

We report our results of these analyses in Table 5, panels A, B, C, D, and E. The effect of investor prominence on the likelihood of CEO replacement is significantly different from zero only when the startup (i) received an investment amount in the pre-period below or equal the sector median, (ii) did not receive funds from prominent investors in the pre-period, (iii) had a relatively small board size, (iv) did not list a marketing executive, and (v) listed a chief technology officer or a chief scientist. Findings (ii), (iii) and (iv) complement and provide a more nuanced window into finding (i) showing the effect of prominent investors is significant only during earlier startup stages. Similarly, finding (v) suggests that the prominent-investor effect is significant only for startups focused on science-based technologies. In fact, these added results imply that the participation of prominent investors contributes to startup CEO replacement in a very specific set of circumstances.

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The effects indicated by the coefficients are instructive in this regard. When the startup receives an amount of funds below the sector median, the likelihood of CEO replacement from the participation of prominent investors increases by 9 percentage points. In those startups that did not receive funds from prominent investors in the pre-period (2004-2006), the involvement of prominent investors increases the probability that a CEO is replaced by 9 percentage points. When a startup's board is relatively small (below the median), the involvement of prominent investors increases the likelihood of CEO replacement by 8 percentage points. When the startup is more distant from the product market (i.e., no sales or marketing executive), the increased likelihood of CEO replacement from the participation of prominent investors is 8 percentage points. And finally, when a startup is focused on science-based technologies, prominent-investors involvement boosts the probability of CEO replacement by 9 percentage points.

A possible concern is that these effects are the result of our several proxy measures for "early stage" startups also tending to identify companies that are rapidly growing and, therefore, disproportionally more likely to attract prominent investors and have their CEO replaced. We reply to this concern by pointing out that the CEM-weighted probit estimates are larger than the corresponding non-weighted estimates, and that this difference is largest for early stage startups. These results provide a clear indication that the un-weighted probit estimates are downward biased, especially in the case of early stage startups. As a result, any possible omitted factors are a source of negative correlation – not positive correlation –   between prominent investor involvement and CEO replacement.

While we are unable to effectively separate the strong bargaining explanation in prior research from other explanations, our results suggest that the participation of prominent investors is more critical and produces greater value in relatively immature startups, when uncertainty is likely highest. As such, they support the notion that prominent investors have an advantage when interacting with relatively immature startups in recognizing opportunities, and acting on them, compared with non-prominent investors. While

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our findings run in the opposite direction to what we would expect given the Fulghieri and Sevilir (2009) results, we offer the caveat that – by themselves – these results do not refute bargaining power explanations.

< Insert Table 5 about here>

***Startup governance.*** Next, we explore the role of startup governance in shaping the relationship between prominent investor involvement and CEO replacement. A number of studies have recognized that monitoring portfolio investments is costly and, critically, that these costs fall as the quality of governance in the investment increases (Fama, 1980; Jensen, 1993; Hermalin, 2005). The central idea is that performance-based decision making is more costly when companies are poorly governed. Investors differ in their costs of implementing such decisions, with prominent investors incurring lower implementation costs (Gompers and Lerner, 2004). Building on this insight, we expect the effect of prominent investor involvement on CEO replacement will be strongest in startups with poor governance. We anticipate this effect since the higher monitoring costs imposed by inadequate governance will tend to erase any net gains from monitoring among less prominent investors.

Empirically, we consider startups as having weak governance when their CEO is listed as a member of the board of directors. In doing so, we rely on a large literature that highlights the inverse relationship between company CEOs being board members and board independence, and the positive influence of increasing levels of board independence on the implementation of performance-based decisions (Hermalin and Weisbach, 2003; Harris and Raviv, 2008; Adams *et al*., 2010; Guo and Masulis, 2015). We then re-estimate the effect of prominent investor involvement on CEO replacement in subsamples of startups for which in 2008 the CEO is listed, or alternatively not listed, on the company's roster of board members. Results reported in Panel F of Table 5 point to a strong, positive effect for prominent investor involvement on CEO replacement among those startups exhibiting weak governance structures. Interestingly, among startups that do not list their CEO as a board member, this effect is small and non-significant. Specifically,

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startups exhibiting weak governance that are treated with prominent investor participation are 13 percentage

points more likely to have their CEO replaced, while other startups treated with prominent investors show

only a 2.6 percentage point increase, although this effect is not statistically different from zero.

**IV. Assessing the effect of CEO replacement on startup performance**

**A. Econometric methodology**

While it is notable that we have produced a positive, causal relationship between prominent-investor

involvement in startups and CEO replacement, we recognize that our findings would yield more important

insights if tied to startups' *ex post* performance. The replacement of incumbent CEOs following the

involvement of professional investors could be a result of matching new skills to new firm or market

demands in later stages of a startup's development. This notion is supported by research showing that the

organizational skills needed to prototype a product in an early stage are often quite different from those

required to scale up production and take a product to market, let alone those necessary to manage a

successful exit event such as an IPO (Gompers, 1995). So, while prominent investors may be interested in

replacing incumbent CEOs not well suited to the managerial tasks required in more mature stages, it remains

an open empirical question whether successor CEOs are better at fulfilling those tasks.

To examine CEO replacement effects on startup performance, our equation of interest is:

$StartupPerformance_i = f(CEOReplacement_i, \boldsymbol{\Theta}_i; u_i)$ (2)

where we consider several different measures of startup $i$'s performance. First we focus on the amount of

funding the startup attracted during the 2009-2015 period, employing $\boldsymbol{\Theta}_i$ as a vector of covariates.

Specifically, we consider an indicator for whether a startup had received any follow-on financing after

2009, and alternatively 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 estimate models using as a dependent variable the

natural logarithm of the startup's 2009-20015 funding amount, 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 problems. As an additional measure of performance, we employ an indicator for startup survival, taking a value 1 if a startup was not abandoned by investors during 2008-2015, and zero otherwise. With this indicator, we follow the convention (Nanda and Rhodes-Kropf, 2013) treating as abandoned those startups for which we observe no funding for a period of at least five years after the last recorded round, and which did not experience either an IPO or acquisition. According to this definition, 75% of the startups in our sample survived (were not abandoned). Since investments in research and development drive both private and social returns (Bloom, Shankerman, and Van Reenen, 2013), we generate an alternative indicator based on startups' innovative performance, taking value 1 if a startup had been awarded at least one US patent during 2008-2015, and zero otherwise. This indicator equals 1 in 27% of the cases.

We face a likely endogeneity issue concerning the indicator for whether a startup had its CEO replaced (our main independent variable of interest) since startups may undergo a re-organization of their top management with the aim of attracting investor funding. Indeed, the correlations we report in Table 2 demonstrate that CEO replacement is more likely in startups underperforming across several outcome measures. We address this endogeneity concern by implementing the CEM algorithm, again balancing treatment and control observations using a similar set of controls listed in our previous models. Notably, we include the likelihood that a startup attracts funding from prominent investors, measured over the 2006-2008 period. We also use the cumulative amount of funds that a startup had received through 2008 (in thousands of constant USD). Following the convention, we partitioned this continuous variable into separate bins with cutoff values at the $50^{th}$, $75^{th}$, $90^{th}$, $95^{th}$, and $99^{th}$ percentiles, determined at the startup's activity-sector level. We also include an indicator flagging those companies that, in 2008, listed among their executives a chief technology or science officer, and another flagging startups that received at least one US patent grant during the pre-treatment period. We also include an indicator for whether the CEO has prior experience managing an investor-backed startup, and another for whether the startup had across all prior rounds at least one investor specialized in the startup's operating sector. Finally, we use sector,

founding-period, and region dummies. To adjust for any possible remaining imbalance, we include in our weighted regressions founding-year fixed effects and a more fined-grained set of region dummies. Given an initial number of 1,496 treated observations, after processing we find at least one control observation in 782 cases (71%). As shown in Table 6, our CEM procedure eliminates any statistically meaningful differences across the means of all observables.

< Insert Table 6 about here>

## B. CEO replacement and startup performance

Table 7 reports the correlations from estimating equation (2). We estimate probit models for each startup performance measure, and control for the predetermined regressors used in the implementation of the CEM algorithm. Reported coefficients are marginal effects and standard errors are clustered around the startup's activity sector. As shown, CEO replacement is significantly and positively correlated with each of the performance measures we consider.

< Insert Table 7 about here>

Because the model used to generate Table 7 does not disentangle selection from treatment effects, we report an additional set of findings in Table 8 resulting from our application of the CEM matching algorithm. As shown in Column I of Table 8, startups experiencing a CEO replacement are 24 percentage points more likely to receive follow-on financing after 2008. Additionally, Column II shows that a CEO replacement produces a 16 percentage point increase in the probability that the startup is in the top quartile of its sector follow-on investment distribution, regardless of the sample the definition. In Column III, we consider the effect of a CEO replacement on the probability that a startup survives through 2015. As shown, CEO replacement increases by 10 percentage points the odds of receiving continuing investor funding (survival). Finally, in Column IV, we observe that CEO replacement increases by 11 percentage points the startup's odds of having received at least one US patent 2009-2015, regardless of sample definition. As a

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general note, we find that the coefficient magnitudes obtained by estimating weighted probit models in Table 8 are mostly larger than those reported in Table 7. The likely reason is that, in implementing the CEM algorithm, we tend to exclude from the sample unmatched startups in the lower tail of the performance distribution ("poor performers"). These observations are a likely source of negative correlation between the CEO replacement and higher startup performance.

< Insert Table 8 about here>

## C. CEO characteristics and startup performance

Having shown previously that conditions under which CEO replacement occurs are relevant, it is natural to inquire into whether the superior performance we observe is moderated by these conditions. In Table 9 we disentangle the performance effects of CEO turnover by first distinguishing between "outsider" and "insider" replacement CEOs. We partition too on the other relevant individual trait we identified earlier: whether the replacement had prior CEO experience at another investor-backed startup. We are thereby able to generate a more fine-grained taxonomy of "outsider" CEOs, distinguishing between individuals with and without prior startup CEO experience. We are left with three categories of individuals who are chosen to replace incumbent CEOs in startups: insiders; outsiders with no prior CEO startup experience; and outsiders having prior experience serving as CEO of an investor-funded startup. To address obvious endogeneity concerns relating the choice of CEOs to investor funding, we again apply the CEM algorithm to find for each CEO replacement type a valid counterfactual drawn from the set of startups that did not experience a CEO replacement.

In columns I-IV in Table 9, we report results from estimating four weighted probit models. The outcome variable in Column I represents the probability that a startup received any follow-on financing during 2009-2015, and in Column II whether the amount received places a startup in the top quartile of its sector investment distribution. The regressors of interest are dichotomous indicators for whether a CEO is

replaced with an insider, whether the CEO is replaced with an outsider, with the reference dummy indicator taking value 1 if the startup did not experience a CEO turnover, and zero otherwise. As shown, an outsider CEO replacement is more likely to show superior funding, regardless of the outcome variable we examine. A test of the equality of the indicators' coefficients rejects the null hypothesis that these are equal, with a p-value of 0.00.

When we consider the more fine-grained taxonomy of outsider CEOs, by distinguishing between those with and without prior startup CEO experience, we find that outsider CEOs with such experience are associated with greater performance than those without experience, regardless of the performance outcome we consider. Consistent with Panel A, the results reported in Panel B point to a strong positive influence from outsider CEOs – particularly those with prior experience – on the likelihood a startup survives through 2015. Column IV reports our results demonstrating that the replacement of an existing CEO with an outsider leads to an increased likelihood that a startup was awarded at least one US patent 2009-2015, this influence being strongest for "experienced outsider" CEOs. We observe a general pattern across all outcome measures we consider: replacement CEOs produce a performance hike in startups, with this influence being boosted more if the new CEO was hired in from outside the startup, and to an even greater extent if the replacement CEO is an outsider with prior CEO experience at another investor-backed startup: the so-called "experienced outsider."

< Insert Table 9 about here>

**V. Prominent-investor participation, CEO replacement, and startup performance**

While this paper has shown that prominent investor participation increases the incidence of CEO replacement, and that CEO replacement boosts startup performance, an important question remains: Are these superior performance outcomes a specific consequence of prominent investor participation in the startup? In this section, we examine that important question by estimating the effect of prominent investor-

induced CEO turnover on startups' financial and innovative performance. Previously we produced two relevant findings. First, we discovered that prominent investor involvement in the startup most strongly produces replacement CEOs who are "experienced outsiders." Second, we found that having an "experienced outsider" successor CEO is associated with more follow-on funds across several measures, a greater likelihood of survival, and increased US patenting. Combining these two findings allows us to make a conjecture: The performance effects associated with a prominent investor-induced CEO replacement will be larger compared with other types of CEO replacements, all else equal.

## A. Econometric methodology

In order to test this conjecture, we estimate an instrumental variable (IV) weighted probit model that relates (1) the probability of CEO replacement to investor prominence (first-stage) and (2) the probability of CEO turnover to startup performance (second-stage), measuring performance using our aforementioned financing, survival, and patenting indicators. Conditional on several pre-requisites being met, implementing the IV weighted probit model allows us to generate causal evidence relating the specific influence of prominent investor involvement in a startup to our several startup performance outcomes of interest.

To be a valid instrument of startup CEO replacement, investor prominence must have no direct effect on startup performance beyond the replacement of a CEO. To fulfill this exclusion restriction, we implement the CEM algorithm described in Section III: in this instance, we employ the CEM in order to assign appropriate control observations to those startups receiving prominent investor funding. Given the richness of startup characteristics we are using to balance both treatment and control observations, employing the CEM in this fashion ensures as much as possible that the investor prominence instrument is as trustworthy as if it had been randomly assigned. After applying this methodology, the IV will estimate the effect of CEO replacement on startup performance for the subpopulation that experienced a CEO turnover *due independently to prominent-investor participation* (Imbens and Angrist, 1994). In this way,

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we are able to isolate the outcome effects resulting from the involvement of prominent investors in the startup, and distinguish them from other influences.

**B. The influence of prominent investor-led CEO replacement on startup performance**

We report results in Table 10, presenting marginal effects only for the second-stage equations given that first-stage results were previously shown in Table 3. We reiterate that these effects are for the subpopulation of startups 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, Table 10 reports only the coefficients associated with CEO replacement, although we control in the model for all available startup characteristics (identified previously) in order to eliminate as much as possible any residual bias. For these IV models, the F-statistic on the excluded instrument is 8 and thus nearly 10, the standard rule-of-thumb. Hence, instrument weakness should not be a concern.

Our findings are striking, and show large performance increases. Reading from Columns I and II, a prominent investor-induced CEO replacement increases the probability that a startup receives funding by 58 percentage points, and the odds that the startup is in the top quartile of its funding distribution by 54 percentage points. Notably, these coefficients are considerably larger than the analogous results reported in Table 8 (24 percentage points and 16 percentage points, respectively).[10] Other results reported in Table 10 confirm these findings. In Column III, we show that a prominent investor-induced CEO replacement increases the likelihood of a startup's survival by 54 percentage points (a large premium compared to the 10% effect for the sample reported in Table 8). In terms of innovative performance, Column IV shows that a prominent investor-led CEO replacement increases by 43 percentage points the odds that a startup had at least one US patent after 2008. This prominent investor-specific effect is again much larger than the 12 percentage point increase reported in Table 8. All in all these findings are profound: CEO replacements

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[10] We find very similar differences in coefficient magnitudes when we estimate linear probability models with endogenous treatment effects.

induced by the participation of prominent investors produce very large and statistically robust performance dividends across several different and relevant startup outcome measures, including more financing, longer firm survival, and increased patenting.

< Insert Table 10 about here>

## VI. Robustness checks

In an online appendix we report results from a set of robustness checks. In this supplementary analysis, we verify to the extent possible that our findings relating prominent investors to outcomes are not a consequence of us comparing heterogeneous investors (VCs as compared with other types of investors), nor do they depend on how we construct our prominent investor indicator. In a test meant to eliminate possible bias arising from investor heterogeneity, we restrict the sample to those 3,454 startups that had received funds from venture capitalists during the 2006-2008 period, and build an alternative eigenvector measure taking into account only the investments of lead VCs in startups' rounds. Startups that received funds from prominent VCs comprise 44.5% of the newly defined sample. To address possible bias arising from our methods of constructing variables, we use an alternative approach and construct our prominent investor indicator using as a reference only those investors participating in the financing rounds of our sample startups, rather than of all startups in the population. Applying this filter reduces that share of treated startups from 47.7% to 40.7%. As another alternative, we construct 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%. In yet a third alternate approach, we modify our measure of investor prominence, using instead the number of rounds in which an investor had participated during the three-year window prior to the focal funding round. Under this approach, a startup is treated with prominent-investor financing if, in 2008, it received funds from an investor whose round-count is in the 95th percentile of the distribution of all round-counts,

computed for all investors active in 2008 per Venture Economics. Using this definition, the share of treated startups increases from 47.7% to 60%.

We present the results of these robustness checks in the online appendix, Tables A1 to A6. Regardless of the alternative approaches considered, we find that prominent investor involvement in a startup positively influences startup CEO replacement (Table A1), and that participation by prominent investors increases the odds that a startup's replacement CEO will be an "experienced outsider" (Table A2). We also produce additional support (Table A3) for our earlier finding that the marginal contribution of prominent investors is significant only when startups are in their early stages, such as having received a funding amount below or equal the sector median by 2006, receiving no funds from prominent investors during 2004-2006, having a comparatively small board of directors, listing no sales or marketing executive, or listing either a chief technology or chief science officer. We continue to find support for our finding that the marginal contribution of prominent investors is strongest in startups that exhibit weak governance (Panel F of Table A3). Additionally, results (Table A4) support our other findings by again showing that CEO replacement has a positive impact on startup performance, increasing the odds of a startup securing follow-on financing, surviving through 2015, and earning a US patent. We also produce additional support (Table A5) for our prior finding that these *ex post* startup performance effects are strongest when startups' CEOs are replaced with "experienced outsiders." Finally, our alternative tests again confirm our findings relating the specific influence of prominent-investor involvement to startup performance, demonstrating that the CEO turnover effect on startups' financial, survival, and patenting performance is strongest when CEO replacement is specifically induced by prominent investors' participation (Table A6).

To guard against any concerns related to founding effects, we conduct an additional robustness check, redefining our sample to include startups founded during 1997-1998. This move increases our sample size to 4,154 startup companies. We also re-estimate the effects of prominent-investor involvement on the replacement of an existing CEO, and of CEO-replacement led startup performance (across our

several measures), using a weighted conditional logit model. This model addresses possible remaining unobserved heterogeneity by computing the likelihood relative to each group identified, using the CEM algorithm. Because the conditional logit model requires that each observation belong to no more than one group, we restrict the CEM to generate one-to-one matches only. The results generated by conducting these several empirical exercises confirm our earlier findings (Tables A7 to A12).

## VI. Concluding remarks

In this paper, we have been primarily concerned with the influence prominent investor participation in startup financing has on one of the main mechanisms through which investors exercise their monitoring role in the enterprises in which they invest: replacing CEOs. 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, producing a set of novel findings that offer causal evidence on a set of important questions. This study is the first of which we are aware that applies the CEM in finance research of this genre, providing explanation through application of an algorithm that offers distinct and important advantages to researchers over other matching methods. By applying the CEM we generate causal evidence showing prominent-investor involvement in startups produces increased incidence of CEO replacement, and that individuals chosen to fill these posts are disproportionately outsiders with previous CEO experience at other investor-funded startups. Moreover, we demonstrate that this prominent-investor effect on CEO replacement is stronger when startups are in their earlier stages of development, and when startups exhibit relatively weak governance structures. Provocatively given prior literature suggesting CEO replacement in startups is primarily influenced by the arrival of VC investors (Hellmann and Puri, 2002), our causal evidence demonstrates that the VC effect is in fact not significant, and that instead the prominent-investor influence is the consequential effect.

Since firm performance and value creation is our ultimate touchstone, we investigate the influence of prominent investor involvement, and CEO replacement, on *ex post* startup performance across several dimensions, including financing, survival, and patenting. After applying the CEM algorithm, we produce results showing that CEO replacement results in increased startup firm performance, and demonstrate that incrementally better performance is explained by characteristics of the successor CEO: outsiders perform better than insiders, with the best performance outcomes being associated with "experienced outsiders." Bringing our findings full circle, we finish our investigation by relating prominent investor involvement to startup performance, employing CEM in an instrumental-variable system of equations. By so doing, we are able to isolate the effect prominent investor participation has on CEO replacement and its *ex post* startup-performance effect. Our findings show that prominent investor-led CEO replacement produces disproportionately greater performance in the startup.

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 (Haltiwanger *et al.*, 2013), it is desirable to increase our understanding of how the involvement and actions of financial intermediaries – even when acting in their narrow self-interest – increase the odds of startups succeeding in the long term. By investigating heretofore unexamined questions, and using appropriate methods to overcome endogeneity concerns, we contribute by showing that variation among startup investors is consequential, not only by examining differences in investor prominence, but also by extending our focus to investors other than VCs. We believe we are the first to document empirically the set of startup company conditions under which investor-led CEO turnover occurs, and the characteristics of the individuals chosen to succeed incumbent CEOs. We also believe we are the first to demonstrate how the participation of prominent investors drives CEO turnover and – through that mechanism – influences superior performance in startup firms, thereby

providing insights to not only finance scholars, but also to researchers interested in the economic implications of organizations and management more broadly.

Whereas our findings provide unique causal evidence informing important questions, it is appropriate that we discuss several limitations of our study. Although the CEM algorithm offers advantages to researchers, like other models of this type it matches on observables. While we cannot exclude the possibility that unobservables influence our results, our implementation has been designed to minimize that risk as much as possible, by including measures of a wide set of characteristics found to relate meaningfully to both startup firms and their investors, and the economic conditions relevant to such investment (Gompers and Lerner, 2004). Moreover, we note that the marginal effects associated with coefficients in our unweighted probit models are weaker than those associated with the CEM-weighted probit models, indicating that prominent investors disproportionally self-select into startups that are less likely to experience a CEO replacement. Consequentially, even if we have an omitted variable problem, we are confident we are finding a lower bound for the estimate.

Possible sample selection issues also deserve attention. While our sample is drawn from Venture Economics, a data source that fairly represents startup investments, we recognize that our research design tends to introduce bias such that observations may be based on startup survivorship, or success. We take assurance, however, that any such sample bias would tend to support our main results. By selecting on more successful (and more highly valuable) startups, our design produces lower-bound effects for the disproportionate influence of prominent investors on performance, since our design filters out the worst performers from the sample we employ in our analyses. It is also worth noting that we observe the composition of startup executives only in the cross-section at two distinct points in time: 2008 and 2015. That fact limits our ability to say anything about the longevity of incumbent CEOs (observed in 2008), and although we cannot say definitively whether startup firms may have experienced multiple CEO replacements during their lifetime, an analysis of a hand checked, random sampling of online sources we

conducted suggests this phenomenon is rare: only 10 in 900 (~1%) showed more than one CEO replacement. Finally, while we relate the participation of prominent investors to CEO replacement, we are unable to observe the mechanisms through which such replacement occurs (such as the role of prominent investor board representation, or the conditions and preferences of investors in equity contracts signed during the focal funding round). As such, these limitations in our study provide opportunities for future research.

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**VIII. Tables**

**Table 1**
Covariate balance in full and matched samples

Panel A reports means of each variable, distinguishing between startups receiving (treated startups) and not receiving (control startups) funding from prominent investors. Panel B reports the CEM-weighted means of each variable. CEM weights are described in Iacus *et al.* (2012). The last column in each panel reports the absolute differences of means for treated and control startups and information about the statistical significance of each difference. Significance noted as: ***p<0.01.

**Panel A**

| | Startups receiving prominent investor funding (treated startups) | | Startups not receiving prominent investor funding (control startups) | | Absolute difference of means |
|---|---|---|---|---|---|
| | Mean | Standard Dev. | Mean | Standard Dev. | |
| Age since founding (years) | 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*** |
| Received funding from prominent investors by 2006 (1/0) | 0.403 | 0.491 | 0.045 | 0.207 | 0.358*** |
| Founded by serial entrepreneurs (1/0) | 0.275 | 0.447 | 0.204 | 0.403 | 0.071*** |
| Granted at least one US patent by 2008 (1/0) | 0.352 | 0.478 | 0.212 | 0.409 | 0.141*** |
| High-level executives other than a CEO or President (count) | 0.789 | 0.891 | 0.659 | 0.852 | 0.130*** |
| Board members (count) | 4.223 | 2.126 | 2.851 | 2.203 | 1.372*** |
| External board members (count) | 3.987 | 2.076 | 2.654 | 2.128 | 1.333*** |
| Listed a chief scientist or technology officer (1/0) | 0.711 | 0.454 | 0.515 | 0.500 | 0.196*** |
| Listed a sales or marketing executive (1/0) | 0.466 | 0.499 | 0.300 | 0.458 | 0.166*** |
| Coded as IPO or acquisition [successful exit] (1/0) | 0.544 | 0.498 | 0.391 | 0.488 | 0.153*** |
| *Observations* | 1,763 | | 1,932 | | |

**Panel B**

| | Startups receiving prominent investor funding | | Startups not receiving prominent investor funding | | Absolute difference of means |
|---|---|---|---|---|---|
| | Weighted Mean | Standard Dev. | Weighted Mean | Standard Dev. | |
| Age since founding (years) | 11.510 | 2.610 | 11.630 | 14.740 | 0.120 |
| Cumulative funding stock by 2006 (mill. constant USD) | 12.246 | 17.032 | 11.586 | 37.683 | 0.660 |
| Received funding from prominent investors by 2006 (1/0) | 0.190 | 0.390 | 0.190 | 1.010 | 0.000 |
| Founded by serial entrepreneurs (1/0) | 0.170 | 0.380 | 0.170 | 0.600 | 0.000 |
| Granted at least one US patent by 2008 (1/0) | 0.260 | 0.440 | 0.260 | 0.860 | 0.000 |
| High-level executives other than a CEO or President (count) | 0.710 | 0.880 | 0.730 | 1.630 | 0.020 |
| Board members (count) | 3.810 | 1.990 | 3.510 | 5.920 | 0.300 |
| External board members (count) | 3.580 | 1.930 | 3.260 | 5.640 | 0.320 |
| CEO is a board member (1/0) | 0.550 | 0.500 | 0.530 | 1.020 | 0.020 |
| Listed a chief scientist or technology officer (1/0) | 0.690 | 0.460 | 0.690 | 1.190 | 0.000 |
| Listed a sales or marketing executive (1/0) | 0.430 | 0.500 | 0.380 | 1.000 | 0.050 |
| Coded as IPO or acquisition [successful exit] (1/0) | 0.490 | 0.500 | 0.460 | 0.970 | 0.030 |
| *Observations* | 823 | | 898 | | |

**Table 2**

Influence of prominent investor participation on startup CEO replacement

 This table reports probit regression results for the likelihood that a startup's CEO is replaced. The regressor of interest, *Prominent Investor* , is an indicator that takes value 1 if a startup 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. Standard errors (in parentheses) are clustered around the startup's activity sector. Significance noted as: **p<0.05; ***p<0.01.

|  | Likelihood that a startup's CEO is replaced |
| --- | --- |
|  | Marginal Effects |
|  | I |
| Prominent Investor (1/0) | 0.067*** |
|  | (0.015) |
| Natural log of the cumulative funding stock by 2006 | -0.008*** |
|  | (0.002) |
| CEO is an "experienced outsider" (1/0) | -0.135*** |
|  | (0.016) |
| Granted at least one US patent by 2008 (1/0) | -0.026** |
|  | (0.012) |
| Listed a chief scientist or technology officer (1/0) | 0.043*** |
|  | (0.015) |
| Board size (count) | 0.017*** |
|  | (0.005) |
| Startup operating in a sector in which at least one | -0.004 |
| of the round investors is specialized (1/0) | (0.021) |
| Sector FE | YES |
| Region FE | YES |
| Foundation Year FE | YES |
| *Observations* | 3,695 |

**Table 3**

Influence of Prominent investors and VCs on startup CEO replacement

 This table reports weighted probit regression results for the likelihood that a startup's CEO is replaced. Column I reports marginal effects of prominent investor involvement in startup financing. Column II reports marginal effects of VC involvement in a startup financing. Regardless of treatment (Prominent-investor or VC involvement), we balance treatment and control observations by implementing the CEM algorithm. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach. Significance noted as: ***p<0.01.

| | Likelihood that a startup's CEO is replaced | |
|---|---|---|
| | Marginal Effects | |
| | I | II |
| Prominent Investor (1/0) | 0.077*** | |
| | (0.027) | |
| Venture Capital Investor (1/0) | | -0.006 |
| | | (0.078) |
| Region FE | YES | YES |
| Foundation Year FE | YES | YES |
| *Observations* | 1,721 | 552 |

**Table 4**

Influence of prominent investor participation on startup CEO replacements, individual characteristics

This table reports weighted probit regression results. In column I, the outcome indicator takes value 1 if the existing CEO was replaced with an outsider. In columns II and III, the outcome indicator takes value 1 if the existing CEO was replaced with an experienced outsider. An "experienced outsider" is an outsider who had previously been CEO or President in another investor-funded startup. In column II, we compare experienced outsiders to all other CEO replacement types. In column III, we compare experienced- to inexperienced-outsider CEOs. In columns I and II, the sample includes startups experiencing a CEO replacement by 2015. In column III, the sample includes startups in which an outsider replaced the prior CEO. We balance treatment and control observations by implementing the CEM algorithm described in the text. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach. Significance noted as: *p<0.1; **p<0.05.

| | Likelihood that the successor CEO is an outsider | Likelihood that the successor CEO is an experienced outsider | Likelihood that the successor CEO is an experienced outsider |
|---|---|---|---|
| | | Marginal Effects | |
| | I | II | III |
| Prominent Investor (1/0) | 0.070 | 0.120** | 0.108* |
| | (0.049) | (0.048) | (0.056) |
| Region FE | YES | YES | YES |
| Foundation Year FE | YES | YES | YES |
| *Observations* | 529 | | 325 |

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**Table 5**
Influence of prominent investor participation on startup CEO replacement in early-stage and later-stage startups

  This table reports weighted probit regression results for the likelihood that a startup's CEO is replaced. Panel A divides the sample by the cumulative funding amount the startup had received as of 2006 (the predetermined period), splitting at the sector median (mill. constant USD). Panel B partitions the sample by whether or not the startup received prominent investor funding in any round through 2006. Panel C splits the sample by whether or not the startup's board size is greater than the sample median in 2008. Panel D divides the sample by whether or not the startup listed a sales or marketing executive in 2008. Panel E partitions the sample by whether or not the startup listed a chief scientist or technology officer in 2008. Panel F partitions the sample by whether or not a startup's CEO was listed as a board member in 2008. We balance treatment and control observations by implementing the CEM algorithm described in the text. In all models, we control for founding-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach. Significance noted as: **p<0.05; ***p<0.01.

| | Likelihood that a startup's CEO is replaced | |
|---|---|---|
| | Marginal Effects | |
| | **Panel A** | |
| | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median |
| | I | II |
| Prominent Investor (1/0) | 0.093*** | 0.063 |
| | (0.035) | (0.042) |
| *Observations* | 1,012 | 709 |
| | **Panel B** | |
| | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period |
| | I | II |
| Prominent Investor (1/0) | 0.089*** | 0.012 |
| | (0.027) | (0.086) |
| *Observations* | 1,517 | 204 |
| | **Panel C** | |
| | Startup board size below or equal the median value | Startup board size above the median value |
| | I | II |
| Prominent Investor (1/0) | 0.077** | 0.056 |
| | (0.032) | (0.045) |
| *Observations* | 919 | 802 |
| | **Panel D** | |
| | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive |
| | I | II |
| Prominent Investor (1/0) | 0.076** | 0.063 |
| | (0.032) | (0.048) |
| *Observations* | 1,071 | 650 |
| | **Panel E** | |
| | Startup listed a chief scientist or technology officer | Startup did not list a chief scientist or technology officer |
| | I | II |
| Prominent Investor (1/0) | 0.088** | 0.040 |
| | (0.035) | (0.041) |
| *Observations* | 1,091 | 630 |
| | **Panel F** | |
| | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 |
| | I | II |
| Prominent Investor (1/0) | 0.128*** | 0.026 |
| | (0.035) | (0.038) |
| *Observations* | 861 | 860 |

**Table 6**

Covariate balance in full and matched samples

Panel A reports mean of each variable, distinguishing between startups having (treated startups) and not having (control startups) their CEO replaced by 2015. Panel B reports the CEM-weighted means of each variable. CEM weights are described in Iacus et al. (2012). The last column in each panel reports the absolute differences of means for treated and control startups and information about the statistical significance of each difference. Significance noted as: *p<0.1; **p<0.05; ***p<0.01.

| Panel A | Startups that experienced a CEO replacement (treated startups) | | Startups that did not experience a CEO replacement (control startups) | | Absolute difference of means |
|---|---|---|---|---|---|
| | Mean | Standard Dev. | Mean | Standard Dev. | |
| Age since founding (years) | 11.84 | 2.53 | 12.01 | 2.57 | 0.170* |
| Cumulative funding stock by 2008 (mill. constant USD) | 32.999 | 51.253 | 27.921 | 59.800 | 5.078** |
| Cumulative funding stock by 2006 (mill. constant USD) | 18.160 | 43.548 | 16.582 | 30.001 | 1.578 |
| Received funding from prominent investors during 2006-2008 (1/0) | 0.53 | 0.5 | 0.45 | 0.5 | 0.080*** |
| Received funding from prominent investors by 2006 (1/0) | 0.22 | 0.42 | 0.21 | 0.41 | 0.010 |
| Founded by serial entrepreneurs (1/0) | 0.16 | 0.37 | 0.27 | 0.44 | 0.110*** |
| High-level executives other than a CEO or President (count) | 0.79 | 0.91 | 0.69 | 0.85 | 0.100*** |
| Granted at least one US patent by 2008 (1/0) | 0.28 | 0.45 | 0.28 | 0.45 | 0.000 |
| Board members (count) | 3.74 | 2.35 | 3.41 | 2.23 | 0.330*** |
| External board members (count) | 3.51 | 2.28 | 3.2 | 2.17 | 0.310*** |
| CEO is a board member (1/0) | 0.47 | 0.5 | 0.46 | 0.5 | 0.010 |
| Listed a chief scientist or technology officer (1/0) | 0.64 | 0.48 | 0.6 | 0.49 | 0.040** |
| Listed a sales or marketing executive (1/0) | 0.38 | 0.49 | 0.38 | 0.49 | 0.000 |
| *Observations* | 1,107 | | 2,588 | | |

| Panel B | Startups that experienced a CEO replacement (treated startups) | | Startups that did not experience a CEO replacement (control startups) | | Absolute difference of means |
|---|---|---|---|---|---|
| | Weighted Mean | Standard Dev. | Weighted Mean | Standard Dev. | |
| Age since founding (years) | 11.810 | 2.550 | 11.860 | 10.600 | 0.050 |
| Cumulative funding stock by 2008 (mill. constant USD) | 26.133 | 37.934 | 24.617 | 48.288 | 1.516 |
| Cumulative funding stock by 2006 (mill. constant USD) | 14.906 | 31.723 | 14.992 | 37.186 | 0.086 |
| Received funding from prominent investors during 2006-2008 (1/0) | 0.500 | 0.500 | 0.500 | 0.840 | 0.000 |
| Received funding from prominent investors by 2006 (1/0) | 0.210 | 0.410 | 0.230 | 0.610 | 0.020 |
| Founded by serial entrepreneurs (1/0) | 0.130 | 0.330 | 0.130 | 0.420 | 0.000 |
| High-level executives other than a CEO or President (count) | 0.730 | 0.880 | 0.710 | 1.350 | 0.020 |
| Granted at least one US patent by 2008 (1/0) | 0.250 | 0.440 | 0.250 | 0.640 | 0.000 |
| Board members (count) | 3.600 | 2.220 | 3.400 | 4.290 | 0.200 |
| External board members (count) | 3.390 | 2.140 | 3.170 | 4.120 | 0.220 |
| CEO is a board member (1/0) | 0.480 | 0.500 | 0.490 | 0.770 | 0.010 |
| Listed a chief scientist or technology officer (1/0) | 0.660 | 0.480 | 0.660 | 0.880 | 0.000 |
| Listed a sales or marketing executive (1/0) | 0.380 | 0.480 | 0.380 | 0.730 | 0.000 |
| *Observations* | 782 | | 1,450 | | |

**Table 7**

Influence of CEO replacement on startup performance

This table presents probit regression results for venture outcomes. Column I reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. Column II reports 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. Column III reports the marginal effects of CEO replacement on the likelihood that a startup survives (is not abandoned) through 2015. Column IV reports the marginal effects of CEO replacement on the likelihood that a startup is granted at least one US patent by 2015. The regressor of interest is an indicator that equals 1 if a startup had its CEO repalced by 2015 and 0 otherwise. Controls at the startup-level include: an indicator for whether prominent-investor funding was received during 2006-2008; the cumulative funding received through 2006 (mill. constant USD, natural log); an indicator for whether the replacement CEO had prior experience as CEO of another investor-backed startup; an indicator for whether at least one US patent grant was awarded through 2006 (the pre-treatment period); an indicator for whether a chief science or technology officer was listed in 2008; the board size in 2008 (count); and an indicator for whether at least one investor was specialized in the startup's operating sector through 2006. Standard errors (in parentheses) are clustered around the startups' activity sector. Significance noted as: ***p<0.01.

| | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup survived to 2015 | Likelihood that the startup is awarded at least one US patent grant by 2015 |
|---|---|---|---|---|
| | I | II | III | IV |
| | | Marginal Effects | | |
| CEO replacement (1/0) | 0.233*** | 0.161*** | 0.093*** | 0.098*** |
| | (0.017) | (0.016) | (0.019) | (0.011) |
| Controls | YES | YES | YES | YES |
| Sector FE | YES | YES | YES | YES |
| Region FE | YES | YES | YES | YES |
| Founding Year FE | YES | YES | YES | YES |
| *Observations* | | | 3,695 | |

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**Table 8**

Influence of CEO replacement on startup performance, after implementing our CEM algorithm

This table presents weighted probit regression results for startup performance outcomes. Column I reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. Column II reports 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. Column III reports the marginal effects of CEO replacement on the likelihood that a startup survives (is not abandoned) through 2015. Column IV reports the marginal effects of CEO replacement on the likelihood that a startup is awarded at least one US patent grant by 2015. The regressor of interest is an indicator that equals 1 if a startup had its CEO repalced by 2015 and 0 otherwise. We balance treatment and control observations by implementing the CEM algorithm described in the text. In all models, we control for founding-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach. Significance noted as: ***p<0.01.

| | Likelihood that the startup received any financing 2009-2015 | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution 2009-2015 | Likelihood that the startup survived to 2015 | Likelihood that the startup is awarded at least one US patent grant 2009-2015 |
|---|---|---|---|---|
| | | Marginal Effects | | |
| | I | II | III | IV |
| CEO replacement (1/0) | 0.241*** | 0.159*** | 0.103*** | 0.118*** |
| | (0.022) | (0.018) | (0.022) | (0.020) |
| Region FE | YES | YES | YES | YES |
| Founding Year FE | YES | YES | YES | YES |
| *Observations* | | 2,232 | | |

**Table 9**

Influence of CEO replacement on startup performance: Enhanced effects related to successor CEO characteristics

This table presents weighted probit regression results for startup outcomes. Column I reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. Column II reports 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. Column III reports the marginal effects of CEO replacement on the likelihood that a startup survives (is not abandoned) through 2015. Column IV reports the marginal effects of CEO replacement on the likelihood that a startup is awarded at least one US patent grant by 2015. In Panel A, the regressors of interest are an indicator for whether a CEO is replaced with an insider, another for whether the CEO is replaced with an outsider, and the reference indicator takes value 1 if the startup did not experience a CEO turnover, and zero otherwise. In Panel B, we distinguish replacement CEOs between outsiders with and without prior CEO experience at another investor-funded startup, producing three categories of replacement CEOs: insiders, outsiders without experience, and outsiders with experience. We balance treatment and control observations by implementing the CEM algorithm described in the text. In all models, we control for founding-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach. Significance noted as: *p<0.1; **p<0.05; ***p<0.01.

| | Likelihood that the startup received any financing 2009-2015 | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution 2009-2015 | Likelihood that the startup survived to 2015 | Likelihood that the startup was awarded at least one US patent grant 2009-2015 |
|---|---|---|---|---|
| | I | II | III | IV |
| | | Marginal Effects | | |
| **Panel A:** | | | | |
| Successor CEO is an insider (1/0) | 0.130*** | 0.092*** | 0.051* | 0.062** |
| | (0.031) | (0.026) | (0.030) | (0.028) |
| Successor CEO is an outsider (1/0) | 0.315*** | 0.198*** | 0.139*** | 0.151*** |
| | (0.026) | (0.020) | (0.026) | (0.023) |
| **Panel B:** | | | | |
| Successor CEO is an insider (1/0) | 0.129*** | 0.091*** | 0.051* | 0.062** |
| | (0.031) | (0.025) | (0.030) | (0.028) |
| Successor CEO is an outsider without experience (1/0) | 0.191*** | 0.115*** | 0.050 | 0.107*** |
| | (0.036) | (0.030) | (0.032) | (0.032) |
| Successor CEO is an experienced outsider (1/0) | 0.408*** | 0.245*** | 0.216*** | 0.178*** |
| | (0.033) | (0.023) | (0.035) | (0.028) |
| *Observations* | | 2,232 | | |

**Table 10**

Instrumental variable (IV) test of prominent investor-led CEO replacement on startup performance

This table presents IV weighted probit regression results for startup outcomes. We report second-stage results only, since first-stage results are reported in Table 3. Because our instrument is the indicator for whether a startup had received prominent investor funding, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to the participation of prominent investors. Column I reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. Column II reports 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. Column III reports the marginal effects of CEO replacement on the likelihood that a startup survives (is not abandoned) through 2015. Column IV reports the marginal effects of CEO replacement on the likelihood that a startup is awarded a US patent grant by 2015. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach implemented in Table 3. Significance noted as: ***p<0.01.

| | IV weighted probit models (second-stage results) | | | |
| --- | --- | --- | --- | --- |
| | Likelihood that the startup received any financing 2009-2015 | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution 2009-2015 | Likelihood that the startup survived to 2015 | Likelihood that the startup is awarded at least one US patent grant 2009-2015 |
| | | Marginal Effects | | |
| | I | II | III | IV |
| CEO replacement (1/0) | 0.583*** | 0.538*** | 0.543*** | 0.432*** |
| | (0.018) | (0.018) | (0.109) | (0.092) |
| Region FE | YES | YES | YES | YES |
| Founding Year FE | YES | YES | YES | YES |
| *Observations* | 1,721 | | | |

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**Online Appendix: Robustness check tables**

**Table A1**

Influence of Prominent investors on startup CEO replacement

We report weighted probit regression results for the likelihood that a startup's CEO is replaced. In column I, we restrict the sample to startups that had received funds from venture capitalists during the 2006-2008 period. For the results presented in column II, the prominent-investor indicator is built using as a reference those investors who participated in the financing rounds of our sample startups. For the results presented in column III, the prominent-investor indicator is built 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. For the results presented in column IV, we use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window. We balance treatment and control observations by adopting the CEM algorithm described in the text. In all models, we control for founding-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to the treatment prominent investor involvement. Significance noted as: *p<0.10; **p<0.05; ***p<0.01.

| | Likelihood that a startup's CEO is replaced | | | |
|---|---|---|---|---|
| | Restrict the sample to startups that had received funds from venture capitalists during the 2006–2008 period | Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups | Prominent-investor indicator built 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 | Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window |
| | Marginal Effects | | | |
| | I | II | III | IV |
| Prominent Investor (1/0) | 0.079*** | 0.076*** | 0.057** | 0.065** |
| | (0.028) | (0.025) | (0.023) | (0.028) |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |
| *Observations* | 1,594 | 1,888 | 2,220 | 1,635 |

**Table A2**

Influence of prominent investor participation on startup CEO replacements, individual characteristics

Compare the notes to Table A1. The sample includes only those startups that had experienced a CEO replacement by 2015. In columns I-IV, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an outsider. In columns V-VIII, 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.

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| | Restrict the sample to startups that had received venture funds from venture capitalists during the 2006-2008 period | Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups | Prominent-investor indicator built 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 | Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window | Restrict the sample to startups that had received venture funds from venture capitalists during the 2006-2008 period | Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups | Prominent-investor indicator built 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 | Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window |
| | | Likelihood that the successor CEO is an outsider | | | | Likelihood that the successor CEO is an experienced outsider | | |
| | | | | Marginal Effects | | | | |
| Prominent Investor (1/0) | 0.073 | 0.047 | 0.079* | 0.076 | 0.140*** | 0.084* | 0.129*** | 0.097* |
| | (0.051) | (0.050) | (0.041) | (0.047) | (0.049) | (0.047) | (0.037) | (0.054) |
| Region FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES | YES | YES | YES | YES |
| *Observations* | 492 | 587 | 692 | 512 | 492 | 587 | 692 | 512 |

A2

**Table A3**

Influence of prominent investor participation on startup CEO replacement, across startup characteristics

Compare the notes to Table A1. Panel A divides the sample by the cumulative funding amount the startup had received as of 2006 (the predetermined period), splitting at the sector median (mill. constant USD). Panel B partitions the sample by whether or not the startup received prominent investor funding in any round through 2006. Panel C splits the sample by whether or not the startup's board size is greater than the median number in 2008. Panel D divides the sample by whether or not the startup listed a sales or marketing executive in 2008. Panel E partitions the sample by whether or not the startup is focused on science-based technologies. Panel F partitions the sample by whether or not a startup's CEO was listed as a board member in 2008.

Column groups:
- Columns I–II: Restrict the sample to startups that had received funds from venture capitalists during the 2006-2008 period
- Columns III–IV: Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups
- Columns V–VI: Prominent-investor indicator built 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
- Columns VII–VIII: Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window

Marginal Effects

**Panel A**

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Header | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median |
| Prominent Investor (1/0) | 0.092*** | 0.065 | 0.150*** | 0.013 | 0.078** | 0.040 | 0.082** | 0.030 |
| | (0.035) | (0.043) | (0.030) | (0.038) | (0.036) | (0.030) | (0.036) | (0.043) |
| Observations | 916 | 678 | 1,053 | 835 | 1,240 | 980 | 1,055 | 580 |

**Panel B**

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Header | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period |
| Prominent Investor (1/0) | 0.094*** | 0.002 | 0.097*** | -0.051 | 0.058** | 0.052 | 0.073** | 0.031 |
| | (0.027) | (0.090) | (0.023) | (0.096) | (0.027) | (0.044) | (0.029) | (0.081) |
| Observations | 1,400 | 194 | 1,712 | 176 | 1,953 | 267 | 1,417 | 216 |

**Panel C**

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Header | Startup board size below or equal the median value | Startup board size above the median value | Startup board size below or equal the median value | Startup board size above the median value | Startup board size below or equal the median value | Startup board size above the median value | Startup board size below or equal the median value | Startup board size above the median value |
| Prominent Investor (1/0) | 0.098** | 0.056 | 0.098*** | 0.030 | 0.086** | 0.022 | 0.052* | 0.055 |
| | (0.030) | (0.047) | (0.030) | (0.043) | (0.034) | (0.037) | (0.031) | (0.044) |
| Observations | 954 | 759 | 954 | 934 | 961 | 876 | 1,178 | 748 |

**Panel D**

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Header | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive |
| Prominent Investor (1/0) | 0.087*** | 0.053 | 0.109*** | 0.019 | 0.066* | 0.044 | 0.090*** | 0.021 |
| | (0.033) | (0.049) | (0.028) | (0.043) | (0.034) | (0.031) | (0.034) | (0.044) |
| Observations | 979 | 615 | 1,149 | 739 | 1,107 | 1,113 | 1,043 | 592 |

**Panel E**

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Header | Startup focused on science-based technologies | Startups not focused on science-based technologies | Startup focused on science-based technologies | Startups not focused on science-based technologies | Startup focused on science-based technologies | Startups not focused on science-based technologies | Startup focused on science-based technologies | Startups not focused on science-based technologies |
| Prominent Investor (1/0) | 0.093*** | 0.036 | 0.148*** | 0.054 | 0.062** | 0.042 | 0.072** | 0.042 |
| | (0.036) | (0.041) | (0.032) | (0.038) | (0.027) | (0.039) | (0.036) | (0.040) |
| Observations | 1,047 | 547 | 1,242 | 646 | 1,398 | 822 | 1,031 | 604 |

**Panel F**

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Header | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 |
| Prominent Investor (1/0) | 0.124*** | 0.032 | 0.113*** | 0.031 | 0.060* | 0.050* | 0.149*** | -0.021 |
| | (0.036) | (0.039) | (0.034) | (0.037) | (0.033) | (0.030) | (0.034) | (0.039) |
| Observations | 815 | 779 | 958 | 930 | 1,126 | 1,094 | 797 | 838 |

**Table A4**

Influence of CEO replacement on startup performance

Compare notes to Table A1. We present weighted probit regression results for startup outcomes. Panel A reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015 and on the likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. Panel B reports the marginal effects of CEO replacement on the likelihood that a startup survives through 2015. Panel C reports the marginal effects of CEO replacement on the likelihood that a startup is granted a patent by 2015. The regressor of interest is an indicator that equals 1 if a startup had its CEO repalced by 2015 and 0 otherwise. We balance treatment and control observations by implementing the CEM algorithm described in the text. In all models, we control for founding-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to the treatment prominent investor involvement. Significance noted as: *p<0.10; **p<0.05; ***p<0.01.

**Marginal Effects**

| | Restrict the sample to startups that had received funds from venture capitalists during the 2006-2008 period | | Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups | | Prominent-investor indicator built 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 | | Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window | |
| | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution |
| **PANEL A** | I | II | III | IV | V | VI | VII | VIII |
| CEO replacement (1/0) | 0.239*** | 0.156*** | 0.249*** | 0.152*** | 0.248*** | 0.167*** | 0.246*** | 0.163*** |
| | (0.023) | (0.020) | (0.022) | (0.018) | (0.022) | (0.018) | (0.022) | (0.019) |
| Region FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES | YES | YES | YES | YES |

**PANEL B** — Likelihood that the startup survived to 2015

| | I | II | III | IV |
|---|---|---|---|---|
| CEO replacement (1/0) | 0.097*** | 0.105*** | 0.097*** | 0.099*** |
| | (0.023) | (0.023) | (0.023) | (0.023) |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |

**PANEL C** — Likelihood that the startup is granted at least one US patent by 2015

| | I | II | III | IV |
|---|---|---|---|---|
| CEO replacement (1/0) | 0.118*** | 0.113*** | 0.110*** | 0.110*** |
| | (0.022) | (0.021) | (0.022) | -0.022 |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |
| *Observations* | 2,088 | 2,232 | 2,180 | 2,180 |

A4

**Table A5**

Influence of CEO replacement on startup performance: Enhanced effects related to successor CEO characteristics

Compare notes to Table A4. We present weighted probit regression results for startup outcomes. In columns I-III-V-VII-IX-XI-XIII-XV, 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 indicator taking value 1 if the startup did not experience a CEO turnover; and zero otherwise. In columns II-IV-VI-VIII-X-XII-XIV-XVI, we distinguish between outsiders with and without prior CEO experience at an investor-funded startup, producing three categories of replacement CEOs: insiders, outsiders without experience, and outsiders with experience.

Column groups:
- Columns I–IV: Restrict the sample to startups that had received funds from venture capitalists during the 2006–2008 period
- Columns V–VIII: Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups
- Columns IX–XII: Prominent-investor indicator built 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
- Columns XIII–XVI: Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window

Within each group: the first two columns = "Likelihood that the startup received any follow-on financing"; the last two columns = "Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution".

**Marginal Effects**

**PANEL A**

| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | XIII | XIV | XV | XVI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Successor CEO is an insider (1/0) | 0.127*** (0.032) | | 0.090*** (0.027) | | 0.141*** (0.030) | | 0.092*** (0.026) | | 0.139*** (0.032) | | 0.101*** (0.026) | | 0.130*** (0.032) | | 0.096** (0.026) | |
| Successor CEO is an outsider (1/0) | 0.316*** (0.027) | | 0.194*** (0.022) | | 0.324*** (0.026) | | 0.1888*** (0.020) | | 0.321*** (0.026) | | 0.204*** (0.020) | | 0.324*** (0.027) | | 0.201*** (0.021) | |
| Successor CEO is an insider (1/0) | | 0.126*** (0.032) | | 0.090*** (0.027) | | 0.141*** (0.030) | | 0.091*** (0.026) | | 0.138*** (0.032) | | 0.101*** (0.026) | | 0.129*** (0.032) | | 0.095** (0.025) |
| Successor CEO is an outsider without experience (1/0) | | 0.177*** (0.038) | | 0.109*** (0.033) | | 0.199*** (0.037) | | 0.098*** (0.031) | | 0.196*** (0.037) | | 0.119*** (0.031) | | 0.191*** (0.037) | | 0.109*** (0.032) |
| Successor CEO is an experienced outsider (1/0) | | 0.426*** (0.034) | | 0.243*** (0.025) | | 0.416*** (0.033) | | 0.238*** (0.023) | | 0.419*** (0.033) | | 0.254*** (0.023) | | 0.421*** (0.034) | | 0.252*** (0.023) |

**PANEL B** — Likelihood that the startup survived to 2015

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Successor CEO is an insider (1/0) | 0.049 (0.030) | | 0.052* (0.030) | | 0.045 (0.031) | | 0.038 (0.031) | |
| Successor CEO is an outsider (1/0) | 0.132*** (0.027) | | 0.144*** (0.028) | | 0.135*** (0.026) | | 0.144*** (0.027) | |
| Successor CEO is an insider (1/0) | | 0.049 (0.030) | | 0.052* (0.030) | | 0.045 (0.031) | | 0.038 (0.031) |
| Successor CEO is an outsider without experience (1/0) | | 0.032 (0.033) | | 0.054 (0.034) | | 0.047 (0.033) | | 0.050*** (0.033) |
| Successor CEO is an experienced outsider (1/0) | | 0.225*** (0.036) | | 0.219*** (0.036) | | 0.211*** (0.037) | | 0.223*** (0.036) |

**PANEL C** — Likelihood that the startup is granted at least one US patent by 2015

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Successor CEO is an insider (1/0) | 0.061** (0.030) | | 0.065** (0.028) | | 0.063** (0.030) | | 0.064** (0.029) | |
| Successor CEO is an outsider (1/0) | 0.153*** (0.024) | | 0.144*** (0.024) | | 0.138*** (0.025) | | 0.139*** (0.025) | |
| Successor CEO is an insider (1/0) | | 0.061** (0.030) | | 0.065** (0.028) | | 0.063** (0.030) | | 0.064** (0.029) |
| Successor CEO is an outsider without experience (1/0) | | 0.109*** (0.034) | | 0.097*** (0.032) | | 0.091*** (0.031) | | 0.085*** (0.032) |
| Successor CEO is an experienced outsider (1/0) | | 0.181*** (0.030) | | 0.172*** (0.030) | | 0.168*** (0.031) | | 0.170*** (0.031) |
| *Observations* | 2,088 | | | | 2,232 | | | 2,180 |

A5

**Table A6**

Influence of prominent investor participation on CEO replacement and startup performance

Compare notes to Table A4. We present IV weighted probit regression results for startup outcomes. We only report second-stage results as first-stage results are reported in Table A1. Because our instrument is the indicator for whether a startup had received prominent investor funding, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to prominent investor participation. Panel A reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015 and on the likelihood that a startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. Panel B reports the marginal effects of CEO replacement on the likelihood that a startup survives through 2015. Panel C reports the marginal effects of CEO replacement on the likelihood that a startup is granted a patent by 2015. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach implemented in Table A1.

IV weighted probit models (second-stage results)

Marginal Effects

| PANEL A | Restrict the sample to startups that had received funds from venture capitalists during the 2006-2008 period | | Prominent-investor indicator built using as a reference those investors who participated in the financing rounds of our sample startups | | Prominent-investor indicator built 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 | | Use as a measure for investor prominence the number of rounds that an investor had participated in during a three-year window | |
|---|---|---|---|---|---|---|---|---|
| | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution |
| | I | II | III | IV | V | VI | VII | VIII |
| CEO replacement (1/0) | 0.575*** | 0.539*** | 0.580*** | 0.531*** | 0.573*** | 0.524*** | 0.587*** | 0.544*** |
| | (0.033) | (0.018) | (0.012) | (0.018) | (0.022) | (0.023) | (0.009) | (0.018) |
| Region FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES | YES | YES | YES | YES |

**PANEL B** — Likelihood that the startup survived to 2015

| | I | II | III | IV |
|---|---|---|---|---|
| CEO replacement (1/0) | 0.575*** | 0.608*** | 0.604*** | 0.608*** |
| | (0.074) | (0.036) | (0.040) | (0.020) |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |

**PANEL C** — Likelihood that the startup is granted at least one US patent by 2015

| | I | II | III | IV |
|---|---|---|---|---|
| CEO replacement (1/0) | 0.439*** | 0.503*** | 0.460*** | 0.486*** |
| | (0.083) | (0.028) | (0.069) | (0.036) |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |
| *Observations* | 1,594 | 1,505 | 2,220 | 1,635 |

A6

**Table A7**

Influence of Prominent investors on startup CEO replacement

In column I, we report weighted probit regression results, including in the sample those startups founded during 1997-1998. In column II, we report conditional logit regression results for the original sample of startups founded during 1999-2008. We balance treatment and control observations by adopting the CEM algorithm described in the text. For the conditional logit regression model, we force the CEM algorithm to generate one-to-one matches. In all models, we control for foundation-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach. Significance noted as: *p<0.10; **p<0.05; ***p<0.01.

| | Weighted probit regression, including in the sample those startups founded during 1997-1998 | Conditional logit regression for the original sample of startups founded during 1999-2008 |
|---|---|---|
| | Marginal Effects | |
| | I | II |
| Prominent Investor (1/0) | 0.072*** | 0.089*** |
| | (0.027) | (0.030) |
| Region FE | YES | YES |
| Foundation Year FE | YES | YES |
| *Observations* | 1,791 | 782 |

**Table A8**

Influence of prominent investor participation on startup CEO replacements, individual characteristics

Compare notes to Table A7. The sample includes only those startups that had experienced a CEO replacement by 2015. In columns I and II, the outcome is an indicator that takes the value of 1 if an existing CEO was replaced with an outsider. In columns III and IV, 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 CEO or President position in an investor-funded startup.

| | Weighted probit regression, including in the sample those startups founded during 1997-1998 | Conditional logit regression for the original sample of startups founded during 1999-2008 | Weighted probit regression, including in the sample those startups founded during 1997-1998 | Conditional logit regression for the original sample of startups founded during 1999-2008 |
|---|---|---|---|---|
| | Likelihood that the successor CEO is an outsider | | Likelihood that the successor CEO is an experienced outsider | |
| | Marginal Effects | | | |
| | I | II | III | IV |
| | 0.073 | 0.091 | 0.116** | 0.150** |
| Prominent Investor (1/0) | (0.047) | (0.068) | (0.047) | (0.063) |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |
| *Observations* | 558 | 185 | 544 | 177 |

**Table A9**
Influence of prominent investor participation on startup CEO replacement, across startup characteristics

Compare notes to Table A7. Panel A divides the sample by the cumulative funding amount the startup had received as of 2006 (the predetermined period), splitting at the sector median (mill. constant USD). Panel B partitions the sample by whether or not the startup received prominent investor funding in any round through 2006. Panel C splits the sample by whether or not the startup's board size is greater than the median number in 2008. Panel D divides the sample by whether or not the startup listed a sales or marketing executive in 2008. Panel E partitions the sample by whether or not the startup is focused on science-based technologies. Panel F partitions the sample by whether or not a startup's CEO was listed as a board member in 2008.

| | Weighted probit regressions, including in the sample those startups founded during 1997-1998 | | Conditional logit regression for the original sample of startups founded during 1999-2008 | |
|---|---|---|---|---|
| | Marginal Effects | | | |
| **Panel A** | | | | |
| | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median | Startup received investment amount in the pre-period below or equal to the sector median | Startup received investment amount in the pre-period above the sector median |
| | I | II | III | IV |
| Prominent Investor | 0.097** | 0.051 | 0.103** | 0.063 |
| | (0.035) | (0.040) | (0.040) | (0.051) |
| *Observations* | 1,016 | 774 | 518 | 264 |
| **Panel B** | | | | |
| | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period | Startup did not receive prominent investor funding in the pre-period | Startup received prominent investor funding in the pre-period |
| | I | II | III | IV |
| Prominent Investor | 0.082** | 0.018 | 0.095*** | 0.026 |
| | (0.027) | (0.082) | (0.033) | (0.109) |
| *Observations* | 1,569 | 222 | 724 | 58 |
| **Panel C** | | | | |
| | Startup board size below or equal the median value | Startup board size above the median value | Startup board size below or equal the median value | Startup board size above the median value |
| | I | II | III | IV |
| Prominent Investor | 0.076** | 0.048 | 0.080 | 0.037 |
| | (0.031) | (0.043) | (0.051) | (0.057) |
| *Observations* | 935 | 856 | 362 | 279 |
| **Panel D** | | | | |
| | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive | Startup did not list a sales or marketing executive | Startup listed a sales or marketing executive |
| | I | II | III | IV |
| Prominent Investor | 0.065*** | 0.063 | 0.113** | 0.012 |
| | (0.031) | (0.046) | (0.045) | (0.060) |
| *Observations* | 1,152 | 689 | 423 | 206 |
| **Panel E** | | | | |
| | Startup focused on science-based technologies | Startups not focused on science-based technologies | Startup focused on science-based technologies | Startups not focused on science-based technologies |
| | I | II | III | IV |
| Prominent Investor | 0.079*** | 0.047 | 0.097*** | 0.077 |
| | (0.034) | (0.041) | (0.040) | (0.052) |
| *Observations* | 1,145 | 643 | 488 | 294 |
| **Panel F** | | | | |
| | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 | Startup CEO listed as board member in 2008 | Startup CEO not listed as board member in 2008 |
| | I | II | III | IV |
| Prominent Investor | 0.122*** | 0.020 | 0.104** | 0.056 |
| | (0.034) | (0.037) | (0.048) | (0.058) |
| *Observations* | 900 | 891 | 324 | 277 |

**Table A10**

Influence of CEO replacement on startup performance

Compare notes to Table A7. We present regression results for startup outcomes. Panel A reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015 and on the likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution, during 2009-2015. Panel B reports the marginal effects of CEO replacement on the likelihood that a startup survives through 2015. Panel C reports the marginal effects of CEO replacement on the likelihood that a startup is granted a patent by 2015. The regressor of interest is an indicator that equals 1 if a startup had its CEO replaced by 2015 and 0 otherwise. We balance treatment and control observations by implementing the CEM algorithm described in the text. In all models, we control for founding-year and region fixed effects. Standard errors (in parentheses) are clustered around the strata identified by applying the CEM approach to the treatment prominent investor involvement. Significance noted as: *p<0.10; **p<0.05; ***p<0.01.

| | Weighted probit regressions, including in the sample those startups-founded during 1997-1998 | | Conditional logit regression for the original sample of startups-founded during 1999-2008 | |
|---|---|---|---|---|
| | | Marginal Effects | | |
| **PANEL A** | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution |
| | I | II | III | IV |
| CEO replacement (1/0) | 0.228*** | 0.146*** | 0.224*** | 0.200*** |
| | (0.021) | (0.018) | (0.021) | (0.024) |
| Region FE | YES | YES | YES | YES |
| Foundation Year FE | YES | YES | YES | YES |
| Observations | 2,384 | | 1,064 | |
| **PANEL B** | Likelihood that the startup survived to 2015 | | | |
| | I | | II | |
| CEO replacement (1/0) | 0.082*** | | 0.132*** | |
| | (0.021) | | (0.030) | |
| Region FE | YES | | YES | |
| Foundation Year FE | YES | | YES | |
| Observations | 2,384 | | 862 | |
| **PANEL C** | Likelihood that the startup is granted at least one US patent by 2015 | | | |
| | I | | II | |
| CEO replacement (1/0) | 0.122*** | | 0.151*** | |
| | (0.019) | | (0.028) | |
| Region FE | YES | | YES | |
| Foundation Year FE | YES | | YES | |
| Observations | 2,384 | | 922 | |

**Table A11**

Influence of CEO replacement on startup performance: Enhanced effects related to successor CEO characteristics

Compare notes to Table A7. We present regression results for startup outcomes. In columns I-III-V-VII, 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 indicator taking value 1 if the startup did not experience a CEO turnover, and zero otherwise. In columns II-IV-VI-VIII, we distinguish between outsiders with and without prior CEO experience at an investor-funded startup, producing three categories of replacement CEOs: insiders, outsiders without experience, and outsiders with experience.

### PANEL A

| | Weighted probit regressions, including in the sample those startups founded during 1997-1998 | | | | Conditional logit regression for the original sample of startups founded during 1999-2008 | | | |
| | Likelihood that the startup received any follow-on financing | | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | | Likelihood that the startup received any follow-on financing | | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution | |
| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Successor CEO is an insider (1/0) | 0.112*** | | 0.074*** | | 0.116*** | | 0.122*** | |
| | (0.029) | | (0.025) | | (0.035) | | (0.040) | |
| Successor CEO is an outsider (1/0) | 0.310*** | | 0.189*** | | 0.297*** | | 0.242*** | |
| | (0.025) | | (0.019) | | (0.026) | | (0.028) | |
| Successor CEO is an insider (1/0) | | 0.111*** | | 0.073*** | | 0.114*** | | 0.121*** |
| | | (0.029) | | (0.025) | | (0.035) | | (0.040) |
| Successor CEO is an outsider without experience (1/0) | | 0.198*** | | 0.109*** | | 0.131*** | | 0.163*** |
| | | (0.035) | | (0.029) | | (0.040) | | (0.052) |
| Successor CEO is an "experienced outsider" (1/0) | | 0.403*** | | 0.240*** | | 0.431*** | | 0.282*** |
| | | (0.032) | | (0.022) | | (0.040) | | (0.033) |
| *Observations* | 2,384 | | | | 1,064 | | 940 | |

*Marginal Effects*

### PANEL B

| | Likelihood that the startup survived to 2015 | | | |
| | I | II | III | IV |
|---|---|---|---|---|
| Successor CEO is an insider (1/0) | 0.018 | | 0.073 | |
| | (0.028) | | (0.047) | |
| Successor CEO is an outsider (1/0) | 0.130*** | | 0.174*** | |
| | (0.025) | | (0.035) | |
| Successor CEO is an insider (1/0) | | 0.017 | | 0.070 |
| | | (0.028) | | (0.046) |
| Successor CEO is an outsider without experience (1/0) | | 0.049 | | 0.028 |
| | | (0.031) | | (0.047) |
| Successor CEO is an experienced outsider (1/0) | | 0.207*** | | 0.310*** |
| | | (0.035) | | (0.051) |
| *Observations* | 2,384 | | 862 | |

### PANEL C

| | Likelihood that the startup is granted at least one US patent by 2015 | | | |
| | I | II | III | IV |
|---|---|---|---|---|
| Successor CEO is an insider (1/0) | 0.075*** | | 0.059 | |
| | (0.027) | | (0.041) | |
| Successor CEO is an outsider (1/0) | 0.153*** | | 0.208*** | |
| | (0.022) | | (0.033) | |
| Successor CEO is an insider (1/0) | | 0.075*** | | 0.059 |
| | | (0.026) | | (0.041) |
| Successor CEO is an outsider without experience (1/0) | | 0.116*** | | 0.162*** |
| | | (0.030) | | (0.053) |
| Successor CEO is an experienced outsider (1/0) | | 0.178*** | | 0.232*** |
| | | (0.028) | | (0.042) |
| *Observations* | 2,384 | | 922 | |

**Table A12**
Influence of prominent investor participation on CEO replacement and startup performance

We present IV weighted probit regression results for startup outcomes, including in the sample those startups founded during 1997-1998. We only report second-stage results as first-stage results are reported in A7. Because our instrument is the indicator for whether a startup had received prominent investor funding, reported marginal effects are for the subpopulation of startups that experienced a CEO turnover due to prominent investor participation. In Panel A, column I reports the marginal effects of CEO replacement on the likelihood that a startup received any follow-on financing during 2009-2015. Column II reports 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. Panel B reports the marginal effects of CEO replacement on the likelihood that a startup survives through 2015. Panel C reports the marginal effects of CEO replacement on the likelihood that a startup is granted a patent by 2015. Standard errors (in parentheses) are clustered around the strata identified by the CEM approach implemented in A7. Significance noted as: ***p<0.01.

| | IV weighted probit models (second-stage results) | |
| --- | --- | --- |
| | Marginal Effects | |
| | Weighted probit regressions, including in the sample those startups founded during 1997-1998 | |
| **PANEL A** | Likelihood that the startup received any follow-on financing | Likelihood that the startup is in the last quartile of its sectorial follow-on financing amount distribution |
| | I | II |
| CEO replacement (1/0) | 0.584*** | 0.512*** |
| | (0.013) | (0.017) |
| Region FE | YES | YES |
| Foundation Year FE | YES | YES |
| **PANEL B** | Likelihood that the startup survived to 2015 | |
| | I | |
| CEO replacement (1/0) | 0.562*** | |
| | (0.087) | |
| Region FE | YES | |
| Foundation Year FE | YES | |
| **PANEL C** | Likelihood that the startup is granted at least one US patent by 2015 | |
| | I | |
| CEO replacement (1/0) | 0.438*** | |
| | (0.087) | |
| Region FE | YES | |
| Foundation Year FE | YES | |
| *Observations* | 1,791 | |