Do Venture Capital-Driven Top Management Changes Enhance Corporate Innovation in Private Firms?

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Abstract

Using hand-collected data on top management changes in venture capital (VC)-backed private firms, I show that VC-driven top management changes are associated with significantly more and higher quality innovation. Further, the effect of VC-driven top management changes on innovation is stronger for firms with greater VC power. An instrumental variable analysis using an exogenous shock to the supply of outside managers available for hire shows that the above relations are causal. Making use of hand-collected information on the founders of private firms, I find that both founder replacements and non-founder top management changes have a positive effect on corporate innovation. Decomposing top management changes into different types, I show that replacing top managers with new ones (rather than adding or removing managers alone) is most effective in enhancing innovation. Delving deeper into the educational background and employment history of the top management team, I find that adding seasoned CEOs has a significantly positive effect on innovation, while changing senior managers with a prior technical background does not. I also analyze the possible mechanisms through which top management changes affect corporate innovation, and establish that one such mechanism is through new management teams hiring a greater number of inventors for a given investment size. Finally, I find that VC-driven top management changes increase the probability of a firm's successful exit (via an IPO or an acquisition), partially driven by their enhanced innovation.

Keywords: Corporate Innovation; Private Firms; Top Management Changes; Inventor Mobility; IPOs versus Acquisitions

JEL Classification: G24; G30; O31; O32

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1 Introduction

The role of venture capital (VC) in adding value to the entrepreneurial firms they invest in has been a widely debated topic by both academics and practitioners. Existing studies have suggested that VCs take an active role in the portfolio companies that they finance beyond providing capital (see, e.g., Gorman and Sahlman (1989), Lerner (1995), or Chemmanur, Krishnan and Nandy (2011)). One channel through which VCs may add value to their portfolio companies is by professionalizing their management team, either by adding new managers in areas where the firm is lacking in managerial expertise or by removing managers who underperform: see, e.g., Hellmann and Puri (2002). VC investments often focus on high technology and high growth sectors of the economy, such as information technology, life sciences, and energy technology (Da Rin, Hellmann, and Puri (2013). VCs have also been shown to enhance the innovation output by the entrepreneurial firms they finance: see, e.g., Tian and Wang (2014) and Chemmanur, Loutskina, and Tian (2014).[1] However, the channels through which VCs enhance innovation is such firms are less well understood. In this paper, I propose and analyze a new channel through which VCs enhance the quantity and quality of the innovation output of the entrepreneurial firms they invest in, namely, by improving the top management teams of the firms they invest in: by replacing poor quality managers and adding new managers. I use a unique hand-collected dataset to provide new evidence on how VC-driven top management changes affect corporate innovation in VC-backed private firms and on the possible mechanisms through which this occurs.

I explore several interesting research questions in this paper. First, what is the effect of VC investments on top management changes in VC-backed private firms? To answer this question, I analyze whether the probability of top management changes is higher in VC-backed firms where VCs have greater power (e.g., greater board membership).[2] Second, do top management changes indeed lead to more and higher quality innovation? Third, is the relation between top management

[1] Tian and Wang (2014) show that the enhanced innovation in VC-backed firms is positively related to the failure tolerance of the VC syndicate investing in them. Chemmanur, Loutskina, and Tian (2014) compare innovation nurturing by corporate venture capitalists (CVCs) versus independent venture capitalists (IVCs) and show that VC syndicates containing CVCs enhance innovation to a greater extent, partly due to their greater failure tolerance and transfer of technological knowhow to from the CVC parent to the portfolio firm. I explore a different channel in this paper that may complement the above channels in which VCs help to enhance innovation in the entrepreneurial firms they invest in.

[2] Since I am analyzing private firms, data limitations prevent me from comparing VC-backed versus non-VC-backed private firms in terms of top management changes, given the lack of sufficient data on non-VC-backed private firms.

changes and corporate innovation stronger in firms in which VCs have greater power? Fourth, how do founder replacements versus non-founder top management changes affect corporate innovation? Fifth, since top management changes may include adding new managers, removing existing managers, or both, how does each type of top management changes affect innovation output? Further, what type of top management background (in terms of educational and employment experience) is important in spurring innovation? In particular, are managers with general managerial skills (having worked as a CEO in another company), or those with a prior technical background (having engaged in the research and development process themselves), or both, important in spurring innovation?[3] Next, what are the underlying mechanisms through which top management changes affect corporate innovation in VC-backed private firms? Finally, how do top management changes and enhanced innovativeness affect the probability of a successful exit (either through an IPO or an acquisition) of VC-backed private firms?

The empirical analysis of the relation between top management changes and corporate innovation in VC-backed private firms is hampered by two major challenges. First, the data (especially management team and board of directors data) on VC-backed private firms is very limited. Second, potential endogeneity may confound any empirical analysis on the relation between top management changes and corporate innovation. On the one hand, one may argue that the relationship between top management changes and corporate innovation may be largely driven by omitted variables such as the underlying quality (innovativeness) of the firm or technological shocks to the firm: for example, both top management changes and corporate innovation may be positively related to firm quality, in which case OLS regression estimates linking top management changes and corporate

[3]Anecdotal evidence suggests that VC-backed entrepreneurial firms may add seasoned CEOs as well as top managers with a prior technical background to help firms succeed. For example, SpaceClaim Corporation, a provider of 3D Modeling Software based in Concord, Massachusetts, announced the addition of Michael McGuinness (a seasoned CEO and President with rich software industry experience) to its top management team right before it received the third round of VC financing. SpaceClaim commented that McGuinness brought to SpaceClaim "broad executive experience across several industries" and strategic vision in high technology, management, and business development. See more details at `http://www.spaceclaim.com/fr/company/news/pressreleases/07-03-20/SpaceClaim_Announces_Addition_of_Michael_McGuinness_as_Chief_Operating_Officer.aspx`. An example of a VC-backed firm that added a top manager with a prior technical background is Acceleron Pharma, Inc., a biopharmaceutical company based in Cambridge, Massachusetts. Acceleron announced the appointment of Matthew L. Sherman, M.D. (who was responsible for clinical research and clinical operations in another pharmaceutical company prior to joining Acceleron and published a number of research papers) as Senior Vice President and Chief Medical Officer when it received VC financing in 2006. The company claimed that the addition of Sherman brought to Acceleron "broad scientific and clinical research knowledge along with his experience and proven record of building clinical development organizations." See more details at `http://investor.acceleronpharma.com/news-releases/news-release-details/acceleron-pharma-appoints-matthew-l-sherman-md-chief-medical`.

innovation will be biased upwards. On the other hand, VCs may be more likely to intervene in firms (i.e., induce management changes) when they are performing poorly in order to help them improve their performance, in which case OLS regression estimates will be biased downwards.

I overcome the first challenge by constructing a unique hand-collected dataset of top management team and board information of VC-backed private firms, using which I can identify the top managers as well as board of directors for each firm across different financing rounds. I begin with all the VC-backed deals covered in VentureXpert over the period of 2002–2010 and hand-collect top management team and board information for these VC-backed private firms in each financing round from their "Form D" filings on the Securities and Exchange Commission (SEC) EDGAR website. Many VC-backed firms use exemptions under Regulation D, which allow them to sell equity to accredited investors (such as VCs) without having to register with the SEC and become a public company. When relying on Regulation D, firms are required to file a Form D, which is a brief notice that contains important information about the firm and the offering, including the names and addresses of the firm's executive officers (such as CEO, president, Chief Technology Officer) and directors, the amount of investment made by investors, and the date of sale.

I overcome the second challenge related to endogeneity using an instrumental variable (IV) analysis. I instrument for top management changes using a plausibly exogenous shock to the supply of outside managers that are able to move across firms and are available for hire by VC-backed private firms. Specifically, the instrument that I use is the number of acquisitions made by established firms in the same industry and in the same state as the VC-backed private firm interacted with an index measuring the enforceability of non-compete clauses in that state. This instrument is motivated by the following facts. First, incoming managers to startups often come from established firms, and these firms are dominant players in the acquisition market. In other words, there is a strong correlation between the movement of executives across firms and the number of acquisitions made by established firms in the industry. Second, the enforceability of non-compete clauses, which are commonly used in employment contracts for top management to prohibit them from joining or founding a rival company, affects the mobility of managers across firms. In each stage of my IV regressions, I include industry-by-year and state-by-year fixed effects to absorb any industry-wide technology shock and any local economic shock that may affect innovation. Therefore, my instrument is unlikely to affect innovation through channels other than through its effect on

the ease of recruiting top management, thus satisfying the exclusion restriction. In addition to the IV analysis, I also conduct several robustness and placebo tests to further support the causal interpretation of the relation between top management changes and corporate innovation.

My empirical findings can be summarized as follows. First, I show that the probability of management changes in VC-backed firms is increasing with the power of VCs in the firm (as measured by the number of outside board members), suggesting that management changes in my VC-backed sample are primarily driven by VCs. Second, I find that top management changes are associated with significantly more and higher quality corporate innovation subsequent to top management changes (as measured by patent counts and patent citations) in VC-backed private firms. For example, three-year patent counts and three-year patent citations increase by 5.6% and 9.2%, respectively, following top management changes. Third, I find that the effect of VC-driven management changes on corporate innovation is stronger for firms in which VCs have greater power, consistent with my hypothesis that VCs add value to their portfolio companies through inducing management changes. My IV analysis (making use of a plausibly exogenous shock to the supply of outside managers as described above) shows that the positive relationship that I documented earlier between management changes and corporate innovation is causal. Fourth, I find that both founder replacements and non-founder top management changes have a positive impact on corporate innovation. Fifth, I find that replacing managers has a positive and significant effect on innovation, while adding managers only or removing existing managers only does not have a significant effect. Next, I find that adding seasoned CEOs has a positive and significant effect on innovation, while changing senior managers with a prior technical background does not have a significant effect on innovation.

I then investigate a potential underlying mechanism through which top management changes may foster greater innovation activities. I hypothesize that the new management teams may select and allocate resources to higher quality innovation projects, manage innovative assets more efficiently, and provide a better environment for inventors (i.e., scientists and engineers) to succeed in the firm (for example, by creating a more failure-tolerant environment for inventors, in the sense of Manso (2011)). Thus, one way that top management changes in VC-backed firms may enhance corporate innovation is by the new management teams being able to hire more inventors to work for the firm (for a given amount of resources available). My result is consistent with this conjecture: I

find that top management changes are associated with a significantly greater net inflow (inflow minus outflow) of inventors in the next one, two, and three years following top management changes. Further, the positive relation between top management changes and the net inflow of inventors is stronger for firms in which VCs have greater power.

Finally, I explore the relation between top management changes, corporate innovation, and successful exit outcomes (as measured by an IPO or an acquisition by another company) in VC-backed private firms. I find that both top management changes and innovation output are significantly and positively related to the probability of successful exit outcomes. I also show that the effect of top management changes on the successful exit is at least partly mediated through enhanced corporate innovation output.

I conduct a number of robustness tests and find that the positive relation between top management changes and corporate innovation that I documented earlier is robust to these tests. First, I find that the positive relation between management changes and corporate innovation is robust to controlling for industry-by-state-by-year fixed effects. Since my IV analysis makes use of variation at the industry-by-state-by-year level, this helps to alleviate the concern that that industry-by-state-by-year level omitted variables may drive both management changes and corporate innovation. Second, to alleviate the concern that enhanced corporate innovation by VC-backed entrepreneurial firms following management changes may be driven by a general trend of technological development, I conduct a placebo test using innovation output generated prior to management changes as the dependent variable. I find that the relation between management changes and prior innovation is insignificant, suggesting that the positive relation between management changes and subsequent innovation is unlikely due to a general trend in technological development. Third, I conduct a placebo analysis in which I randomly assign "pseudo" management changes variables to certain firm-year observations and find these "pseudo" management changes are not significantly associated with future corporate innovation, providing further support for the causal interpretation of the positive relationship between (real) top management changes and corporate innovation. Finally, I show that the positive relation that I documented earlier between top management changes and corporate innovation is robust to controlling for lead VC firm fixed effects. The results of this robustness test confirm that the positive relation between top management changes and corporate innovation is not driven by any unobservable and time-invariant VC firm characteristics that may

affect innovation (such as VC firms' project selection ability and preferences).

The rest of the paper is organized as follows. Section 2 discusses the relation and contribution of this paper to the literature. Section 3 discusses the underlying theory and develops testable hypotheses. Section 4 outlines the data and the sample selection procedure. Section 5 provides a discussion of my main empirical tests and results. Section 6 presents a discussion of my robustness test results. Section 7 concludes. An Internet Appendix (not to be published) presents the results of supplemental tests that accompany the results in the paper.

2 Relation to the Existing Literature and Contribution

This paper contributes to several strands in the literature. First, it improves our understanding on how VCs add value to the entrepreneurial firms that they invest in through active intervention in recruiting and improving these firms' top management teams. Several existing studies show that VCs play a role in recruiting managers (especially CEOs) and replacing founders. For example, Hellmann and Puri (2002) use a sample of 170 Silicon Valley startups and show that venture capitalists professionalize nascent firms by instituting human resource policies and bringing in professional CEOs to replace founders. They, however, do not study the effect of such management changes on any subsequent outcomes (including innovation). Wasserman (2003) shows that raising financing from outside investors (mainly VCs) leads to higher chances of founder-CEO being replaced by an outside CEO, using a sample of 202 Internet startups. Amornsiripanitch, Gompers, and Xuan (2019) show that successful VCs who have a good track record of past investment and a large network are likely to hire outside managers and outside board members for their portfolio companies. Ewens and Marx (2018) find that VCs improve the exit outcomes (measured by IPOs or acquisitions) of their portfolio companies by replacing founder CEOs.

None of the above papers, however, study the relationship between top management changes and product market innovation in private firms, which is the focus of this paper. Further, this is the first paper in the literature to establish that an important channel through which VCs enhance corporate innovation in their portfolio firms is by inducing changes in the top management teams in these firms. In addition, while some of the above papers document that VCs often replace founders and founder replacements improve successful exit, none of them analyze the role of top management changes (either founder replacements or non-founder changes) on innovation in VC-backed startups.

Finally, this is the first paper to establish that VC-driven non-founder top management changes enhance corporate innovation (over and above any effect due to founder replacements).[4]

Second, my paper adds to the literature on how VC-backing improves innovation efficiency, by establishing the link between a specific action by VCs (i.e., top management changes) and corporate innovation. Several papers study how VC-backing affects innovation in VC-backed firms, relative to non-VC-backed firms, while other studies attempt to identify the relationship between VC characteristics (such as experience, industry expertise, syndication, and failure tolerance) and innovation in VC-backed firms. Recent studies include Chemmanur, Loutskina, and Tian (2014), and Tian and Wang (2014), Bernstein, Giroud, and Townsend (2016), etc. Another related literature is the one studying whether VC-backing improves efficiency (measured by total factor productivity) in private firms and the mechanisms through which they do so (see, e.g., Chemmanur, Krishnan, and Nandy (2011)).

Third, this paper contributes significantly to the literature on top management turnover. Existing studies have shown that management changes are important corporate events. In particular, there is empirical evidence documenting improvements in accounting and stock performances following CEO turnover mainly for large public companies (Huson, Malatesta, and Parrino (2004); Denis and Denis (1995); Cornelli, Kominek, and Lungquivst (2013)). Bereskin and Hsu (2013) study the effect of CEO turnover on corporate innovation in large public companies. Dasgupta, Li, and Wang (2018) find that forced CEO turnover due to increased industry competition (subsequent to tariff cuts) improves accounting performance and total factor productivity in large public companies. However, with a few exceptions (Gao, Harford, and Li (2017) and Cornelli and Karakaş (2015)), the literature above focuses on publicly traded firms and provides few insights into management changes in private firms due to data limitations.[5] My paper contributes to this literature by examining, for the first time, the effect of top management changes on corporate innovation in private firms.

Fourth, this paper contributes to the broader literature that studies various determinants of

[4]By unveiling the effect of founder replacements versus non-founder top management changes on innovation, my paper is also distantly related to the broader literature that analyzes the importance of founder CEOs: see, e.g., Adams, Almeida, and Ferreira (2009).

[5]Gao, Harford, and Li (2017) find that public firms have higher CEO turnover rates and exhibit greater CEO turnover-performance sensitivities than large private firms, using a sample of U.S. public firms and large private firms. Cornelli and Karakaş (2015) find that CEO turnover decreases and is less contingent on performance when a firm is taken private, using a sample of LBO firms in the UK.

corporate innovation theoretically as well as empirically (e.g., Manso (2011) and Marx, Strumsky, and Fleming (2009)). Some of these determinants include managerial compensation (Ederer and Manso (2013)), anti-takeover provisions (e.g., Atanassov (2013) and Chemmanur and Tian (2018)), board independence (Balsmeier, Fleming, and Manso (2017)), public versus private status (Ferreira, Manso,and Silva (2014); Bernstein (2015)), CEO overconfidence (Hirshleifer, Low, and Teoh (2012)), analyst coverage (e.g., He and Tian (2013)), and media attention (e.g., Dai, Shen, and Zhang (2020)), and banking competition (Cornaggia, Mao, Wolfe, and Tian (2015)). However, none of the above papers have analyzed the role of VC-driven top management changes on corporate innovation. My paper contributes to this literature by establishing that VC-driven top management changes enhance subsequent innovation for private firms.

Finally, this paper establishes a new mechanism through which top management changes may affect corporate innovation, namely, through attracting a greater number of inventors. Thus, my paper contributes to a relatively small but growing literature on labor mobility and innovator flows (e.g., Chemmanur, Kong, Krishnan, and Yu (2019) and Marx, Strumsky, and Fleming (2009)).

3 Theory and Hypothesis Development

In this section, I briefly review the underlying theory and develop testable hypotheses for my empirical tests. My first hypothesis deals with whether management changes in VC-backed private firms are primarily driven by VCs. If management changes in VC-backed private firms are indeed driven by VCs investing in the firm, i.e., VCs proactively add and/or remove managers in the firms they back to help them succeed rather than replacing managers who resign from the firm voluntarily, then I would expect firms in which VCs have greater power to have a greater probability of top management changes. This is the first hypothesis that I test here (**H1**).

My next hypotheses deal with the relation between top management changes and corporate innovation in VC-backed private firms. Existing literature has suggested that management changes have both a positive and a negative side for corporate outcomes. On the one hand, existing studies offer several explanations for why management changes can create firm value. One view is that top management changes are part of an error correction process. The new management teams may reverse the bad decisions of past management teams and reallocate resources to more

promising projects (e.g., Boot (1992) and Weisbach (1995)).[6] Another view is that new managers may bring additional resources to the firm (such as additional human capital) and may establish complementarities between these new resources and existing human capital, which can create value for the firm (e.g., Oyer and Schaefer (2011), Pan (2017), and Huang (2014)).[7] Based on the above views, if the new management teams can correct bad decisions and reallocate resources to more innovative projects, or if they can bring additional human capital enabling them to select more innovative projects and manage these projects more ably, top management changes will have a positive impact on corporate innovation. On the other hand, several studies suggest that management changes can be costly and disruptive: they may discourage managers to invest in firm-specific human capital (for example, as indicated by Salop (1979)). Additionally, since VCs typically raise funds for a fixed period (Lerner and Nanda (2020)), they may favor ideas or projects which can be commercialized and the value of which can be realized in exits within a shorter horizon, compared to innovation projects that may generate value only in the long-run. If this is the case, VC-driven management changes will have a negative impact on corporate innovation. Therefore, whether top management changes enhance or impede corporate innovation in VC-backed private firms is an empirical question. If the positive effects of top management changes dominate the negative effects, I expect top management changes to enhance subsequent corporate innovation in VC-backed private firms: i.e., management changes will be associated with a larger number of and higher quality corporate innovation subsequently (**H2A**). On the other hand, if the negative effects of top management change dominate the positive effects, then I expect top management changes to impede subsequent corporate innovation in VC-backed private firms: i.e, top management changes will be associated with a smaller number of and lower quality corporate innovation subsequently (**H2B**).

If **H2A** holds, i.e., VC-driven top management changes have an overall positive effect on cor-

[6]Boot (1992) theorizes that unskilled managers are reluctant to divest because a divesture is an admission of a mistake. Therefore, on average, there is too little divesture relative to the shareholders' optimum. Consistent with Boot's implications, Weisbach (1995) finds that the probability of divesting poorly performing projects increases after CEO turnover.

[7]Oyer and Schaefer (2011) suggest that management attributes (such as talents, skills, or experience) may complement certain production technologies and improve productivity of the firm. Pan (2017) uses a model of executive-firm matching and shows that complementarity between the firm and management attributes may lead to increased productivity of the firm. Huang (2014) investigates how the complementarity between managers' industry experience and the firm affects firm value. His empirical findings show that CEOs in conglomerates are more likely to refocus on divisions in which they have specialized and divest those in which they have less experience.

porate innovation, then I would expect the positive effect of management changes on innovation to be stronger for firms in which VCs have greater power (**H3A**). This is because, if VCs have greater power, they may be more effective in using top management changes to enhance innovation and create value for firms they invest in. If, on the other hand, **H2B** holds, i.e., VC-driven management changes have an overall negative effect on corporate innovation, I would expect the negative effect of management changes on innovation to be stronger for firms in which VCs have greater power (**H3B**). This is because, if VCs have greater power, the negative effect of VC-driven top management changes on innovation are likely to be amplified.

My next set of hypotheses deals with the effects of founder replacements versus non-founder top management changes on corporate innovation. The existing literature has provided evidence that the likelihood of founder CEO turnover increases when startups raise VC funding (Hellmann and Puri (2002) and Wasserman (2003)) and VCs improve the likelihood of successful firm exits through replacing founders (Ewens and Marx (2018)). However, *ex ante*, it is not clear how founder replacements will affect innovation. On the one hand, if corporate innovation largely depends on founders' ideas or vision, then I would expect founder replacements to have a negative effect on corporate innovation (**H4A**). On the other hand, the initial innovative ideas of founders may not be applicable or conducive to the further development of firms as they grow beyond the early startup stage, so that founders' control may actually hold back firms' future growth and success in innovation. If this is the case, VCs' replacing founders may take the firm in a new direction conducive to innovation so that I expect founder replacements to have a positive effect on corporate innovation under this scenario (**H4B**).

Similar to the arguments above, there may be positive and negative effects associated with non-founder top management changes as well. On the one hand, existing non-founder managers in VC-backed startups may already play an important role in corporate innovation. For example, they may be innovators themselves or be able to attract talented employees (e.g., scientists and engineers) to create value for the firm, even if they do not participate in innovative activities directly. If this is the case, VC-driven non-founder top management changes may be disruptive to the firm and therefore have a negative effect on corporate innovation (**H5A**). On the other hand, VC-backed private firms may outgrow the capacity of existing non-founder top managers once they grow beyond the early startup stage. Under this scenario, VC-driven non-founder top management

changes may help the firms to bring in competent outside managers who are able to manage firm resources better or attract more talented employees, allowing these firms to be managed more efficiently. If this is the case, then I expect VC-driven non-founder top management changes to have a positive effect on corporate innovation (**H5B**).

If VC-driven top management changes indeed have an overall positive effect on subsequent corporate innovation (assuming **H2A** holds), I would like to decompose top management changes into different types, including the addition of new managers, removal of existing mangers, or both (i.e., replacements), and explore how each type of top management changes may affect corporate innovation. As suggested in existing theoretical studies (e.g., Boot (1992)), removing existing managers may result in correcting past errors in terms of investment and other decisions, such as abandoning poorly performing projects. If that is the case, I would therefore expect removing existing managers to be positively related with the quantity and quality of innovation. Further, if top management changes are indeed a source of value-addition by VCs, I would expect the relation between removing existing managers and innovation to be stronger in firms where VCs have more power. Existing studies (e.g., Oyer and Schaefer (2011)) also suggest that adding new managers may bring in new blood to the firm's existing human capital, in addition to correcting past errors. If that is the case, I would therefore expect adding new managers to be positively related to the quantity and quality of corporate innovation. Further, if top management changes are indeed a source of value-addition by VCs, I would expect the relation between adding new managers and innovation to be stronger in firms where VCs have more power. Finally, it may be the case that replacing existing managers (especially those who underperform) by new managers who can bring in new human capital (such as new ideas and new skill sets) to the VC-backed private firms is most effective in enhancing innovation. If that is the case, I would therefore expect that replacing existing managers with new managers to be positively related to the quantity and quality of corporate innovation. Further, if top management changes are indeed a source of value-addition by VCs, I would expect the relation between replacing managers and innovation to be stronger in firms where VCs have more power.

In addition to investigating how different types of top management changes may affect corporate innovation, I also delve deeper into the background of each manager that is added to or removed from the top management team and study how different backgrounds of the managers may play

a role in affecting innovation. One possibility is that managers with general managerial skills (for example, who have worked as a CEO or president before) are better at allocating resources, managing assets, and attracting human capital and thus enhance innovation. If so, I would expect having seasoned CEOs (or presidents) on the firm's top management team (although not necessarily as a CEO or president) to have a positive effect on corporate innovation. Another possibility is that the managers with a prior technical background (for example, who either hold a research degree in a field related to the firm's business or have engaged in the research and development process in another company) are better at selecting innovative projects to invest in and participating in the development process due to their technical skills and research experience. If so, I would expect having such managers to have a positive effect on the quantity and quality of innovation. These two effects are not mutually exclusive to each other and both may exist.

I now turn to an analysis of the possible underlying mechanisms through which management changes may enhance corporate innovation in VC-backed firms (assuming **H2A** holds). One possible mechanism is through attracting more inventors for a given amount of resources available to the firm. New management teams may select and allocate resources to more innovative projects, manage innovative assets better, and provide a better environment for inventors to succeed (for example, by creating a more failure-tolerant environment for inventors, in the sense of Manso (2011)). This, in turn, may enable the firm to attract more inventors. Therefore, I would expect management changes to be associated with a greater net inflow of inventors for a given amount of resources available to the firm (**H6**). Further, if VCs have greater power in the firm, they may be more effective in using top management changes to create value for the firm through the inventor mobility mechanism. I would therefore expect the effect of management changes on the net inflow of inventors to be stronger in firms where VCs have greater power (**H7**).

Finally, I investigate the effect of top management changes as well as enhanced innovation output on the probability of successful exit (either through an IPO or an acquisition) for VC-backed firms. First, if one of the ways in which VCs add value to a firm that they invest in is by inducing top management changes when appropriate, then I would expect such top management changes to be positively associated with the probability of successful exit. Second, since successful innovations are likely to be associated with positive net present value investment opportunities, I would expect firms with greater innovative success to be associated with a higher probability of a

successful exit (**H8**).

4 Data and Sample Selection

4.1 Sample Selection

My sample is derived from multiple data sources. The list of VC-backed private firms comes from the VentureXpert database. The management team and board member information for selected VC-backed firms is hand-collected from the "Form D" filings on the SEC EDGAR website. Under the Securities Act of 1933, any offer to sell securities must either be registered with the SEC (which will make the company selling securities a public company) or meet an exemption. Regulation D (or Reg D) contains three rules (i.e., Rule 504, Rule 505, and Rule 506) providing exemptions from the registration requirements, i.e., the Reg D private placement is an equity-financing alternative to a public offering.[8] Many VC-backed private firms use exemptions under Reg D to sell equity to VCs. Firms relying on a Reg D exemption are required to file a "Form D," which is a brief notice that includes the names and addresses of the company's top managers (such as CEO, president, Chief Technology Officer, and VP Finance), board of directors, size of the offering, and date of the sale.[9,10] To the best of my knowledge, Form D filings are the only public data source that provide reliable information on the composition of the top management teams and the boards of directors in VC-backed private firms over time.

The sample construction procedure is as follows. I begin with all the VC-backed deals (VC investments) with at least two financing rounds over the period of 2002–2010 covered in the VentureXpert database. I require that the first round information and the amount of investment made by VCs for all the rounds must be available for a firm. This results in 12,840 firm-round observations and 3,752 distinct VC-backed firms. Prior to hand-collection of detailed information on private firms' top management teams and boards, I conduct a preliminary matching of the above selected sample of firms from VentureXpert and the list of firms which have ever filed a Form D, Form D-A, Form REGDEX, or Form REGDEX-A with the SEC based on the name and location of the firm reported in the document headers on the SEC EDGAR website. This leaves us with

[8] See Ivanov and Bauguess (2013) for more details on Reg D offerings.

[9] Please refer to a detailed description about Form D at `https://www.sec.gov/smallbusiness/exemptofferings/formd`.

[10] Although firms are not required to disclose each manager's specific title in their Form D filings, they have to disclose the names and titles of the managers who signed the document. From the names and titles of these signers, I am able to partly identify the titles of the managers that may be included in Form D filings.

6,436 firm-financing round observations and 1,777 distinct VC-backed firms post-matching. Then I proceed to hand-collect the management team and board member information for each of the 1,777 VC-backed firms from the Form D filings on the SEC EDGAR website. For each firm-financing round observation, I search the firm for its Form D filings on the SEC EDGAR website based on the name of the company, the filing date, and the amount of investment by VCs and hand-collect the names of all members on the management team as well as board of directors for these VC-backed firms.

I hand-collect firm-year patent and citation information from the United States Patent and Trademark Office (USPTO) website based on the names and addresses of the VC-backed entrepreneurial firms in my sample. I collect the inventor information associated with each patent from the U.S. Patent Inventor Database (1975–2010) (see Li, Lai, D'Amour, Doolin, Sun, Torvik, Yu, and Fleming (2014)). Information on the successful exit outcomes of these VC-backed entrepreneurial firms (as measured by an IPO or an acquisition by another company) comes from the SDC Global New Issues database and the SDC Mergers & Acquisitions database, respectively.

The final merged sample results in 936 firms and 2,234 firm-financing round observations. Most of my sample firms stay private and active under VC investment over 2002–2010, while about 6.2% of the these firms exited through an IPO and 31.5% of them exited through an acquisition within ten years after receiving the first round of VC financing. A typical VC-backed firm in my sample receives $5.73 million investment from VCs per round. The median number of investors in a syndicate is 3. Firms in biotechnology and health care industries account for 14.9% of the sample and those in computer related (hardware and software) industries account for 34.3% of the sample. Firms headquartered in Massachusetts and California account for 13.9% and 41.4% of the sample, respectively.

4.2 Measures of VC Power

Following the existing literature (e.g., Ewens and Marx (2018)), I use the number of outside board members (i.e., board members that are not on the management team) to assess the power of VCs in VC-backed private firms. The board of a firm is known to be responsible for hiring, monitoring, and firing top management team.[11] The board of directors in VC-backed entrepreneurial firms are

[11] Existing studies show that outside board members are likely to play a role in changing management in VC-backed private firms (see, e.g., Kaplan and Strömberg (2003) and Ewens and Marx (2018)). Studies on the boards of public

usually composed of insiders (executive officers or founders), investors (e.g., VCs), and independent directors (who are mutually agreed upon both by investors and insiders, see Kaplan and Strömberg (2003) for more details). Existing studies document that other outside board members are likely to vote along with VCs (especially when the firm performs poorly), thus justifying the use of outside board members as a proxy for the power of VC in the firm. My primary measure for VC power in my main analyses, *VC Power*, is constructed as the natural log of one plus the number of outside board members for a VC-backed firm in a given year.[12] For robustness, I also consider an alternative measure, *VC Power (Alternative Measure)*, which is constructed as the outside board members divided by the total number of board members and obtain similar results. I also construct a dummy variable, *High VC Power*, to indicate that VCs have greater power in some firms relative to in others. Specifically, *High VC Power* is equal to one if the number of outside board members is above the sample median and zero otherwise.

4.3 Measures of Top Management Changes

The main measure of top management changes in a VC-backed private firm, *Mgmt Change*, is an indicator variable equal to one for a firm-round (i.e., firm-year of financing round) observation if the composition of the firm's top management team in the current round is different from that in the previous round and zero otherwise. Specifically, the indicator is turned on if either new managers were added to the top management team or existing managers from the previous financing round were removed from the top management team in the current round. Since management changes may include adding new managers to expand team, removing existing managers from the team, or both (i.e., replacement, but not necessarily a one-on-one replacement), I therefore create three separate indicators for each of the above three cases. *Add Only* is a dummy variable equal to one if new managers were added to the management team for a firm-round but no existing managers were removed, and zero otherwise; *Remove Only* is a dummy variable equal to one if existing managers were removed from the management team for a firm-round but no new managers were added, and zero otherwise; *Replace* is a dummy variable equal to one if new managers were added to and existing managers were removed from a firm's management team as well for a firm-round

firms such as Weisbach (1988) and Knyazeva, Knyazeva, and Masulis (2013) show that the outside board size or board independence are connected with shareholder power and have a direct effect on CEO turnover.

[12] I add one to the number of outside board members before taking logs to avoid losing observations.

observation, and zero otherwise. Other than the above dummy variables, I also look at the natural log of one plus the number (or fraction) of new managers added and the natural log of one plus the number (or fraction) of existing managers, as alternative measures for different types of top management changes.

4.4 Measures of Corporate Innovation

Following the existing literature (e.g., Hall, Jaffe, and Trajtenberg (2001), Chemmanur, Loutskina, and Tian (2014), and Seru (2014)), I use patent-based metrics to capture firm innovativeness. I hand-collect information about patents (granted up to 2018) associated with each firm in my VC-backed sample based on the name and address of the firm from the USPTO website.

Patent data is subject to two types of truncation bias. First, patents are recorded on the USPTO website only after they are granted and the lag between patent applications and patent grants is significant (about two years on average). Therefore, we observe a smaller number of patent applications that are eventually granted towards the end of my sample period. Many patent applications filed during these years were still under review and had not yet been granted. I mitigate this bias by restricting my analyses to patents that are filed up to 2012. Further, following Hall, Jaffe, and Trajtenberg (2001) and Seru (2014), I correct this bias by dividing each patent for each firm-year by the mean number of patents for all firms for that year in the same 3-digit technology class as the patent. The second type of truncation problem is stemming from citation counts (i.e., the total number of citations received till now). Patents tend to receive citations over a long period of time, so the citation counts of more recent patents are significantly downward biased. Following Seru (2014), this bias is accounted for by scaling citations of a given patent by the mean number of citations received by all patents in that year in the same 3-digit technology class as the patent. Note that the above methodology gives us class-adjusted measures of patents and citations, which adjust for trends in innovative activity in particular industries.

Specifically, I use the following variables to measure the quantity and quality of innovation output, respectively: $Patents^{(N)} = Ln(1+\sum_{\tau=1}^{N} Patents_{i,t+\tau})$, and $Cites^{(N)} = Ln(1+\sum_{\tau=1}^{N} Cites_{i,t+\tau})$, where $N = 1$, 2, or 3. These proxies represent the natural log of one plus the adjusted patent counts and citation counts over the following one, two, or three years, and the log-linearization is used to mitigate skewness following Lerner (1995). $Patents_{i,t}$ is firm i's patent counts in year t, defined as

the total adjusted number of patent applications filed by firm i in year t that were finally granted. $Cites_{i,t}$ is firm i's patent citations in year t, defined as the number of adjusted number of citations received by all patents filed by firm i in year t. Table 1 reports the summary statistics for my innovation measures. For example, $Patents^{(2)}$ has a mean value of 0.431 and a median value of zero; $Cites^{(2)}$ has a mean value of 0.440 and a median value of zero.

4.5 Measures of Inventor Mobility

To identify inventor mobility, I collect inventor information of each patent from the U.S. Patent Inventor Database (1975–2010) (see Li, Lai, D'Amour, Doolin, Sun, Torvik, Yu, and Fleming (2014)). The U.S. Patent Inventor Database includes inventor names, inventor addresses, assignee names, application date, and grant date for each patent. More importantly, it identifies unique inventors over time so that we could possibly track the moves of each inventor. Following Marx, Strumsky, and Fleming (2009) and Chemmanur, Kong, Krishnan, and Yu (2019), I identify mobile inventors as changing employers if he has ever filed two successive patent applications that are assigned to different firms (or organizations). Since I need at least two patents to detect a move, inventors that have filed a single patent throughout their career are necessarily excluded from my analysis.

In line with Chemmanur, Kong, Krishnan, and Yu (2019), I assume the inventor's move to occur in the year when he filed his first patent in a given firm. For a given firm, an inventor's move-in year is the year when he filed his first patent in this firm; the inventor's move-out year is the year when he filed his first patent in the subsequent firm. For the inventor's very last employer, I assume that the inventor stayed with that firm and did not move out.[13] For example, in the inventor database, an inventor named Christopher L. Holderness has filed two patent applications till 2010. He filed patent application with Corning Inc. in 1999 and then with Dell Inc. in 2003. In accordance with my assumption, for Corning, Mr. Holderness's move-in year is 1999 and move-out year is 2003; and for Dell, Mr. Holderness's move-in year is 2003, and he has stayed with Dell since 2003. Once I identify each mobile inventor's move-in and move-out year, I aggregate the number of mobile inventors that move in and move out at the firm-year level to obtain the total inflow and outflow of mobile inventors for a given firm in a year. I define the difference between

[13] As a robustness check, I redefine the dates that the inventor moved out of his last employer as one or two years after he filed his last patent in that firm. My results remain qualitatively similar with this alternative definition.

the natural logarithm of one plus the inflow and the natural logarithm of one plus the outflow as the net inflow of mobile inventors. For firms without any mobile inventors, I assign zero values to the inflow, outflow, and net inflow of mobile inventors. Specifically, the net inflow of mobile inventors for firm i in the next N years following management changes in year t is defined as: $Net\ Inflow^{(N)} = Ln(1 + \sum_{\tau=1}^{N} Inflow_{i,t+\tau}) - Ln(1 + \sum_{\tau=1}^{N} Outflow_{i,t+\tau})$, where $N = 1$, 2, or 3; and $Inflow_{i,t+\tau}$ and $Outflow_{i,t+\tau}$ are the inflows and outflows of mobile inventors for firm i in year $t+\tau$, respectively.

4.6 Other Variables

I control for the following characteristics and fixed effects that may affect firms' innovation output following the literature (see, for example, Chemmanur, Loutskina, and Tian (2014), Chemmanur, Krishnan, Kong, and Yu (2019), and Tian and Wang (2014)). In the baseline regressions, my control variables include the following: *Ln(VC Investment)*, which is the natural log of the VC investment amount for a firm-financing round; *Ln(Syndicate Size)*, which is the natural log of one plus the number of investing VCs; and *Ln(Mgmt Team Size)*, which is the natural log of one plus the number of managers in a firm's top management team; *Ln(Firm Age)*, which is the natural log of one plus the number of years since a firm's incorporation; and *VC Rep*, which is the reputation measure of the lead VC firm backing the private company, following Nahata (2008). Specifically, *VC Rep* is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year.[14] Table 1 provides summary statistics for the control variables described above. For example, *VC Investment* has a mean value of \$9.48 million and a median value of \$5.73 million. A typical (median) firm in my sample has a top management team composed of 2 senior managers and receives VC funding from 3 syndicating venture capitalists. In all regressions, I also include industry fixed effects (defined at the 2-digit SIC code level), year of financing round fixed effects, and development stage fixed effects, unless otherwise specified.

[14]Following the existing literature (e.g., Hochberg, Ljungqvist, and Lu (2007) and Nahata (2008)), I define the lead VC as the one that participates in the first-round investment (or second-round investment if the identity information of first-round investors is not available) and makes the largest total investment across all rounds of funding in a VC-backed firm.

5 Empirical Results

5.1 Top Management Changes and VC Power in VC-backed Private Firms

In this section, I first examine whether the top management changes in VC-backed private firms are indeed primarily driven by VCs. As discussed earlier, if VCs proactively add or remove managers in VC-backed firms to help them succeed rather than replacing managers who resign from the firm voluntarily due to having attractive outside opportunities or losing interest in the firm, then I would expect the probability of management changes to increase with the power of VCs.

To test whether management changes are primarily driven by VCs, I estimate the following probit model:

$$Prob(Mgmt\ Change)_{i,t} = \alpha + \theta\, VC\ Power_{i,t} + \gamma Z_{i,t} + Industry + Year + Stage + \epsilon_{i,t}. \quad (1)$$

In the above, *Mgmt Change*, is a dummy variable indicating whether there was a change in the composition in firm i's top management team in year t, which is the year of the current financing round. *VC Power* is measured by the natural log of one plus the number of outside board members.[15] Z is a vector of control variables that may affect a firm's innovation output, which includes *Ln(VC Investment)*, *Ln(Syndicate Size)*, *Ln(Mgmt Team Size)*, *Ln(Firm Age)*, and *VC Rep* as described in Section 4.6. Industry fixed effects (defined at 2-digit SIC code level), financing year fixed effects, and development stage fixed effects are also included.[16] In all regressions throughout the paper, standard errors are clustered at the industry level unless otherwise specified.

Table 2 reports the results for the above probit model. Columns (1) uses natural log of one plus the outside board members as a proxy for the power of VCs in the VC-backed firm. I find that the coefficient on *VC Power* is positive and significant at the 1% level, with the predicted sign. The economic magnitude of the effect of VC power on the probability of top management changes is very significant. For example, the estimate in Column (1) implies that a one standard deviation increase in the log of the number of outside board members (0.48) is associated with a

[15] Due to data limitations, I am not able to exactly identify which board of directors are from the VC firms. Therefore, I use the number of outside board members (those who are not managers or founders of the VC-backed firm) as proxy for the power of VCs, since other outside board members (mainly independent directors) typically vote along with VCs as discussed in Section 4.2.

[16] For robustness, I also conduct regressions of top management changes on VC power measures using a linear probability model and obtain consistent results. These results are reported in Table A4 in order to conserve space.

12.6% increase in the probability of a management change.[17] For robustness, Column (2) uses the fraction of outside board members as the main explanatory variable. As expected, the coefficient on *VC Power (Alternative Measure)* is significantly positive. A one standard deviation increase in the fraction of outside board members (0.21) is associated with 11.1% increase in the probability of a management change. Overall, the results in Table 2 provide strong evidence that management changes in my sample of VC-backed private firms, on average, are likely to be driven by venture capitalists, supporting **H1**.

5.2 The Effect of Top Management Changes on Corporate Innovation

Then I move on to examine the relationship between top management changes and corporate innovation in VC-backed private firms (corresponding to my hypotheses **H2A** and **H2B**). I empirically test these hypotheses by estimating the following model:

$$Innovation^{(N)} = \alpha + \beta Mgmt\ Change_{i,t} + \gamma Z_{i,t} + Industry + Year + Stage + \epsilon_{i,t}, \qquad (2)$$

where i indexes firm and t indexes time and N equals 1, 2, or 3. $Innovation^{(N)}$ are the cumulative patent counts in the following one, two, or three years and the total forward citations received by these patents, as described in detail in Section 4.4.

Table 3 reports the OLS estimation results for regression (2). Columns (1)–(3) report the regression results using the cumulative patent counts in the following one, two, or three years as the dependent variables, respectively; Columns (4)–(6) report the regression results using the total number of patent citations received by the patents filed in the next one, two, and three years as the dependent variables, respectively. I find that the coefficients on *Mgmt Change* are positive and significant at the 5% level in all columns except one. The coefficient in Column (4) is still positive but becomes insignificant due to increased standard errors. The economic magnitude of the effect of management changes on innovation is significant as well: for example, Column (3) suggests that three-year patent counts increase by 5.6% following management changes, and Column (6) suggests that three-year patent citations increase by 9.2% following management changes. Collectively, these results suggest that management changes are associated with significantly more and higher quality subsequent innovation, which lend strong support to **H2A**.

[17] The predicted probability of a management change at the mean of control variables is 27.9%. Fixing means while increasing the logged outside board size by one standard deviation (0.48) results in a predicted probability of 40.6%.

5.3 The Effect of Top Management Changes on Corporate Innovation for Firms with Different VC Power

The results in Section 5.2 suggest a positive link between VC-driven top management changes and corporate innovation. In this section, I explore whether the positive relation between management changes and corporate innovation is stronger for firms in which VCs have greater power.[18]

I conduct the following interaction tests to study whether the effect of management changes on corporate innovation is stronger for firms in which VCs have greater power. I therefore interact *Mgmt Change* with an indicator for greater VC power (*High VC Power*) and test the following model:

$$\begin{aligned} Innovation^{(N)} = \alpha &+ \beta Mgmt\ Change_{i,t} \\ &+ \delta High\ VC\ Power_{i,t} + \theta Mgmt\ Change_{i,t} \times High\ VC\ Power_{i,t} \\ &+ \gamma Z_{i,t} + Industry + Year + Stage + \epsilon_{i,t}, \end{aligned} \tag{3}$$

where *High VC Power* is defined as a dummy variable equal to one if the number of outside board members is above the sample median and zero otherwise. Table 4 reports the results for these interaction tests.[19] Consistent with **H3A**, I find that the coefficients on the interaction between *Mgmt Change* and *High VC Power* are positive and significant for all the specifications. Once the interaction terms are included in the regressions, the effect of *Mgmt Change* becomes insignificant or even negative. These findings suggest that top management changes are more effective in enhancing innovation for firms in which VCs have greater power, consistent with the notion that VCs add value to their portfolio companies through actively improving firm management. In sum, the results in this section lend support for **H3A**.

[18] Ideally, to establish the link that VCs induce top management changes and thereby enhance innovation in VC-backed private firms, I would like to compare the effect of management changes induced by VCs versus those not induced by VCs. However, due to data limitations, I cannot identify exactly which management changes are indeed driven by VCs and which are not. Therefore, here I choose to compare the effect of management changes in firms where VCs have greater power (and are therefore more likely to induce effective management changes to help firms) versus those in firms where VCs only have less power (and are therefore less likely to induce effective management changes.)

[19] The results are qualitatively similar if I define *High VC Power* as a dummy variable indicating the fraction of outside board members being above the sample median. These results are not reported here in order to conserve space.

5.4 The Effect of Top Management Changes on Corporate Innovation: Instrumental Variable Analysis

In my baseline (OLS regression) analysis, I find a positive association between top management changes and enhanced innovation activities subsequently in VC-backed private firms. However, potential endogeneity can confound the empirical findings from the baseline analysis linking management changes and corporate innovation. On the one hand, one may argue that the positive relationship between management changes and corporate innovation may be driven by omitted variables such as firm quality or innovativeness, since VCs may select more innovative firms to invest in. In this case, the OLS estimates will be biased upwards. On the other hand, VCs may be more likely to intervene the firms when they are off the track to help them to improve their performances. In this case, the OLS estimates will be biased downwards. In order to address the above potential endogeneity concerns, I conduct an IV (2SLS) analysis using a plausibly exogenous shock to the supply of outside managers available for hire (who might serve as suitable replacements). Specifically, my instrument is constructed as the number of acquisitions made by public companies in the same industry and in the same state as the VC-backed private firm interacted with an index measuring the enforceability of the non-compete clauses in that state.

The instrument in my IV analysis is motivated by the following facts. First, incoming managers to startups often come from established firms, and these firms are dominant players in the acquisition market. In other words, there is a strong correlation between the movement of managers across firms and the number of acquisitions in the industry that the firm belongs to. Inspired by Ewens and Marx (2018), I count the number of acquisitions made by established firms in the same industry and in the same state as the VC-backed entrepreneurial firms two years prior as a proxy for the local supply of outside managers for the VC-backed firms.[20] The two-year lag stems from the popular retention contracts employed by the acquirers for target firms. These contracts often compensate the managers of target firms for lost compensation for two to four years and provide strong incentives for these managers to stay with the target firms for another few years. The expiration of these contracts generates a source of variation to the potential supply of managers. Second, the enforceability of non-compete clauses, which are commonly used in employment

[20] An earlier (working paper) version of Ewens and Marx (2018) documents a strong reduced-form correlation between executive replacement and the number of acquisitions in the same industry two years prior.

contracts for top management and prohibit them from joining or founding a rival company within one to two years of leaving, affects the mobility of managers across the firms.[21] Bishara, Martin, and Thomas (2015) analyze an extensive sample of CEO employment contracts and show that 80% of these contracts contain non-compete clauses, often with a broad geographic scope. A growing body of work (e.g., Garmaise (2011) and Marx, Strumsky, and Fleming (2009)) shows that higher enforceability of these non-compete clauses reduces employees' mobility (including that of managers). The enforceability of such non-compete clauses exhibits both cross-state and time series variation, which leads to variation in the mobility of managers that is unlikely to be directly related to innovation. Based on the above facts, I construct an instrument for *Mgmt Change*, making use of the strong correlation between industry acquisitions and the movement of top managers as well as the exogenous variation in the mobility of managers.

Specifically, the instrument variable for *Mgmt Change* in a firm in industry j headquartered in state s in year t, is constructed as follows:

$$Instrument_{j,t} = Acquisitions_{j,s,t-2} \times Enforceability\ Index_{s,t}, \tag{4}$$

where j, s, and t index industry, state, and year, respectively. $Acquisitions_{j,s,t-2}$ is the number of acquisitions made by established (public) companies in industry j in state s in year $t-2$. The information on mergers and acquisitions required to construct this variable is collected from the SDC Mergers & Acquisitions Database. Again, the two-year lag allows for the expiration of retention contracts that work as "golden handcuffs" for managers and thus $Acquisitions_{j,s,t-2}$ proxies for the potential supply of managers from state s in industry j in year t.

$Enforceability\ Index_{s,t}$ is the index measuring the enforceability of non-compete agreements across different U.S. states based on Garmaise (2011). Garmaise (2011) develops an index to measure the enforceability of non-compete clauses by considering 12 questions analyzed by Malsberger (2004), which is the central resource describing noncompetition law in 50 U.S. states and the DC, and assigning 1 point to each jurisdiction for each question if the jurisdiction's enforcement of that dimension of noncompetition law exceeds a certain threshold. Possible totals therefore range from

[21] Since these non-compete clauses become operational only when top managers leave their prior firms, the enforceability of these non-compete clauses can be thought as a measure of the friction facing top managers when they attempt to join the VC-backed private firm.

0 to 12.[22,23] The *Enforceability Index* used here is constructed as the difference between 12 and the value of Garmaise's (2011) index scaled by 12 and thus it potentially ranges from 0 to 1. A higher (lower) value of *Enforceability Index* indicates weaker (greater) enforceability of the non-compete clauses and thus greater (weaker) mobility of managers. The instrument therefore proxies for the supply of managers that are able to move across firms and available for hire by a VC-backed private firm in state s in industry j in year t. I expect my instrument to be positively and significantly related to the probability of top management changes (and empirically show this in my first-stage regression as in below).

To instrument for top managements change of firm i in industry j in year t, I therefore run the first-stage probit regression of my IV analysis as follows:[24]

$$Prob(Mgmt\ Change)_{i,j,t} = \alpha + \beta Instrument_{j,t} + \gamma Z_{i,t} + Industry \times Year + State \times Year + Stage + \epsilon_{i,t}. \quad (5)$$

In each stage of my IV regressions, I include industry-by-year fixed effects and state-by-year fixed effects.[25] These fixed effects help to absorb any industry-wide technology shock (e.g. innovation wave) and any local economic shock that may affect innovation. Therefore, the instrument is unlikely to affect innovation through channels other than through affecting the supply of managers and inducing top management changes, thus satisfying the exclusion restriction.

Table 5 report the first and second-stage results of my IV analysis. Column (1) reports the first-stage probit result. I find that the coefficient on my instrument is positive and significant at the 1% level, even after controlling for industry-wide shock and local economic shock. Pseudo R-squared is as large as 30.3%. The first stage F-statistic for the weak instruments tests is 70.33

[22] Garmaise (2011)'s index measuring the enforceability of non-compete clauses originally covers the period of 1992–2004. Eritmur, Rawson, Rogers, and Zechman (2018) adopt the same methodology and extend the index to cover the period of 1980–2014. In my analysis, I therefore use the values of the index from Garmaise (2011) for the period prior to 2004 and from Ertimur, Rawson, Rogers, and Zechman (2018) for the period from 2004 onwards.

[23] Higher values of Garmaise's (2011) index indicate higher enforceability of the non-compete agreements in this state and thus less mobility of the managers from this state. For example, Garmaise's index (2011) is equal to 0 for California and is equal to 9 for Florida after 1997.

[24] Since the endogenous variable *Mgmt Change* is binary, I use a probit model in the first stage, following Wooldrige (2010). I then compute the predicted probability ($\widehat{Mgmt\ Change}$) from the probit estimation in the first stage and use $\widehat{Mgmt\ Change}$ as the instrument for *Mgmt Change* to estimate the effect of top management changes on corporate innovation. I obtain qualitatively similar results using linear models in each stage.

[25] As documented in Section 5.3, the power of VCs is a significant determinant of the probability of top management changes for a VC-backed private firms. I therefore include *VC Power* as an additional control variable in addition to those used in the baseline analysis, as described in Section 4.6.

and is significantly above the critical value as suggested in Stock and Yogo (2005). These results indicate that the relevance condition for the instrument is satisfied.

Columns (2)–(7) in Panels A of Table 5 report the second-stage results of my IV analysis. I find that management changes continue to have a significantly positive effect on the quantity and quality of subsequent innovation for the two or three years following top management changes, even after accounting for the potential endogeneity concerns described earlier. The results using the cumulative patent count and citations in one year after management changes are weaker but remain in the right direction. Further, the coefficient estimates on *Mgmt Change* in my IV regression results become larger compared with the OLS regression estimates, suggesting that the OLS regression estimates tend to be downward biased. This is likely due to the fact that VCs are more likely to intervene in firms that do not perform well and therefore management changes are more likely to occur in such firms.

In Panel B of Table 5, I report the IV results for the regressions that use the interaction term between management changes and a dummy variable for greater investor power as the main explanatory variable.[26] I find that the interaction terms load significantly and positively in all the specifications.[27] This is consistent with my earlier findings in Section 5.3 and lends support to **H3A** that the effect of VC-driven top management changes on corporate innovation is more pronounced in firms where VCs have greater power.

5.5 The Effects of Founder versus Non-Founder Top Management Changes on Corporate Innovation

The existing literature provides evidence that VCs improve the probability of successful exit of entrepreneurial firms through replacing founder CEOs with outsiders (Ewens and Marx (2018)). Yet to the best of my knowledge, the literature still lacks evidence on how top management changes (either founder replacements or non-founder top management changes) affect corporate innova-

[26]Following Wooldrige (2010), I run the first-stage probit regression as shown in regression (5) and compute the predicted probability of a top management change ($\widehat{Mgmt\ Change}$). Then I use $\widehat{Mgmt\ Change}$ and $\widehat{Mgmt\ Change} \times$ *High VC Power* as instruments for *Mgmt Change* and *Mgmt Change*×*High VC Power* and conduct an IV analysis. The first-stage F-statistic for the weak instrument test is 23.64, which is significantly larger than the critical value suggested in Stock and Yogo (2005).

[27]In untabulated analyses, I also conduct the above IV regressions using a subsample of firms excluding those in California for robustness, since they account for over 40% of the sample. I find that the positive relation between VC-driven top management changes and corporate innovation still holds, although becoming slightly weaker due to the decreased sample size.

tion.[28] In particular, the role of non-founders has often been overshadowed by the importance of founders. In this subsection, I will investigate the impact of VC-driven founder replacements versus non-founder top management changes (either by adding a non-founder manager and/or removing an existing non-founder manager) on corporate innovation.

To identify founders of my sample firms, I search and hand-collect the founder information for each firm from the firm's website, LinkedIn, Crunchbase, Bloomberg, etc. I find that 15.2% (142 out of 936) of the sample firms have experienced at least one founder removal, which is consistent with the descriptive statistics documented in existing studies such as Ewens and Marx (2018) who use a different data source.[29]

I construct two dummy variables, *Founder Replacement* and *Non-founder Change*, to indicate for the case of a founder being removed for a given firm-round and the case of only non-founder top managers being removed and/or added, respectively. I first conduct probit regressions of *Founder Replacement* and *Non-founder Change*, respectively, on measures of VC power to analyze whether both founder replacements and none-founder top management changes are both primarily driven by VCs. I find that both the probability of founder replacements and that of non-founder top management changes are positively and significantly related to VC power, indicating that both founder-replacements and non-founder top management changes are indeed primarily driven by VCs. These results are presented in Table A3 in the Internet Appendix in order to conserve space. Next, to examine the effects of founder replacement versus non-founder changes on corporate innovation, I regress the innovation measures on *Founder Replacement* and *Non-founder Change*, respectively. The results of these tests are presented in Table 6. I find that, in most regressions, *Founder Replacement* and *Non-founder Change* both carry a positive and significant coefficient, suggesting that both founder replacements and non-founder top management changes enhance innovation. The economic magnitude of these effects are significant as well: for example, founder replacement is associated with 12.6% increase in next year's patent counts and non-founder top management changes are associated with 5.4% increase in next year's patent counts. Collectively, these results support **H4B** and **H5B**.

One may be concerned that the positive relations I document above between corporate inno-

[28] Founder replacements and founder removals are used interchangeably in this paper.

[29] For reference, 440 out of 936 firms in my sample have experienced non-founder top management changes only.

vation and management changes are likely to be driven by removing founders only, given that the effect of founder replacements is greater than that of non-founder changes as in Table 6. To address this concern and establish that non-founder top management changes indeed enhance innovation, I conduct a subsmaple analysis restricting the subsample to firms that have never experienced any founder removal. In specific, I drop the firm-round observations of the 142 firms that have ever experienced a founder replacement and re-run the same regressions as in Tables 3 and 4. The results of these tests are reported in Table 7. Panel A reports the effect of VC-driven non-founder top management changes on corporate innovation in VC-backed private firms. I find that the coefficients of non-founder top management changes are positive and significant in all specifications but one, suggesting that VC-driven non-founder top management changes have a positive and significant effect on the quantity and quality of corporate innovation. Panel B reports the effect of VC-driven non-founder top management changes on corporate innovation in firms with different VC power. I find that the coefficients on the interaction between non-founder top management changes and greater VC power are positive and significant in all specifications, suggesting the positive relation between non-founder top management changes and innovation is stronger in firms where VCs have greater power. Collectively, the above results demonstrate that the positive relationship that I document between VC-driven top management changes and corporate innovation is not driven only by founder replacements. In fact, my evidence demonstrates that both founder replacements and non-founder top management changes play a significant role in enhancing innovation.

5.6 The Effects of Different Types of Top Management Changes on Corporate Innovation

Since top management changes may include adding new managers, removing existing managers, or both (i.e., replacement of some top managers by others), I examine in this section how each type of top management changes may affect innovation in VC-backed private firms.[30] To do this, I create three separate dummy variables to indicate that only new managers were added (*Add Only*), that only existing managers were removed (*Remove Only*), and that both happened (*Replace*), and use them as the main explanatory variables for innovation. Other than these dummy variables indicating different types of top management changes, I also consider continuous variables (i.e., the

[30]Note that replacement here is used as a general term for both adding new managers and removing existing managers at the same time in a given financing round. This may not be a one-for-one replacement though.

fraction and the number of managers) to measure the extent of different types of top management changes, which I will detail below.

Panel A of Table 8 reports the estimation results using *Add Only*, *Remove Only*, and *Replace* as the main explanatory variables. In Columns (1)–(6), I find that the coefficients on *Replace* are all positive and significant (mostly at least at the 5% level); while the coefficients on *Add Only* and those on *Remove Only* are all insignificant. The findings suggest that replacing existing managers and bringing in new managers is most effective in enhancing innovation; while simply expanding the top management team or firing/removing existing managers has no significant impact on the quantity and quality of corporate innovation. In sum, these results suggest that replacing existing managers with "new blood" most effectively helps to enhance innovation.

Panels B and C of Table 8 reports regression results using alternative (continuous) measures of different types of top management changes. Both panels use the quantity and quality of corporate innovation following top management changes as the dependent variables and include the same control variables as in Panel A, the coefficients of which are not reported in order to conserve space. In Panel B, I consider the fractions of managers added or removed. The main explanatory variables are as follows. *Frac(Added+Removed)|Replace* is equal to the fraction of managers added (joiners) and those removed (leavers) if new managers were added and existing managers were removed as well (i.e., there was a replacement) for a firm-round observation, and zero otherwise (i.e., if no replacement occurred for the firm-round observation). *Frac(Added)|Add Only* is equal to the fraction of managers added (joiners) if only new managers were added and no existing managers were removed for a firm-round observation, and zero otherwise. *Frac(Removed)|Remove Only* is equal to the fraction of managers removed (leavers) if only existing managers were removed and no new managers were added for a firm-round observation, and zero otherwise. In Panel C, I consider the logged number of managers that have been changed and the main explanatory variables are as follows. *Ln(Added+Removed)|Replace* is equal to the natural log of one plus the number of managers added (joiners) and those removed (leavers) if new managers were added and existing managers were removed as well (i.e., there was a replacement) for a firm-round observation, and zero otherwise. *Ln(Added)|Add Only* is equal to the natural log of one plus the number of managers added (joiners) if only new managers were added and no existing managers were removed for a firm-round observation, and zero otherwise. *Ln(Removed)|Remove Only* is equal to the natural log of

one plus the number of managers removed (leavers) if only existing managers were removed and no new managers were added for a firm-round observation, and zero otherwise. These alternative continuous measures capture not only the nature of different types of top management changes (i.e., whether it is a replacement, expansion, or subtraction in the top management team), but also the extent of changes in the composition of the top management teams.

Consistent with the results reported in Panel A of Table 8, I find in Panels B and C that the coefficients on measures for replacing managers are positive and significant both statistically and economically for most of the regressions, while the coefficients on measures for adding managers only or removing managers only are all insignificant and much smaller in magnitude. These findings, again, suggest that replacing existing managers with new candidates who potentially bring in new ideas and skills is likely to enhance innovation most effectively, compared to simply expanding the management team or removing existing managers.

I then turn to explore the effect of adding new managers as well as removing existing managers on innovation for firms with different VC power. To do this, I interact the three indicator variables for replacing managers, adding new managers only, and removing existing managers only with the dummy variable for greater VC power. I report the results for these interaction tests in Table 9. I find that the interaction terms *Replace* $\times$ *High VC Power* load positively and significantly for all the regressions except one, which is consistent with the conjecture that bringing in new managers to replace existing amangers is a source of value addition by VCs and venture-driven management changes are more effective in enhancing corporate innovation if VCs have more power in the firm. The coefficients on the other two interaction terms are mostly insignificant, consistent with my earlier results reported in Table 8 that replacing the existing managers with new blood plays a major role in enhancing innovation. Collectively, the results in this section provide support for my earlier conjecture that replacing existing managers with new managers (who may bring new ideas and skill sets) is most effective in terms of enhancing innovation.

5.7 The Relation between the Background of New Managers and Corporate Innovation

I show in the previous section that replacing existing managers with new blood is the major drive that enhances corporate innovation. In this section, I delve deeper into the profiles of new managers

added to (joiners) and existing managers removed from the management team (leavers) and explore how different background of these managers (in terms of educational and employment experience) may play a role in enhancing corporate innovation. To do this, I search for and read the bios of each manager in my sample on their personal website, their company's website, LinkedIn, or Bloomberg, etc., and collect information on their educational backgrounds and employment history. I then classify all these managers (joiners and leavers) into two broad categories: seasoned CEOs or presidents (who have prior experience working as a CEO or president in another company thereby having acquired general managerial skills) and managers with a prior technical background (who hold a doctoral degree in a field related to the firm's business, or who were previously engaged in research and development process in another company working as a Chief Technology Officer (CTO) or Chief Innovation Officer (CIO), or who were previously granted patents in a field related to the firm's business). If the new management teams are better at managing and attracting human capital (scientists and engineers) and thus foster innovation activities, I would expect that adding seasoned CEOs to have a positive and significant effect on corporate innovation. If the new management teams are better at generating innovation themselves, I would expect adding people with a prior technical background to have a positive and significant effect on corporate innovation. These two effects are not mutually exclusive and may coexist. To test these implications of the background of managers on innovation, I estimate the following model:

$$\begin{aligned} Innovation^{(N)} = \alpha &+ \beta_1 Ln(Seasoned\ CEOs\ Added)_{i,t} + \beta_2 Ln(Seasoned\ CEOs\ Removed)_{i,t} \\ &+ \beta_3 Ln(Tech\ Mgrs\ Added)_{i,t} + \beta_4 Ln(Tech\ Mgrs\ Removed)_{i,t} \\ &+ \gamma Z_{i,t} + Industry + Year + Stage + \epsilon_{i,t}. \end{aligned} \tag{6}$$

In the above regressions, I use the main explanatory variables as follows. *Ln(Seasoned CEOs Added)* (*Ln(Seasoned CEOs Added)*) is the natural log of one plus the number of managers added to (removed from) the private firm's management team, who had prior working experience as a CEO or president in another company. *Ln(Tech Mgrs Added)* (*Ln(Tech Mgrs Removed)*) is the natural log of one plus of the number of managers added to (removed from) the private firm's management team, who had a prior technical background. These explanatory variables capture the effects of different back ground of managers that have been added to or removed from the top management team in a VC-backed private firm. The results of the above regressions are reported in Table 10. I

find that adding seasoned CEOs or presidents (who acquired general managerial skills through prior working experience) has a positive and significant effect on the quantity and quality of corporate innovation. However, removing seasoned CEOs or presidents from the top management team does not have a significant impact on corporate innovation. As for managers with a prior technical background, I find that neither adding or removing managers with a prior technical background has a significant impact on the quantity and quality of corporate innovation. The differences between the coefficients on *Ln(Seasoned CEOs Added)* and those on other explanatory variables are mostly statistically significant (at least at the 10% level). Collectively, these findings suggest that the new management teams enhance innovation in VC-backed entrepreneurial firms as they are better at managing resources and human capital.

5.8 Mechanism: Attracting Inventors

My evidence so far is consistent with the notion that VC-driven top management changes positively affect future corporate innovation in VC-backed private firms and such changes are more effective in enhancing innovation for firms where VCs have more power. In this section, I investigate one possible underlying mechanism through which this occurs. As discussed earlier, the new management teams may select and allocate resources to higher quality innovation projects, manage innovative assets better, and provide a better environment for inventors (scientists and engineers) to succeed (for example, in the sense of Manso (2011), by creating a more failure-tolerant environment for inventors), all of which may make the firm more attractive to inventors. Thus, one way that management changes may enhance innovation is by being able to hire more inventors to work for the firm (after controlling for the size of investment). To assess the relationship between management changes and the movement of mobile inventors, I test the following model:

$$Net\ Inflow^{(N)} = \alpha + \beta Mgmt\ Change_{i,t} + \gamma Z_{i,t} + Industry + Year + Stage + State + \epsilon_{i,t}, \quad (7)$$

where i indexes firm and t indexes time and N equals 1, 2, or 3. The dependent variables in regression (7) are the cumulative net inflows mobile inventors that have worked for different firms over my sample period of 2002–2010 in the one, two, or three years following management changes, which are defined as in Section 4.5. Z is vector of control variables used in prior tests. In addition to industry and year fixed effects, I further include state (in which the private firm is headquartered)

fixed effects to account for the possibility that firm location may affect an inventor's moving decision.

Panel A of Table 11 reports the results for the above regressions.[31] Columns (1)–(3) in Panel A use *Mgmt Change* as the main explanatory variable. Columns (4)–(6) in Panel A use variables for different types of top management changes, i.e., *Replace*, *Add Only*, and *Remove Only*, as the main explanatory variables. In Columns (1)–(3), I find that the coefficients on *Mgmt Change* are mostly positive and significant, suggesting that top management changes are associated with a significantly greater net inflow of inventors subsequently. The economic magnitude of the effects of management changes on the net inflow of inventors is significant as well: for example, Columns (2) and (3) suggest that top management changes are associated with a 3.8% and 4.6% increase in the net inflow of inventors over the next two and three years, respectively. When examining the effects of different types of top management changes on subsequent net inflows of inventors, I find in Columns (4)–(6) that the coefficient on *Replace* are all positive and significant, while the coefficients on *Add Only* and those on *Remove Only* are all insignificant. These findings are consistent with the results documented in Section 5.6, indicating that replacement of top managers is most effective in attracting inventors to join the startup and therefore helping to enhance corporate innovation. Collectively, these findings support my hypothesis **H6**, and suggest that one mechanism through which top management changes enhance corporate innovation is by the new management teams attracting more inventors to work for the firms (after controlling for the size of VC investment).

As discussed in prior sections, if VCs have more power in the firm, they may be more effective in using top management changes to create value for the firm through the inventor mobility channel. Therefore, I would expect management changes to have a stronger effect on the net inflows of inventors for firms where VCs have greater power. To test this implication, I include the interaction term of management changes and an indicator variable for greater VC power in the inventor net inflow regressions and report the results for these tests in Panel B of Table 11. As shown in Columns (1)–(3), the coefficients on the interaction of *Mgmt Change* and *High VC Power* are significantly positive, suggesting that the effect of management changes on the net inflow of inventors is especially stronger for firms where VCs have greater power. Overall, my results are consistent with the

[31] As described in Section 4.5, the inventor information comes from U.S. Patent Inventor Database. This database identifies inventor information mainly based on patents that were filed up to 2010, with a very small number of exceptions that were filed in 2011. Therefore, the number of observations for the inventor mobility tests presented in this section is smaller compared to that for the baseline analyses presented in Section 5.2, for which I consider patents filed by my sample firms up to 2012.

conjecture that VCs are more effective in using top management changes to enhance innovation through attracting more inventors when they have more power in the firm, lending strong support to my hypothesis **H7**.

5.9 The Effect of Top Management Changes and Corporate Innovation on Successful Exits

My results thus far have documented a positive relation between top management changes and subsequent corporate innovation. In this section, I investigate the implication of top management changes and corporate innovation on successful exits of VC-backed firms. Both IPOs and acquisitions are considered as successful exit outcomes in the existing literature (e.g., Hochberg, Ljungqvist, and Lu (2007), Sörensen (2007), and Nahata (2008)). I therefore use the following variables to measure the successful exit of VC-backed firms: (i) *IPO*, a dummy variable equal to one if the VC-backed firm went public within ten years after receiving the first round of VC financing and zero otherwise; (ii) *MA*, a dummy variable equal to one if the VC-backed firm was acquired by another company within ten years after receiving the first round of VC financing and zero otherwise; (iii) *Exit*, a dummy variable equal to one if the VC-backed firm either went public or was acquired by another company within ten years after receiving the first round of VC financing.[32] In my sample, 6.2% of the VC-backed firms exited through an IPO and 31.5% of them exited through an acquisition. Using the above three measures as the dependent variables, I conduct the following firm-level probit regressions:

$$\begin{aligned} Prob(Successful\ Exit) = \alpha + \beta_1 Replacement + \beta_2 Expansion + \beta_3 Subtraction \\ + \theta Ln(Innovation) + \gamma Z + Industry + \epsilon_i. \end{aligned} \tag{8}$$

In the above regression, *Replacement*, *Expansion*, and *Subtraction* are the measures of different types of top management changes at the firm level. Specifically, *Replacement* is a dummy variable equal to one if new managers were added and existing managers were removed across all the financing rounds and zero otherwise. *Expansion* is a dummy variable equal to one if new managers were added but no existing manager was ever removed from the top management team across all the financing rounds, and zero other wise. *Subtraction* is a dummy variable equal to one if existing

[32] I require an IPO or acquisition to occur within ten years after the first VC financing, since most VC funds typically have a limited life of ten years (although with the possibility of a few years' extension).

managers were removed but no new manager was ever added to the top management team, and zero otherwise. *Ln(Innovation)* is *Ln(Total Patents)* or *Ln(Total Citations)*, which are defined as the natural log of one plus the total adjusted number of patents filed by a firm and the natural log of one plus the total adjusted number of citations received by the patents filed by the firm up to the last financing round, respectively. Z is a set of control variables that may affect the exit outcome of VC-backed firms as suggested in the literature, which includes *Ln(Total VC Investment)* (the natural log of the total investment made by VCs), *Ln(Age Last Round)* (the natural log of a firm's age in the last VC financing round), and *VC Syndication* (a dummy variable equal to one if a firm receives VC funding from more than one VC firm at least for one financing round and zero otherwise). I also include industry fixed effects in the above regressions and use robust standard errors.

Table 12 reports the results for the above regressions. Columns (1)–(3) reports the effect of management changes and corporate innovation output on the probability of a VC-backed private firm going public within ten years of receiving the first VC financing round. The regression in Column (1) uses only the management change measures as the main explanatory variables. I find that the coefficient on *Replacement* is positive and significant at the 10% level, while the coefficients on *Expansion* and on *Subtraction* are all insignificant, suggesting that replacing managers with new blood has an important impact on the probability of a VC-backed private firm going public. In terms of economic magnitude, Column (1) suggests that firms experiencing replacement of managers is associated with 3.8% increase in the probability of IPO. In the regressions in Columns (2) and (3), I include the patent counts and patent citations as additional explanatory variables, respectively. I find that the both coefficients on patent counts and patent citations are positive and significant at the 1% level, indicating that corporate innovation has an important impact on the probability of an IPO, which is considered as a "gold standard" of venture success. Further, the coefficient on *Replacement* becomes insignificant once the innovation variables are included. These results suggest the positive effect of management changes on IPO is likely to be at least partly mediated through enhanced innovation output.

Columns (4)–(6) report regression results using *MA* as the dependent variables. In Column (4), I find that the coefficient on *Replacement* is positive and significant at the 1% level. In Columns (5) and (6), once the patent counts and patent citations are included in the regressions, patent

counts and patent citations remain significant determinants of the probability of VC-backed firms getting acquired, while the effect of replacing top managers becomes less significant and smaller in magnitude. Consistent with what I find in Columns (1)–(3), these findings suggest that the positive effect of management changes on the probability of a firm getting acquired at least partly mediated through corporate innovation. In Columns (7)–(9), I find that replacing managers with new blood is positively and significantly associated with the probability of a VC-backed firm's exit either through a IPO or an acquisitions. Again, when the innovation variables are included in the regressions, the coefficients on the *Replacement* become less significant and smaller in magnitude, suggesting that the effect of replacing top managers on a firm's successful exit is at least partly mediated through innovation. Collectively, these results support my hypothesis **H8**.

6 Robustness Tests

6.1 Robustness to Controlling for Industry-by-State-by-Year Fixed Effects

Since my IV analysis makes use of variation at the industry-by-state-by-year level, one concern may be that industry-by-state-by-year level omitted variables (e.g, technology shocks specific to some states) may affect both management changes and corporate innovation. To alleviate such concerns, I replace the industry and year fixed effects in the baseline model (regression (2)) by industry-by-state-by-year fixed effects and re-run these regressions. I report the results for these regressions in Table A1 of the Internet Appendix in order to conserve space. For all the regressions, I find that the positive effect of management changes on subsequent innovation remains positive and significant, even after controlling for the industry-by-state-by-year fixed effects. The economic magnitude remains significant as well: for example, three-year patent counts increase by 10.2% following management changes, and three-year patent citations increase by 12.9% following top management changes.

6.2 Placebo Test: The Effect of Top Management Changes on Corporate Innovation Generated Prior to Management Changes

To facilitate the causal interpretation of the positive relationship between top management changes and enhanced innovation in VC-backed private firms, I conduct a placebo test using a firm's corporate innovation output generated prior to management changes as the dependent variables in this

section. If enhanced innovation is indeed caused by management changes rather than unobservables such as a trend of technological development, I would expect that management changes to have a significant effect only on innovation generated after management changes, but not on that generated prior to management changes. To test these implications, I estimate the following model:

$$Innovation^{(-N)} = \alpha + \beta Mgmt\ Change_{i,t} + \gamma Z_{i,t} + Industry + Year + Stage + \epsilon_{i,t}, \qquad (9)$$

where $Innovation^{(-N)}$ includes $Patents^{(-N)}$ and $Cites^{(-N)}$, which are defined as the natural log of one plus the number of patents filed in the past N years prior to management changes and the natural log of one plus the total number of citations received by these patents, and N equals 1 or 2. The same set of control variables and fixed effects as in my baseline model (regression (2)) are included in the above models.

I present the results for the above placebo test in Table 13. For all the specifications, I find that top management changes do not have a significant impact on innovation generated prior to top management changes. To summarize, the above results for the placebo test suggest that the positive relation between management changes and enhanced innovation is unlikely to be driven by omitted variables such as a trend of technological development.

6.3 Placebo Test: The Effect of Pseudo Top Management Changes on Corporate Innovation

To further support the causal interpretation of the relationship between top management changes and subsequent corporate innovation, I also conduct a placebo analysis in which I randomly assign "pseudo" top management changes to certain firm-year observations. If the positive relationship between the *real* top management changes and subsequent corporate innovation is indeed causal, we should not expect a significant relationship between the *pseudo* management changes and subsequent innovation.

For this placebo test, I construct a dummy variable, *Mgmt Change Pseudo*, which is equal to one for 805 randomly selected firm-year observations and equal to zero for the rest of the observations in the sample. Note that, by construction, *Mgmt Change Pseudo* has the same statistical distribution as the variable indicating real top management changes, *Mgmt Change*. I use this pseudo management change variable as the main explanatory variable to re-run the baseline innovation

regressions as in regression (2). I conduct 500 replications and use the distribution of placebo coefficients to bootstrap the significance levels following Christeinsen, Hail, and Luiz (2016). The results of this placebo test are presented in Table 14. As expected, I find that the coefficients of *Pseudo Mgmt Change* are tiny and statistically insignificant for all the regressions, demonstrating the placebo effect of pseudo management changes on subsequent corporate innovation is close to zero. In sum, the results of this placebo test further support the causal relationship between real top management changes and corporate innovation.

6.4 Robustness to Controlling for Lead VC Firm Fixed Effects

Prior literature (e.g., Tian and Wang (2014)) has suggested that VC firm characteristics may affect its project selection ability or preferences and thus the characteristics and quality of the projects that it funded. To alleviate the concern that the relation between management changes and corporate innovation may be driven by VC firm characteristics (other than the time-varying VC reputation that I already included in all the regressions), I include lead VC firm fixed effects in my baseline models in this section. This helps to control for the effect of any unobservable and time-invariant VC characteristics. If the VC firm's project selection ability or preference (as reflected in the project quality) has a time-invariant component, then including lead VC firm fixed effects will mitigate this impact.

The results of this test are reported in Table A2 of the Internet Appendix due to space constraints. Consistent with my earlier results, the coefficients on management changes are significantly positive for most of the specifications, even after controlling for the lead VC firm fixed effects. This suggests that the positive relation between management changes and enhanced subsequent innovation is unlikely to be driven by the unobservable characteristics of VC firms such as project selection ability or preferences.

7 Conclusion

Using a unique hand-collected dataset on top management changes in VC-backed private firms, I analyze the effect of VC-driven top management changes on corporate innovation. This is the first paper to establish the causal link between top management changes as a specific action by VCs and product market innovations of their portfolio companies. My evidence suggests that VC-driven top management changes are associated with significantly more and higher quality corporate

innovation output in VC-backed private firms. Further, the effect of such management changes on innovation is stronger for firms in which VCs have more power. I also show that VCs help to enhance corporate innovation in their portfolio companies not only through founder replacements, but also through non-founder top management changes. These results are consistent with the existing studies suggesting that venture capitalists provide value-addition services beyond providing capital for their portfolio companies through active intervention in recruiting management. An IV analysis making use of a plausibly exogenous shock to the supply of outside managers shows that the above documented relation between top management changes and corporate innovation is causal.

My evidence also suggests that replacing existing managers with "new blood" has a positive and significant effect on enhancing innovation, while removing existing managers alone does not. Having established that, I use hand-collected information on educational background and employment history of each manager that was added or removed and find that adding senior manager who acquired general managerial skills (through working as a CEO/president at another company previously) has a positive and significant impact on innovation, while changing senior managers with a prior technical background does not have a significant impact on innovation. Further, I analyze the possible underlying mechanisms through which VC-driven top management changes may affect corporate innovation in VC-backed private firms and establish that one such mechanism is through new management teams hiring a greater number of inventors and scientists for a given investment size. Finally, I find that top management changes have a positive effect on the probability of a firm's successful exit and such an effect is at least partly through enhanced innovation.

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Table 1: Summary Statistics

This table reports the summary statistics for my sample of VC-backed private firms between 2002 and 2010. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; *Cites*$^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. *Management Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *Add Only* is a dummy variable equal to one if new managers were added to the management team for a firm-round and no existing managers were removed, and zero otherwise; *Remove Only* is a dummy variable equal to one if existing managers were removed from the management team for a firm-round but no new managers were added, and zero otherwise; *Replace* is a dummy variable equal to one if new managers were added to and existing managers were removed from a firm's management team as well for a firm-round observation, and zero otherwise. *VC Investment* is the VC investment amount (measured in thousands of U.S. dollars). *Syndicate Size* is the number of investing VCs. *Management Team Size* is the total number of managers on the top management team. *Outside Board Members* is the number of outside board members. *Firm Age* is the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year.

	N	Mean	S.D.	Min	P25	P50	P75	Max
Patents$^{(1)}$	2,234	0.270	0.510	0.000	0.000	0.000	0.429	3.427
Patents$^{(2)}$	2,234	0.431	0.686	0.000	0.000	0.000	0.693	4.031
Patents$^{(3)}$	2,234	0.533	0.795	0.000	0.000	0.000	0.924	4.383
Cites$^{(1)}$	2,234	0.287	0.664	0.000	0.000	0.000	0.000	3.856
Cites$^{(2)}$	2,234	0.440	0.863	0.000	0.000	0.000	0.417	4.522
Cites$^{(3)}$	2,234	0.533	0.978	0.000	0.000	0.000	0.693	4.785
Mgmt Change	2,234	0.360	0.480	0.000	0.000	0.000	1.000	1.000
Replace	2,234	0.159	0.366	0.000	0.000	0.000	0.000	1.000
Add Only	2,234	0.121	0.327	0.000	0.000	0.000	0.000	1.000
Remove Only	2,234	0.080	0.271	0.000	0.000	0.000	0.000	1.000
VC Investment (in 000s)	2,234	9483.332	15267.64	15.000	2470.000	5733.000	11500.000	277620.000
Syndicate Size	2,234	3.324	2.050	1.000	2.000	3.000	4.000	22.000
Management Team Size	2,234	2.636	1.623	1.000	2.000	2.000	3.000	18.000
Outside Board Members	2,234	3.382	1.750	0.000	2.000	3.000	4.000	10.000
Firm Age	2,107	3.579	3.160	0.000	1.000	3.000	5.000	26.000
VC Rep (in %)	2,234	0.195	0.515	0.000	0.000	0.000	0.201	4.557

Table 2: The Effect of VC Power on the Probability of Top Management Changes

This table reports the probit regression results of the probability of top management changes on measures for VC power. The sample used for these tests includes firm-financing round observations from 2002 to 2010. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *VC Power* is the natural log of one plus the number of outside board members. *VC Power (Alternative Measure)* is the number of outside board members divided by the total number of board members. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the firm's age in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

	(1)	(2)
VARIABLES	Mgmt Change	Mgmt Change
VC Power	0.723***	
	(0.151)	
VC Power (Alternative Measure)		1.566***
		(0.293)
Ln(VC Investment)	-0.020	-0.014
	(0.037)	(0.037)
Ln(Syndicate Size)	0.094*	0.150***
	(0.057)	(0.056)
Ln(Mgmt Team Size)	0.775***	0.900***
	(0.074)	(0.082)
Ln(Firm Age)	0.247***	0.264***
	(0.052)	(0.048)
VC Rep	-0.147***	-0.163***
	(0.056)	(0.055)
Observations	2,033	2,021
Pseudo R-squared	0.252	0.249
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stage FE	Yes	Yes

Table 3: The Effect of Top Management Changes on Corporate Innovation (Baseline Results)

This table reports the OLS regression results of corporate innovation on top management changes. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; *Cites*$^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects (defined at the 2-digit SIC code level), financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Mgmt Change	0.049**	0.044**	0.056**	0.041	0.068**	0.092**
	(0.023)	(0.021)	(0.025)	(0.030)	(0.031)	(0.043)
Ln(VC Investment)	0.091***	0.118***	0.138***	0.115***	0.147***	0.156***
	(0.024)	(0.027)	(0.032)	(0.030)	(0.030)	(0.034)
Ln(Syndicate Size)	0.021	0.036	0.046*	0.021	0.027	0.038*
	(0.019)	(0.023)	(0.027)	(0.023)	(0.020)	(0.021)
Ln(Mgmt Team Size)	0.021	0.030	0.021	-0.009	-0.012	-0.017
	(0.039)	(0.050)	(0.057)	(0.054)	(0.058)	(0.060)
Ln(Firm Age)	-0.017	-0.021	-0.033	-0.036	-0.041	-0.057*
	(0.021)	(0.030)	(0.035)	(0.024)	(0.029)	(0.032)
VC Rep	0.007	0.007	0.002	-0.003	0.003	0.004
	(0.025)	(0.035)	(0.039)	(0.039)	(0.053)	(0.060)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.205	0.231	0.238	0.160	0.175	0.178
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: The Effect of Top Management Changes on Corporate Innovation for Firms with Different VC Power

This table reports the OLS regression results of corporate innovation on the interaction between top management changes and a dummy variable for greater VC power. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; *Cites*$^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *High VC Power* is a dummy variable equal to one if the number of outside board members is above the sample median and zero otherwise. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Mgmt Change× High VC Power	0.127***	0.171***	0.223***	0.190**	0.225*	0.316**
	(0.035)	(0.061)	(0.073)	(0.084)	(0.122)	(0.139)
Mgmt Change	-0.053	-0.093*	-0.124**	-0.108	-0.111	-0.161*
	(0.034)	(0.052)	(0.052)	(0.069)	(0.091)	(0.081)
High VC Power	-0.043	-0.061	-0.064	-0.089	-0.090	-0.111
	(0.037)	(0.065)	(0.075)	(0.059)	(0.085)	(0.094)
Ln(VC Investment)	0.092***	0.120***	0.140***	0.118***	0.149***	0.159***
	(0.024)	(0.028)	(0.033)	(0.032)	(0.032)	(0.036)
Ln(Syndicate Size)	0.022	0.037	0.045*	0.026	0.030	0.040**
	(0.021)	(0.024)	(0.027)	(0.022)	(0.019)	(0.019)
Ln(Mgmt Team Size)	0.022	0.032	0.024	-0.008	-0.010	-0.015
	(0.038)	(0.050)	(0.057)	(0.053)	(0.058)	(0.061)
Ln(Firm Age)	-0.013	-0.015	-0.026	-0.026	-0.031	-0.045
	(0.021)	(0.030)	(0.036)	(0.021)	(0.027)	(0.029)
VC Rep	0.006	0.006	0.001	-0.005	0.001	0.002
	(0.023)	(0.032)	(0.036)	(0.038)	(0.051)	(0.057)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.206	0.232	0.239	0.162	0.177	0.181
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: The Effect of Top Management Changes on Corporate Innovation: Instrumental Variable Analysis

Panel A of this table reports the Instrumental Variable (IV/2SLS) regression results of corporate innovation on top management changes. The instrumental variable used is the number of acquisitions made by public firms in the same industry and in the same state as the VC-backed firm interacted by an index measuring the enforceability of non-compete clauses in that state. Column (1) reports the first-stage probit regression result, i.e., regressing the probability of top management changes on the instrumental variable and other controls. Columns (2)–(7) report the second-stage results of the IV regressions using the cumulative number of patents that are filed in the next one, two, and three years and total number of citations received by these patents as the dependent variables. Panel B reports the second-stage results of the IV regressions for the relation between top management changes, VC power, and corporate innovation. All variables are defined as in Table 3 Intercept, industry by year fixed effects, state by year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

Panel A: The Effect of Top Management Changes on Corporate Innovation (2SLS Results)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Mgmt Change	Patents$^{(1)}$	Patents$^{(2)}$	Patents$^{(3)}$	Cites$^{(1)}$	Cites$^{(2)}$	Cites$^{(3)}$
Instrument	0.129***						
	(0.049)						
Mgmt Change		0.073	0.254**	0.302**	0.177	0.436***	0.434**
		(0.130)	(0.113)	(0.128)	(0.149)	(0.129)	(0.189)
Ln(VC Investment)	-0.064	0.086***	0.119***	0.141***	0.108***	0.147***	0.153***
	(0.050)	(0.019)	(0.023)	(0.029)	(0.026)	(0.023)	(0.028)
Ln(Syndicate Size)	0.105	0.050*	0.068*	0.078**	0.063*	0.065	0.073
	(0.086)	(0.029)	(0.039)	(0.040)	(0.036)	(0.049)	(0.047)
Ln(Mgmt Team Size)	0.921***	0.046	0.025	0.010	-0.009	-0.040	-0.036
	(0.082)	(0.045)	(0.051)	(0.057)	(0.051)	(0.048)	(0.047)
VC Power	0.973***	0.004	-0.060	-0.052	-0.050	-0.126**	-0.089
	(0.170)	(0.043)	(0.044)	(0.057)	(0.060)	(0.059)	(0.075)
Ln(Firm Age)	-0.413***	-0.029	-0.011	-0.020	-0.044	-0.029	-0.057*
	(0.054)	(0.025)	(0.024)	(0.025)	(0.027)	(0.025)	(0.030)
VC Rep	-0.074*	-0.020*	-0.029**	-0.038**	-0.011	-0.010	-0.018
	(0.043)	(0.012)	(0.013)	(0.018)	(0.016)	(0.025)	(0.031)
Observations	1,581	1,365	1,365	1,365	1,365	1,365	1,365
Pseudo R-squared	0.303						
Industry by Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State by Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: The Effect of Top Management Changes on Corporate Innovation for Firms with Different VC Power (2SLS Results)

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Mgmt Change × High VC Power	0.286*	0.508***	0.523***	0.487***	0.653***	0.676***
	(0.161)	(0.129)	(0.127)	(0.137)	(0.172)	(0.158)
Mgmt Change	0.027	0.023	0.107	-0.174	0.060	0.121
	(0.120)	(0.131)	(0.149)	(0.119)	(0.153)	(0.141)
High VC Power	-0.056	-0.071	-0.061	-0.157	-0.142	-0.168
	(0.073)	(0.119)	(0.129)	(0.098)	(0.134)	(0.142)
Ln(VC Investment)	0.085***	0.109***	0.118***	0.099**	0.131***	0.121**
	(0.023)	(0.029)	(0.033)	(0.040)	(0.049)	(0.053)
Ln(Syndicate Size)	-0.014	-0.023	-0.025	-0.014	-0.032	-0.030
	(0.026)	(0.043)	(0.052)	(0.019)	(0.041)	(0.052)
Ln(Mgmt Team Size)	0.075	0.080	0.057	0.050	0.009	-0.013
	(0.062)	(0.069)	(0.072)	(0.070)	(0.093)	(0.069)
VC Power	0.021	-0.020	-0.048	0.061	-0.054	-0.031
	(0.061)	(0.095)	(0.102)	(0.073)	(0.094)	(0.121)
Ln(Firm Age)	-0.003	-0.001	-0.002	-0.035	-0.014	-0.035
	(0.028)	(0.039)	(0.037)	(0.042)	(0.047)	(0.052)
VC Rep	-0.605**	-0.891**	-1.049**	-0.869**	-1.323***	-1.576***
	(0.290)	(0.383)	(0.443)	(0.415)	(0.490)	(0.502)
Observations	1,365	1,365	1,365	1,365	1,365	1,365
Industry by Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State by Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: The Effect of Founder Replacement versus Non-Founder Top Management Changes on Corporate Innovation

This table reports the effect of founder replacements versus that of non-founder top management changes on subsequent corporate innovation. *Founder Replacement* is a dummy variable equal to one for a firm-financing round if a founder of the firm was removed. *Non-Founder Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team, which did not involve any founder removal. $Patents^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; $Patents^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; $Patents^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; $Cites^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; $Cites^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; $Cites^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. All other variables are defined in detail in Table 3. Intercept, industry fixed effects (defined at the 2-digit SIC code level), financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) $Patents^{(1)}$	(2) $Patents^{(2)}$	(3) $Patents^{(3)}$	(4) $Cites^{(1)}$	(5) $Cites^{(2)}$	(6) $Cites^{(3)}$
Founder Replacement	0.126**	0.114	0.122*	0.149**	0.189*	0.219**
	(0.049)	(0.073)	(0.071)	(0.073)	(0.094)	(0.089)
Non-founder Change	0.054**	0.057**	0.068**	0.038	0.072**	0.091*
	(0.025)	(0.022)	(0.031)	(0.030)	(0.032)	(0.051)
Ln(VC Investment)	0.086***	0.113***	0.132***	0.107***	0.137***	0.144***
	(0.022)	(0.025)	(0.029)	(0.027)	(0.025)	(0.027)
Ln(Syndicate Size)	0.022	0.041	0.054*	0.026	0.034	0.043*
	(0.021)	(0.025)	(0.029)	(0.025)	(0.021)	(0.022)
Ln(Mgmt Team Size)	0.034*	0.034	0.030	0.017	-0.000	0.008
	(0.020)	(0.029)	(0.034)	(0.030)	(0.036)	(0.037)
Ln(Firm Age)	-0.020	-0.022	-0.035	-0.038	-0.040	-0.058*
	(0.022)	(0.032)	(0.037)	(0.023)	(0.029)	(0.032)
VC Rep	0.013	0.018	0.017	0.025	0.037	0.049
	(0.038)	(0.048)	(0.054)	(0.045)	(0.061)	(0.071)
Observations	1,725	1,725	1,725	1,725	1,725	1,725
Adjusted R-squared	0.211	0.235	0.242	0.163	0.177	0.180
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: The Effect of Non-Founder Top Management Changes on Corporate Innovation

The sample used for the tests in this table includes firm-financing round observations of firms that have not experienced any founder replacement. Panel A reports the OLS regression results of corporate innovation on non-founder top management changes. Panel B reports the OLS regression results of corporate innovation on the interaction between non-founder top management changes and a dummy variable for greater VC power. The main explanatory variable *Non-Founder Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise for the sample of firms that have never experienced any founder replacement. $Patents^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; $Patents^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; $Patents^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; $Cites^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; $Cites^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; $Cites^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. All other variables are defined in detail in Table 3. Intercept, industry fixed effects (defined at the 2-digit SIC code level), financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

Panel A: The Effect of Non-Founder Top Management Changes on Innovation

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Non-founder Change	0.049*	0.062**	0.077**	0.027	0.084*	0.103**
	(0.026)	(0.029)	(0.033)	(0.039)	(0.043)	(0.050)
Ln(VC Investment)	0.084***	0.111***	0.130***	0.114***	0.144***	0.152***
	(0.025)	(0.030)	(0.033)	(0.034)	(0.038)	(0.040)
Ln(Syndicate Size)	0.034	0.049*	0.068**	0.038*	0.052*	0.074**
	(0.021)	(0.025)	(0.030)	(0.021)	(0.030)	(0.029)
Ln(Mgmt Team Size)	0.032	0.022	0.015	-0.016	-0.043	-0.048
	(0.026)	(0.051)	(0.058)	(0.061)	(0.065)	(0.071)
Ln(Firm Age)	-0.017	-0.016	-0.021	-0.028	-0.027	-0.034
	(0.023)	(0.032)	(0.042)	(0.020)	(0.026)	(0.035)
VC Rep	0.002	0.008	-0.001	-0.018	-0.021	-0.027
	(0.029)	(0.040)	(0.040)	(0.049)	(0.068)	(0.072)
Observations	1,441	1,441	1,441	1,441	1,441	1,441
Adjusted R-squared	0.190	0.214	0.221	0.154	0.167	0.173
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: The Effect of Non-Founder Top Management Changes on Innovation in Firms with Different VC Power

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Non-founder Change × High Power	0.094***	0.129***	0.178***	0.151**	0.171***	0.227***
	(0.031)	(0.034)	(0.043)	(0.057)	(0.056)	(0.070)
Non-founder Change	-0.030	-0.041	-0.066	-0.091*	-0.051	-0.078
	(0.025)	(0.036)	(0.041)	(0.050)	(0.059)	(0.052)
High Power	-0.040	-0.054	-0.059	-0.079*	-0.072	-0.087
	(0.030)	(0.052)	(0.057)	(0.047)	(0.063)	(0.064)
Ln(VC Investment)	0.087***	0.113***	0.132***	0.117***	0.147***	0.155***
	(0.026)	(0.031)	(0.034)	(0.036)	(0.039)	(0.042)
Ln(Syndicate Size)	0.037*	0.052**	0.071**	0.044*	0.057*	0.079**
	(0.022)	(0.025)	(0.031)	(0.022)	(0.031)	(0.029)
Ln(Mgmt Team Size)	0.026	0.023	0.017	-0.015	-0.042	-0.046
	(0.041)	(0.051)	(0.058)	(0.059)	(0.064)	(0.070)
Ln(Firm Age)	-0.011	-0.010	-0.015	-0.020	-0.019	-0.025
	(0.023)	(0.035)	(0.046)	(0.021)	(0.029)	(0.038)
VC Rep	0.001	0.006	-0.002	-0.020	-0.023	-0.030
	(0.028)	(0.038)	(0.038)	(0.048)	(0.066)	(0.070)
Observations	1,441	1,441	1,441	1,441	1,441	1,441
Adjusted R-squared	0.190	0.215	0.222	0.156	0.167	0.174
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: The Effect of Different Types of Management Changes on Corporate Innovation

This table reports the OLS regression results of corporate innovation on measures of different types of top management changes. *Add Only* is a dummy variable equal to one if new managers were added to the management team for a firm-round and no existing managers were removed, and zero otherwise; *Remove Only* is a dummy variable equal to one if existing managers were removed from the management team for a firm-round but no new managers were added, and zero otherwise; *Replace* is a dummy variable equal to one if new managers were added to and existing managers were removed from a firm's management team as well for a firm-round observation, and zero otherwise. *Frac(Added+Removed)|Replace* is equal to the fraction of managers added (joiners) and those removed (leavers) if new managers were added and existing managers were removed as well (i.e., there was a replacement) for a firm-round observation, and zero otherwise. *Frac(Added)|Add Only* is equal to the fraction of managers added (joiners) if only new managers were added and no existing managers were removed for a firm-round observation, and zero otherwise. *Frac(Removed)|Remove Only* is equal to the fraction of managers removed (leavers) if only existing managers were removed and no new managers were added for a firm-round observation, and zero otherwise. *Ln(Added+Removed)|Replace* is equal to the natural log of one plus the number of managers added (joiners) and those removed (leavers) if new managers were added and existing managers were removed as well (i.e., there was a replacement) for a firm-round observation, and zero otherwise (i.e., if no replacement occurred for the firm-round observation). *Ln(Added)|Add Only* is equal to the natural log of one plus the number of managers added (joiners) if only new managers were added and no existing managers were removed for a firm-round observation, and zero otherwise. *Ln(Removed)|Remove Only* is equal to the natural log of one plus the number of managers removed (leavers) if only existing managers were removed and no new managers were added for a firm-round observation, and zero otherwise. All other variables are defined in detail in Table 3. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

Panel A: The Effect of Replacing, Adding, and Removing Managers on Innovation

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Patents$^{(1)}$	Patents$^{(2)}$	Patents$^{(3)}$	Cites$^{(1)}$	Cites$^{(2)}$	Cites$^{(3)}$
Replace	0.057***	0.054***	0.070*	0.081***	0.129**	0.167*
	(0.016)	(0.018)	(0.037)	(0.028)	(0.055)	(0.088)
Add Only	0.040	0.060	0.070	0.022	0.081	0.097
	(0.050)	(0.050)	(0.061)	(0.072)	(0.089)	(0.090)
Remove Only	0.048	0.007	0.016	0.007	-0.040	-0.026
	(0.036)	(0.038)	(0.029)	(0.033)	(0.033)	(0.020)
Ln(VC Investment)	0.091***	0.118***	0.139***	0.116***	0.148***	0.158***
	(0.024)	(0.027)	(0.032)	(0.030)	(0.031)	(0.034)
Ln(Syndicate Size)	0.021	0.036	0.045	0.021	0.026	0.037*
	(0.019)	(0.023)	(0.027)	(0.023)	(0.020)	(0.021)
Ln(Mgmt Team Size)	0.021	0.020	0.010	-0.015	-0.039	-0.045
	(0.041)	(0.054)	(0.064)	(0.062)	(0.069)	(0.073)
Ln(Firm Age)	-0.018	-0.021	-0.033	-0.037	-0.041	-0.058*
	(0.020)	(0.030)	(0.035)	(0.023)	(0.029)	(0.031)
VC Rep	0.007	0.007	0.002	-0.003	0.003	0.005
	(0.025)	(0.035)	(0.039)	(0.039)	(0.053)	(0.060)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.204	0.230	0.237	0.160	0.176	0.179
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: The Effect of Different Types of Management Changes on Innovation Using Alternative Measures: Fraction of Managers Changed

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Frac(Added+Removed)|Replace	0.029**	0.026**	0.027**	0.028	0.041**	0.054*
	(0.012)	(0.011)	(0.011)	(0.021)	(0.019)	(0.029)
Frac(Added)|Add Only	0.001	-0.001	-0.008	-0.002	0.014	0.019
	(0.013)	(0.020)	(0.024)	(0.017)	(0.030)	(0.027)
Frac(Removed)|Remove Only	0.035	-0.030	-0.014	-0.002	-0.068	-0.037
	(0.090)	(0.113)	(0.104)	(0.100)	(0.124)	(0.109)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.253	0.301	0.314	0.203	0.239	0.252
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel C: The Effect of Different Types of Management Changes on Innovation Using Alternative Measures: Logged Number of Managers Changed

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Ln(Added+Removed)|Replace	0.026**	0.016	0.018	0.036**	0.047**	0.056**
	(0.011)	(0.013)	(0.014)	(0.018)	(0.019)	(0.026)
Ln(Added)|Add Only	0.012	0.011	0.005	-0.016	0.004	0.005
	(0.025)	(0.033)	(0.040)	(0.036)	(0.063)	(0.053)
Ln(Removed)|Remove Only	0.010	-0.020	-0.010	0.000	-0.032	-0.024
	(0.050)	(0.061)	(0.052)	(0.060)	(0.074)	(0.060)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.253	0.301	0.313	0.203	0.239	0.252
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: The Effect of Adding and Removing Managers on Corporate Innovation for Firms with Different VC Power

This table reports the OLS regression results of corporate innovation on the interaction between measures for different types of top management changes and a dummy variable for greater VC power. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$ is the natural log of one plus the adjusted number of citations received by patents filed over the next two years; *Cites*$^{(3)}$ is the natural log of one plus the adjusted number of citations received by patents filed over the next three years. *High VC Power* is a dummy variable equal to one if the number of outside board members is above the sample median and zero otherwise. *Replace* is a dummy variable equal to one if new managers were added to and existing managers were removed from a firm's management team as well for a firm-round observation, and zero otherwise; *Add Only* is a dummy variable equal to one if new managers were added to the management team for a firm-round and no existing managers were removed, and zero otherwise; *Remove Only* is a dummy variable equal to one if existing managers were removed from the management team for a firm-round but no new managers were added, and zero otherwise. All other variables are defined as in Table 3. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Replace×High VC Power	0.171*	0.290**	0.401**	0.253	0.431*	0.597**
	(0.087)	(0.133)	(0.161)	(0.157)	(0.222)	(0.248)
Add Only×High VC Power	0.121**	0.126	0.143	0.230**	0.173	0.206
	(0.054)	(0.081)	(0.093)	(0.094)	(0.143)	(0.163)
Remove Only×High VC Power	0.057	0.055	0.071	-0.016	-0.045	0.022
	(0.114)	(0.139)	(0.195)	(0.164)	(0.215)	(0.243)
Replace	-0.085	-0.191*	-0.271**	-0.128	-0.235	-0.338**
	(0.074)	(0.110)	(0.122)	(0.130)	(0.164)	(0.161)
Add Only	-0.054	-0.035	-0.036	-0.156	-0.048	-0.055
	(0.065)	(0.089)	(0.111)	(0.095)	(0.145)	(0.149)
Remove Only	0.007	-0.028	-0.031	0.038	0.018	-0.021
	(0.090)	(0.123)	(0.178)	(0.150)	(0.200)	(0.227)
High VC Power	-0.043	-0.062	-0.065	-0.088	-0.090	-0.111
	(0.037)	(0.065)	(0.075)	(0.059)	(0.084)	(0.094)
Ln(VC Investment)	0.092***	0.120***	0.140***	0.119***	0.150***	0.160***
	(0.024)	(0.028)	(0.033)	(0.032)	(0.032)	(0.036)
Ln(Syndicate Size)	0.022	0.037	0.045	0.025	0.028	0.039*
	(0.021)	(0.024)	(0.027)	(0.022)	(0.019)	(0.019)
Ln(Mgmt Team Size)	0.023	0.021	0.013	-0.013	-0.036	-0.042
	(0.041)	(0.055)	(0.065)	(0.062)	(0.070)	(0.075)
Ln(Firm Age)	-0.013	-0.014	-0.025	-0.027	-0.031	-0.045
	(0.020)	(0.030)	(0.035)	(0.020)	(0.025)	(0.027)
VC Rep	0.006	0.006	0.001	-0.006	0.001	0.002
	(0.023)	(0.032)	(0.036)	(0.037)	(0.051)	(0.056)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.205	0.231	0.239	0.162	0.178	0.182
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: The Effect of Management Team Background on Corporate Innovation

This table reports the effects of managers' backgrounds (having worked as a CEO/president before versus having a technical background) on corporate innovation. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$ is the natural log of one plus the adjusted number of citations received by patents filed over the next two years; *Cites*$^{(3)}$ is the natural log of one plus the adjusted number of citations received by patents filed over the next three years. *Ln(Seasoned CEOs Added)* is the natural log of one plus the number of managers added to the firm's management team, who have previously worked as CEOs or presidents in other companies. *Ln(Seasoned CEOs Removed)* is the natural log of one plus the number of managers removed from the firm's management team, who have previously worked as CEOs or presidents in other companies. *Ln(Tech Mgrs Added)* is the natural log of one plus the number of managers added to the firm's management team, who had a prior technical background. *Ln(Tech Mgrs Removed)* is the natural log of one plus the number of managers removed from the firm's management team, who had a prior technical background. All other variables are defined in detail in Table 3. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Ln(Seasoned CEOs Added)	0.199***	0.218***	0.243***	0.248***	0.276***	0.305***
	(0.063)	(0.066)	(0.047)	(0.086)	(0.092)	(0.084)
Ln(Seasoned CEOs Removed)	0.068	0.020	0.030	0.067	0.030	0.098
	(0.081)	(0.111)	(0.140)	(0.085)	(0.103)	(0.135)
Ln(Tech Mrgs Added)	-0.054	-0.033	-0.049	-0.118	-0.032	-0.051
	(0.062)	(0.060)	(0.069)	(0.084)	(0.106)	(0.110)
Ln(Tech Mrgs Removed)	0.061	0.062	0.088	0.116	0.150	0.194
	(0.089)	(0.129)	(0.140)	(0.085)	(0.136)	(0.169)
Ln(VC Investment)	0.090***	0.118***	0.138***	0.115***	0.147***	0.156***
	(0.025)	(0.028)	(0.032)	(0.031)	(0.031)	(0.035)
Ln(Syndicate Size)	0.021	0.034	0.045*	0.019	0.024	0.036*
	(0.018)	(0.023)	(0.026)	(0.022)	(0.019)	(0.020)
Ln(Mgmt Team Size)	0.025	0.024	0.018	0.003	-0.014	-0.012
	(0.022)	(0.032)	(0.039)	(0.033)	(0.041)	(0.043)
Ln(Firm Age)	-0.019	-0.022	-0.034	-0.039*	-0.042	-0.059*
	(0.020)	(0.030)	(0.034)	(0.022)	(0.030)	(0.032)
VC Rep	0.005	0.004	-0.001	-0.006	0.000	0.001
	(0.025)	(0.035)	(0.039)	(0.042)	(0.055)	(0.061)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.209	0.232	0.239	0.165	0.177	0.181
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 11: The Effect of Top Management Changes on Inventor Mobility

Panel A of this table reports the effect of top management changes on the net inflow of mobile inventors in the subsequent one, two, and three years. Panel B reports the effect of top management changes and VC power on the net inflow of mobile inventors in the subsequent one, two, and three years. *Net Inflow*$^{(N)}$ is defined as the difference between the natural log of one plus the total number of inventors that move into the firm and the natural log of one plus the total number of inventors that move out of the firm in the next N years following management changes, where N equals 1, 2, or 3. *High VC Power* is a dummy variable equal to one if the number of outside board members is above the sample median and zero otherwise. All other variables are defined in detail in Table 3. Intercept, industry fixed effects, financing year fixed effects, startup development stage fixed effects, and state of the headquarters fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

Panel A: The Effect of Top Management Changes on the Net Inflow of Mobile Inventors

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Net Inflow$^{(1)}$	Net Inflow$^{(2)}$	Net Inflow$^{(3)}$	Net Inflow$^{(1)}$	Net Inflow$^{(2)}$	Net Inflow$^{(3)}$
Mgmt Change	0.021	0.038***	0.046***			
	(0.020)	(0.012)	(0.014)			
Replace				0.049*	0.071**	0.086**
				(0.026)	(0.034)	(0.039)
Add Only				0.004	0.034	0.039
				(0.024)	(0.023)	(0.025)
Remove Only				-0.002	-0.013	-0.015
				(0.053)	(0.051)	(0.054)
Ln(VC Investment)	0.035**	0.053***	0.054***	0.035**	0.054***	0.055***
	(0.014)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)
Ln(Syndicate Size)	0.014	-0.014	-0.017	0.013	-0.015	-0.018
	(0.025)	(0.041)	(0.044)	(0.025)	(0.041)	(0.044)
Ln(Mgmt Team Size)	0.016	0.028	0.043	0.014	0.030	0.045
	(0.022)	(0.028)	(0.041)	(0.025)	(0.031)	(0.044)
Ln(Firm Age)	-0.070***	-0.068***	-0.085***	-0.071***	-0.069***	-0.086***
	(0.019)	(0.024)	(0.030)	(0.019)	(0.024)	(0.030)
VC Rep	0.023**	0.024	0.018	0.023**	0.024	0.018
	(0.010)	(0.031)	(0.029)	(0.011)	(0.031)	(0.030)
Observations	1,151	1,151	1,151	1,151	1,151	1,151
Adjusted R-squared	0.120	0.160	0.175	0.120	0.160	0.175
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: The Effect of Top Management Changes and VC Power on the Net Inflow of Mobile Inventors

VARIABLES	(1) Net Inflow$^{(1)}$	(2) Net Inflow$^{(2)}$	(3) Net Inflow$^{(3)}$
Mgmt Change×High VC Power	0.090**	0.128***	0.123**
	(0.035)	(0.046)	(0.049)
Mgmt Change	-0.051	-0.062	-0.052
	(0.033)	(0.039)	(0.047)
High VC Power	-0.039	-0.071*	-0.076*
	(0.025)	(0.039)	(0.039)
Ln(VC Investment)	0.036**	0.056***	0.058***
	(0.015)	(0.015)	(0.014)
Ln(Syndicate Size)	0.017	-0.006	-0.008
	(0.023)	(0.040)	(0.043)
Ln(Mgmt Team Size)	0.012	0.024	0.040
	(0.035)	(0.042)	(0.055)
Ln(Firm Age)	-0.065***	-0.059***	-0.075***
	(0.017)	(0.021)	(0.027)
VC Rep	0.023**	0.025	0.018
	(0.011)	(0.031)	(0.030)
Observations	1,151	1,151	1,151
Adjusted R-squared	0.121	0.163	0.176
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes

Table 12: The Effect of Top Management Changes and Corporate Innovation on the Successful Exit of VC-Backed Private Firms

This table reports the firm-level probit regression results of the probability of the successful exit of VC-backed firms on top management changes and corporate innovation output generated up to the last financing round. *IPO* is a dummy variable equal to one if the firm exited via an initial public offering within ten years of the first financing round and zero otherwise. *MA* is a dummy variable equal to one if the VC-backed firm exited via an acquisition within ten years of the first financing round and zero otherwise. *Exit* is a dummy variable equal to one if the VC-backed firm exited via either an initial public offering or an acquisition within ten years of the first financing round and zero otherwise. *Replacement* is a dummy variable equal to one if new managers were added to and existing managers were removed from a firm's management team across all financing rounds, and zero otherwise; *Expansion* is a dummy variable equal to one if new managers were added to the management team but no existing managers were ever removed across financing rounds, and zero otherwise; *Subtraction* is a dummy variable equal to one if existing managers were removed from the management team but no new managers were ever added across all financing rounds, and zero otherwise. *Ln(Total Patents)* is the natural log of one plus the total number of patents filed by the VC-backed firm up to the last financing round. *Ln(Total Citations)* is the natural log of one plus the adjusted total number of citations received by all the patents filed by the VC-backed firms up to the last financing round. *Ln(Total VC Investment)* is the natural log of the total VC investment amount. *Ln(Age Last Round)* is the natural log of the age of the firm in the last VC financing round. *VC Syndication* is a dummy variable equal to one if a firm is backed by more than one VC firm in any financing round and zero otherwise. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008). Intercept and industry fixed effects are included in all regressions. Robust standard errors are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) IPO	(2) IPO	(3) IPO	(4) MA	(5) MA	(6) MA	(7) Exit	(8) Exit	(9) Exit
Replacement	0.299*	0.239	0.225	0.248**	0.221*	0.220*	0.284***	0.239**	0.235**
	(0.175)	(0.183)	(0.184)	(0.112)	(0.113)	(0.113)	(0.110)	(0.111)	(0.111)
Expansion	0.218	0.167	0.175	0.039	0.027	0.027	0.105	0.088	0.086
	(0.206)	(0.210)	(0.209)	(0.139)	(0.140)	(0.140)	(0.135)	(0.137)	(0.137)
Subtraction	-0.050	-0.118	-0.150	0.141	0.130	0.124	0.150	0.131	0.120
	(0.271)	(0.267)	(0.271)	(0.168)	(0.169)	(0.169)	(0.164)	(0.166)	(0.166)
Ln(Total Patents)		0.292***			0.107*			0.181***	
		(0.083)			(0.058)			(0.057)	
Ln(Total Citations)			0.242***			0.082*			0.145***
			(0.068)			(0.047)			(0.047)
Ln(Total VC Investment)	0.215***	0.193**	0.204***	0.127***	0.117***	0.119***	0.189***	0.172***	0.176***
	(0.074)	(0.077)	(0.076)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
Ln (Age Last Round)	0.004	0.002	0.005	-0.011	-0.018	-0.016	-0.015	-0.026	-0.024
	(0.094)	(0.098)	(0.097)	(0.065)	(0.065)	(0.065)	(0.063)	(0.063)	(0.063)
VC Syndication	0.222	0.210	0.185	0.531**	0.525**	0.517**	0.502**	0.490**	0.478**
	(0.463)	(0.466)	(0.467)	(0.212)	(0.210)	(0.211)	(0.208)	(0.203)	(0.205)
VC Rep	-0.003	-0.010	-0.038	0.021	0.015	0.015	-0.030	-0.040	-0.042
	(0.144)	(0.145)	(0.144)	(0.100)	(0.099)	(0.099)	(0.099)	(0.098)	(0.097)
Observations	730	730	730	835	835	835	838	838	838
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.110	0.142	0.145	0.0621	0.0655	0.0651	0.0595	0.0690	0.0687

Table 13: Placebo Test: The Effect of Top Management Changes on Corporate Innovation Generated Prior to Top Management Changes

This table reports the OLS regression results of corporate innovation generated over the past one or two years on top management changes. The sample used for these tests include firm-financing round observations between 2002 and 2010. $Patents^{(-1)}$ is the natural log of one plus the adjusted number of patents filed in the year prior to the year in which management changes are measured; $Patents^{(-2)}$ is the natural log of one plus the adjusted number of patents filed in the two years prior to the year in which management changes are measured; $Cites^{(-1)}$ is the natural log of one plus the adjusted number of citations received by patents filed in the year prior to management changes; $Cites^{(-2)}$ is the natural log of one plus the adjusted number of citations received by patents filed in the past two years prior to management changes. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(-1)}$	(2) Patents$^{(-2)}$	(3) Cites$^{(-1)}$	(4) Cites$^{(-2)}$
Mgmt Change	0.021	0.028	0.010	0.037
	(0.025)	(0.027)	(0.023)	(0.033)
Ln(VC Investment)	0.064***	0.084***	0.081***	0.102***
	(0.011)	(0.013)	(0.015)	(0.018)
Ln(Syndicate Size)	0.046**	0.069***	0.072***	0.094***
	(0.017)	(0.021)	(0.025)	(0.027)
Ln(Mgmt Team Size)	0.020	0.016	0.014	0.012
	(0.030)	(0.040)	(0.056)	(0.072)
Ln(Firm Age)	0.056***	0.115***	0.064***	0.133***
	(0.017)	(0.025)	(0.021)	(0.027)
VC Rep	-0.003	0.011	-0.024	-0.014
	(0.022)	(0.033)	(0.032)	(0.040)
Observations	2,050	2,050	2,050	2,050
Adjusted R-squared	0.176	0.245	0.142	0.211
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes

Table 14: Placebo Test: The Effect of Pseudo Top Management Changes on Corporate Innovation

This table reports the OLS regression results of corporate innovation on pseudo top management changes that are randomly assigned to firm-year observations. *Mgmt Change Pseudo* is a dummy variable equal to one for certain randomly assigned to firm-year observations and zero for other firm-year observations. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; *Cites*$^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Mgmt Change Pseudo	-0.004	0.033	-0.031	0.021	-0.041	0.009
	(0.023)	(0.030)	(0.038)	(0.031)	(0.041)	(0.043)
Ln(VC Investment)	0.083***	0.111***	0.130***	0.105***	0.139***	0.147***
	(0.012)	(0.014)	(0.015)	(0.014)	(0.018)	(0.022)
Ln(Syndicate Size)	0.031	0.046	0.057	0.033	0.039	0.054
	(0.025)	(0.032)	(0.038)	(0.034)	(0.042)	(0.047)
Ln(Mgmt Team Size)	0.028	0.025	0.021	0.014	-0.005	0.003
	(0.021)	(0.029)	(0.031)	(0.029)	(0.038)	(0.040)
Ln(Firm Age)	-0.016	-0.019	-0.031	-0.036	-0.037	-0.051
	(0.017)	(0.023)	(0.030)	(0.022)	(0.030)	(0.034)
VC Rep	0.009	0.009	0.006	0.001	0.007	0.007
	(0.025)	(0.030)	(0.031)	(0.033)	(0.044)	(0.052)
Observations	2,217	2,217	2,217	2,217	2,217	2,217
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes

Internet Appendix to "Do Venture Capital-Driven Top Management Changes Enhance Corporate Innovation in Private Firms?" (Not to Be Published)

In this Internet Appendix, I present the results of supplemental tests that accompany the results in the paper.

Table A1 reports the regression results of corporate innovation on top management changes controlling for industry-by-state-by-year fixed effects. I find that the positive relation between top management changes and subsequent corporate innovation in VC-backed private firms still holds. These results alleviate the concern that industry-by-state-by-year level omitted variables (e.g, technology shocks specific to some states) may drive the positive relation that I document between management changes and corporate innovation.

Table A2 presents the regression results of corporate innovation on top management changes controlling for lead VC firm fixed effects. I find that the positive relation between top management changes and subsequent corporate innovation in VC-backed private firms still holds. These results suggest that the positive relation between top management changes and enhanced subsequent innovation is robust to controlling for any unobservable time-invariant lead VC firm fixed effects (e.g., VCs' project selection ability or preferences).

Table A3 reports the probit regression results of founder replacements and non-founder top management changes, respectively, on different measures of VC power. I find that both the probability of founder replacements and that of non-founder top management changes in VC-backed private firms are positively related to VC power, suggesting that both founder replacements and non-founder top management changes are primarily driven by VCs.

Table A4 reports the linear probability regression results of top management changes on different measures of VC power. I find that the probability of top management changes in VC-backed private firms is positively related to VC power using the linear probability model, consistent with the results documented in Table 2 in the paper. These results lend further support to the notion that top management changes in VC-backed private firms are primarily driven by VCs.

Table A1: Robustness Test: Controlling for Industry-by-State-by-Year Fixed Effects

This table reports the OLS regression results of corporate innovation on top management changes controlling for industry-by-state-by-year fixed effects. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; *Cites*$^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry-by-state-by-year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Mgmt Change	0.080**	0.081**	0.102**	0.086**	0.116**	0.129**
	(0.026)	(0.027)	(0.045)	(0.037)	(0.047)	(0.055)
Ln(VC Investment)	0.095***	0.127***	0.164***	0.131***	0.181***	0.206***
	(0.022)	(0.030)	(0.044)	(0.034)	(0.038)	(0.054)
Ln(Syndicate Size)	0.072*	0.087*	0.083*	0.078	0.078	0.096
	(0.037)	(0.044)	(0.046)	(0.055)	(0.060)	(0.058)
Ln(Mgmt Team Size)	-0.006	0.019	0.004	-0.116***	-0.099*	-0.091
	(0.054)	(0.061)	(0.072)	(0.034)	(0.054)	(0.063)
Ln(Firm Age)	-0.017	-0.030	-0.062	-0.045***	-0.051*	-0.083***
	(0.024)	(0.035)	(0.040)	(0.013)	(0.025)	(0.024)
VC Rep	0.018	0.055	-0.014	0.084	0.116	0.102
	(0.143)	(0.188)	(0.223)	(0.185)	(0.258)	(0.300)
Observations	1,773	1,773	1,773	1,773	1,773	1,773
Adjusted R-squared	0.235	0.253	0.264	0.213	0.221	0.212
Industry × Year × State FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A2: Robustness Test: Controlling for Lead VC Firm Fixed Effects

This table reports the OLS regression results of corporate innovation on top management changes controlling for the lead VC firm fixed effects. *Patents*$^{(1)}$ is the natural log of one plus the number of patents that are filed over the next year; *Patents*$^{(2)}$ is the natural log of one plus the number of patents that are filed over the next two years; *Patents*$^{(3)}$ is the natural log of one plus the number of patents that are filed over the next three years; *Cites*$^{(1)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next year; *Cites*$^{(2)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next two years; *Cites*$^{(3)}$is the natural log of one plus the adjusted number of citations received by patents that are filed over the next three years. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the age of the VC-backed firm in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, lead VC firm fixed effects, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

VARIABLES	(1) Patents$^{(1)}$	(2) Patents$^{(2)}$	(3) Patents$^{(3)}$	(4) Cites$^{(1)}$	(5) Cites$^{(2)}$	(6) Cites$^{(3)}$
Mgmt Change	0.087***	0.073*	0.049	0.044	0.078*	0.063*
	(0.027)	(0.037)	(0.031)	(0.039)	(0.043)	(0.035)
Ln(VC Investment)	0.110**	0.133*	0.104**	0.137*	0.151*	0.092*
	(0.039)	(0.063)	(0.050)	(0.072)	(0.080)	(0.055)
Ln(Syndicate Size)	-0.046	-0.032	0.010	-0.043	-0.038	-0.003
	(0.049)	(0.084)	(0.060)	(0.060)	(0.071)	(0.052)
Ln(Mgmt Team Size)	0.099*	0.123	0.097	0.045	0.043	0.049
	(0.052)	(0.074)	(0.076)	(0.054)	(0.060)	(0.072)
Ln(Firm Age)	0.011	0.020	0.017	-0.023	-0.014	-0.030
	(0.031)	(0.041)	(0.030)	(0.043)	(0.065)	(0.044)
VC Rep	-0.470	-0.689	-0.909*	-0.725*	-1.058*	-1.401***
	(0.312)	(0.447)	(0.453)	(0.398)	(0.493)	(0.491)
Observations	1,624	1,624	1,624	1,624	1,624	1,624
Adjusted R-squared	0.448	0.497	0.502	0.381	0.488	0.495
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A3: The Effect of VC Power on Founder Replacements and Non-Founder Top Management Changes

This table reports the probit regression results of founder replacements and non-founder top management changes on measures for VC power. The sample used for these tests includes firm-financing round observations from 2002 to 2010. *Founder Replacement* is a dummy variable equal to one for a firm-financing round if a founder of the firm was removed. *Non-Founder Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team, which did not involve any founder removal. *VC Power* is the natural log of one plus the number of outside board members. *VC Power (Alternative Measure)* is the number of outside board members divided by the total number of board members. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the firm's age in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects (defined at the 2-digit SIC code level), financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)
VARIABLES	Founder Replacement		Non-founder Change	
VC Power	0.509***			
	(0.176)			
VC Power (Alternative Measure)		0.853**		1.094***
		(0.343)		(0.248)
Ln(VC Investment)	-0.034	-0.020	0.019	0.026
	(0.022)	(0.027)	(0.039)	(0.039)
Ln(Syndicate Size)	0.024	0.063	0.084	0.128*
	(0.095)	(0.094)	(0.071)	(0.072)
Ln(Mgmt Team Size)	-0.365***	-0.295***	0.965***	1.043***
	(0.081)	(0.073)	(0.100)	(0.107)
Ln(Firm Age)	0.102*	0.124**	0.196***	0.211***
	(0.060)	(0.059)	(0.059)	(0.057)
VC Rep	0.042	0.035	-0.063**	-0.073**
	(0.037)	(0.035)	(0.031)	(0.028)
Observations	2,033	2,021	2,033	2,021
Pseudo R-squared	0.128	0.123	0.198	0.196
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Stage FE	Yes	Yes	Yes	Yes

Table A4: The Effect of VC Power on the Probability of Top Management Changes: Linear Probability Model

This table reports the linear probability regression results of top management changes on measures for VC power. The sample used for these tests includes firm-financing round observations from 2002 to 2010. *Mgmt Change* is a dummy variable equal to one for a firm-financing round if there was a change in the composition of the top management team and zero otherwise. *VC Power* is the natural log of one plus the number of outside board members. *VC Power (Alternative Measure)* is the number of outside board members divided by the total number of board members. *Ln(VC Investment)* is the natural log of VC investment amount. *Ln(Syndicate Size)* is the natural log of one plus the number of investing VCs. *Ln(Mgmt Team Size)* is the natural log of one plus the total number of managers on the top management team. *Ln(Firm Age)* is the natural log of one plus the firm's age in the financing year since it was founded. *VC Rep* is the reputation measure of the lead VC firm of a VC-backed company following Nahata (2008), which is computed as the cumulated market value of all companies taken public by the lead VC firm from 1990 up until a given year normalized by the aggregate market value of all VC-backed companies that went public from 1990 up until the same year. Intercept, industry fixed effects, financing year fixed effects, and startup development stage fixed effects are included in all regressions. All standard errors are adjusted for clustering at the industry level and are reported in parentheses below the coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels, respectively.

	(1)	(2)
VARIABLES	Mgmt Change	Mgmt Change
VC Power	0.165***	
	(0.030)	
VC Power (Alternative Measure)		0.340***
		(0.053)
Ln(VC Investment)	-0.007	-0.006
	(0.011)	(0.011)
Ln(Syndicate Size)	0.030*	0.044***
	(0.015)	(0.015)
Ln(Mgmt Team Size)	0.234***	0.263***
	(0.018)	(0.020)
Ln(Firm Age)	0.064***	0.069***
	(0.010)	(0.009)
VC Rep	-0.039**	-0.042***
	(0.015)	(0.015)
Observations	2,049	2,037
Adjusted R-squared	0.256	0.253
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stage FE	Yes	Yes