Firms' Demands on Inventor Executives around IPOs*

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Abstract

We examine how going public affects firms' demands on inventor executives who own both management and innovation experience. Using IPO withdrawn firms as the control group and NASDAQ returns fluctuations as the instrumental variable on IPO competition, we show that firms demand more inventor executives after successful IPOs. The demand is higher for firms with higher product market competition. The number of inventor executives is positively related to survival probability after IPOs, stock market performance, operating performance, and innovation performance. Our results provide new evidence on the effect of going public on human capital mobility from firms' demand perspective.

Keywords: IPO, Inventor Executives, Innovation

JEL Classification: G34; J21; J23; J24; J60; L25; L26

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1 Introduction

The transition from a private firm to a public firm is one of the most important decisions for a firm. Although there is some literature examining the human capital mobility around IPOs, little is known on the firm's demand on human capital. In this paper we provide empirical evidence about the firm's demand on a special type of human capital, which we call inventor executives. The inventor executive is an executive with innovation experience. This type of human capital is crucial for startup firms. For example, Lawrence Page, the former CEO of Google, filed the patent on the search engine and founded Google, which becomes the giant in the technology industry. When a firm goes public, it experiences the pressure from investors on short-term performance. The firm may not need the inventor executives but the executives with pure management ability. Or the firm still demands these executives on their ability of both innovation and management because of the higher risk and various threats encountered as a public firm. In this paper the main research question is to examine the effect of going public on firms' demand on inventor executives.

Finance theories and empirical evidence provide opposite views on this question. On the one hand, the extant empirical evidence from both U.S. and international IPO markets suggests that IPO firms show poor long-run performance with around 30% of firms either failing or being acquired in five years subsequent to the offering (Ritter and Welch (2002); Ritter (2003)). The transition from a private firm to a public firm induces various challenges for the firm. For example, Jain and Kini (2008) show that issuing firms face challenges related to product market competition and technological change. Other challenges include changes in ownership structure and governance mechanisms, increased market monitoring and pressure to meet analyst expectations, and risks related to changes in capital market conditions. All of these challenges threaten the survivability of IPO firms. To overcome these challenges, newly IPO firms need human capital with superior abilities. The inventor executive who owns both experience of management and innovation is an important determinant of corporate innovation. Islam and Zein (2020) document the empirical findings that firms led by "Inventor CEOs" are associated with higher quality innovation. During an inventor CEO's tenure, firms file a greater number of patents and more valuable patents in those technology classes where the CEO's hands-on experience lies. Therefore we can predict that firms demand more inventor executives after IPOs to better overcome various threats, especially the threats from product markets and technology innovation.

On the other hand, although public firms can access more financial capital and ease financial constraints which fuel innovation, they are also exposed to market short-termism (Asker et al. (2015); Edmans et al. (2017)) and disclosure requirements that constrain innovation (Bhattacharya and Ritter (1983); Ferreira et al. (2014)). The market short-termism comes from (i) the scrutiny on performance by financial analysts and (ii) uninformed or unsophisticated investors. The pressure from financial analysts and unsophisticated inventors makes managers sacrifice long-term investments in order to meet short-term earnings targets which minimize managers' career risks. Innovation activities are activities with high returns but also with a high probability of failure risk. Therefore, market short-termism leads managers to engage in myopic activities that impede firm innovation post-IPO. In addition to the short-termism, public firms face the tradeoff of information disclosure about their innovative capabilities. Information disclosure allows the firm to obtain external funds with more advantageous terms. However, disclosure reveals crucial information to competitors and reduces the firm's initial advantage in a patent race (Bhattacharya and Ritter (1983)). Empirical results show that the quality of internal innovation declines following the IPO (Bernstein (2015)). Public firms' patents which rely more on existing knowledge, are more exploitative and are less likely in new technology classes, while private firms' patents are broader in scope and more exploratory (Gao et al. (2018)). According to these theories and empirical results, firms may demand fewer inventor executives who may pay some attention to innovation activities rather than to daily operating activities during their tenure as managers.[1]

There are two main challenges to empirically answer this question. The first challenge is the identification question. Simply comparing the number of inventor executives before and after IPO cannot give us an unbiased answer because of the inherent selection bias associated with the decision to go public. Following Bernstein (2015), to overcome this selection bias we construct a sample of firms that file an initial registration statement with the Securities and Exchange Commission (SEC) in an attempt to go public and then either complete or withdraw their filing as the control group. The concern of using withdrawal firms as the control group is that it introduces a new bias associated with the decision of firms to withdraw the IPO filing yet remain private. The second challenge is the data. No such inventor executive database exists. We manually link IPO firms' executives data downloaded from BoardEx with Harvard Patent

[1] Islam and Zein (2020) uncovers a fact that almost half of all inventor CEOs continue to file patents in their own names during their tenure as CEO. We also document a similar result in our sample.

Database (henceforth PID).[2] We define an executive as an inventor executive from the first year he/she becomes an executive and owns a patent. This data set allows us to track the mobility of each inventor executive.

Using the methodology and data described above, we find that firms need more inventor executives after successful IPOs. We provide two potential channels for this finding. These two channels are not mutually exclusive. As we discuss above, newly public firms encounter various threats after going public, e.g., product market competition and technological innovation pressure. These pressures threaten the survivability of the IPO firms. To overcome the challenges, firms demand high quality executives. Inventor executives are good candidates because they own both the experience of management and innovation. This idea posits that (i) firms with more product and innovation competition pressures demand more inventor executives and (ii) newly IPO firms with more inventor executives have a higher survival probability after IPOs. We test these two hypotheses. For the first hypothesis, we split the sample into two groups with high and low product market and innovation competition pressures. Then we repeat the analysis as we do in the baseline. The measure of product market competition is the well established Herfindahl-Hirschman Index (HHI). We develop two measures on the innovation competition. The first one we call Industry Patent Percentage (IPP) defined as the total number of patents applied for by all firms in a specific industry in a given year over the total number of patents in a given year. The rationale of the IPP is very simple. It captures the distributions of patent applications in different industries. A higher IPP means higher innovation competition pressure. The second measure is the Patent HHI, an HHI-liked measure where the market share is replaced by the shares of patents applied for by a firm in a given year. The empirical results support this hypothesis. We find that the effect of IPO on the demand of inventor executives is more pronounced in the high product (innovation) competition industry firms. Next we link the survival probability after IPO on the number of inventor executives. Both the non-parametric survival analysis and Cox proportional hazard model results show that firms with more inventor executives could survive longer after IPOs keeping other variables constant.

We next answer whether the number of inventor executives is related to firms' performance. We consider three types of performance: the stock market performance, the operating performance, and the R&D performance. The sample of all these tests is restricted to IPO completed firms. The sample period is from the IPO filing year to five years after the IPO year. The

[2] https://dataverse.harvard.edu/dataverse/patent

empirical analysis results show that the number of inventor executives is positively associated with all these three performances. Specifically, (i) firms with a higher number of inventor executives have higher five-year post-IPO buy-and-hold abnormal returns (BHAR) and higher risk-adjusted returns; (ii) the number of inventor executives is positively related to operating performance measured by return on assets (ROA); (iii) the number of inventor executives positively affects the firm's innovation performance measured by the number of patents, the citation of patents, and the value of the patents.

Our last set of empirical analyses focuses on the inventor executives level. We ask whether they continue to file patents during their tenure as executives, especially during the period of post IPOs. We call these executives active inventor executives. We find a large fraction (about 30%) of inventor executives still work on innovation activities. We link the probability of being an active inventor executive to firm characteristics and find that it is related to the product market competition pressure the firm faces and the performance of the firm. These findings provide further evidence on our mechanisms analysis.

This paper has three main contributions. First, this paper contributes to the literature on the human capital of IPO-filing firms and how going public affects firms' demand on human capital. The effects of IPOs on labor markets are unclear. Public firms are able to attract new talent and decrease departures of workers with valuable ideas (Babina (2020)). However, agency problems and short-term focus on safer projects and reduced experimentation may trigger more departures of creative human capital (Manso (2016)). In this paper we add new results on this topic from the firm's demand side. We provide evidence that public firms need higher quality human capital after IPO to better deal with the market competition.

The second contribution is that we add new evidence on the effect of IPO on the firm innovation (e.g., Bhattacharya and Ritter (1983); Bernstein (2015); Gao et al. (2018)). We add empirical evidence from the perspective of a special type of executives, the inventor executives. Previous literature documents that going public may harm the innovation activities. In this paper we show that innovation activities are still important for newly public firms. One way that public firms overcome the threats of competition from the product market and technology is to hire executives with both experience of management and innovation. We find that those firms with a larger number of inventor executives survive longer after IPOs and enjoy better performance in the stock market, operation, and innovation.

The last contribution is related to the effect of executive styles and experience on firm policy and performance, especially on the innovation policy and performance. Since the seminal paper of Bertrand and Schoar (2003), a large literature links the firm policy and performance on different executives characteristics (e.g., Benmelech and Frydman (2015); Malmendier and Tate (2005); Malmendier and Tate (2009)). Past studies focus on the firm innovation policy and performance (e.g., Custódio et al. (2019); Galasso and Simcoe (2011); Hirshleifer et al. (2012)). A recent study by Islam and Zein (2020) show that hands-on experience in innovation is a critical channel. Inventor CEOs may endow them with valuable innovation-related insights that translate into a superior ability to evaluate, select, and execute innovation-intensive investment projects for the firms they lead. We extend their study to all executives and focus on the period before and after IPO periods. We also find that inventor executives are positively related to firms' innovation performance.

The remaining paper is organized as follows. Section 2 describes the data sources and presents the summary statistics. Section 3 discusses the empirical strategy and presents the main results. In section 4 two potential channels are discussed. Section 5 reports the results on the effect of inventor executives and firms' performance. Section 6 provides further analyses on the inventor executives level. We summarize in section 7.

2 Data and Summary Statistics

2.1 Data Sources

Our data are from several sources and include data on IPO filings, executives, patents and inventors, and firms' characteristics. The final data set allows us to identify the executives and track their working and innovation experience over time. In this section I discuss the data sources and sample construction process. Table A2 in Appendix summarizes the sample construction process.

2.1.1 IPO Data

We initially collect IPO filings information from Thompson Reuter Securities Data Corporation (SDC) and Securities and Exchange Commission (SEC) Electronic Data Gathering, Analysis, and Retrieval system (EDGAR). We restrict our IPO firm sample in U.S. companies between the year 1994 and 2006. The sample period starts from 1994 because it is the first year that SEC EDGAR provides reliable S-1 filings. It ends in 2006 to avoid the effect of 2008 financial crisis. SDC contains the withdrawn date for IPO withdrawn firms, which helps us to identify whether an IPO filing firm is an IPO completed firm or an IPO withdrawn firm. Our initial IPO sample contains 4,905 successful and 3,248 withdrawn IPO deals. Following Babina et al. (2020), we exclude financial industry firms (SIC Code between 6000 and 6999) and firms with more than one IPO filing. 3,784 completed IPOs and 1,122 withdrawn IPOs are left.

We also download relevant IPO characteristics for IPO firms from SDC: the date of filling and the under writer's name. To check whether an IPO firm is backed by venture capital, we match our IPO sample with Thomson one venture capital database and Jay Ritter IPO data.[3] IPO underwriters are also matched with Jay Ritter IPO data to measure their rank.

2.1.2 Executives Data

We link SDC IPO firm sample to BoardEx which contains detailed information on the individual position name and employment history to identify the executives in the IPO firms. We first use ISIN and CUSIP code provided in both SDC and BoardEx to link firms. For those firms which are unable to be matched, we apply a fuzzy lookup algorithm to match their company names. Finally, we can identify 2,549 IPO and 646 withdrawn firms employees information in the BoardEx. Following Chemmanur et al. (2019) we define an employee as an executive of the firm if his/her position is the vice president (VP) or higher. The senior managers in our sample can be broadly categorized into six groups: CEOs, presidents, chairmen, other chief officers (e.g., chief financial officer (CFO)), VPs, and division heads.

2.1.3 Financial Data

For IPO completed firms, we download their financial data from Compustat. To overcome the constraint that no financial data is available for private firms in standard databases, we manually collect withdrawn firms accounting data from S-1 filings in SEC EDGAR database. The S-1 filing is a registration filing form for companies to complete the registration of securities offering. It includes the selected financial data of the firm which plans to go public. We manually collect the relevant accounting information for the IPO filing year in the S-1 filings. Totally we could find financial data for 2,160 IPO firms and 487 withdrawn firms in our sample.

[3] https://site.warrington.ufl.edu/ritter/ipo-data/

2.1.4 Patent Data

The patent data we rely on are downloaded from Harvard Patent Database (PID). PID includes inventor names, inventor addresses, assignee names, and application and grant dates for each patent. The amazing feature of this data set is that it uses the disambiguation approach developed in Li et al. (2014) to identify the unique inventor and the assignee firm ID. Therefore we can potentially track the mobility of each inventor. We use the following steps to match the inventor names with the employee names in the IPO-BoardEx sample. Our methodology follows Islam and Zein (2020) which identifies inventor CEOs. We extend it to identify all executives defined above.

First, we standardize employee names in our IPO-BoardEx sample in accordance with the format in PID. We convert names in both data sets into lower case and delete apostrophes and space. Second, we create a name format by concatenating the first name and surname in both IPO-BoardEx sample and PID. We use this name format to merge two data sources. We then use the name format first name+middle name+surname to merge the rest names. Third, for each matched case, we use the working experience and biographical information provided by BoardEx and LinkedIn to check whether the employee once is employed by the assignee companies/organizations where he/she is regarded as a patentee. If the employee once worked for the assignee, we think that the employee is the patentee. We also double-check whether the patent industry classification is consistent with the SIC code of the assignee company where the executive once worked. After all these steps, we designate an employee as an inventor if he/she has at least one patent. Take a real case in our sample to illustrate the matching procedure. Adept Technology Inc went public successfully in the year 1995 and is one of the observations in our IPO sample. Brian R. Carlisle (BoardEx directorid = 346771), serves as the CEO and chairman at Adept Technology Inc between the year 1983 and 2003. From PID, we find that an inventor with the name Brian R. Carlisle owns four patents all with assignee ADEPT TECHNOLOGY INC and that the first one was granted in year 1987. We believe these two Brian R. Carlisle are the same people because they share the exact same name and company.

2.2 Inventor Executives Identification

The employee-inventor dataset we construct above allows us to track each employee's career over time. Now we could identify the inventor executive (IE), an individual who owns the experience of both management and innovation. Suppose for individual i the first year he/she becomes an executive is $t_i^{executive}$ and the first year he/she owns a patent is $t_i^{inventor}$. For year t in which $t \geq \max\{t_i^{executive}, t_i^{inventor}\}$, we consider individual i is an inventor executive (IE) at that year. Still take the above Brian R. Carlisle as an example. His management experience starts from year 1983, i.e., $t_i^{executive}$. His innovation experience begins from the year 1987, i.e., $t_i^{inventor}$ is 1987. We think Brian Carlisle is an inventor executive from the year 1987, the most recent year when he owns both management and innovation experience.

2.3 Main Variables

To examine the effect of going public on the firms' demand on inventor executives, we construct the following variables. The main explanatory variable we are interested in is *IPO*, which is a dummy variable that equals one if a firm goes to IPO successfully, or equals zero in the case of IPO withdrawal.

We measure the absolute and relative number of inventor executives in a firm. The measure of the absolute number of inventor executives is *IE Num*, which is the total number of inventor executives in the top management team of a firm in a given year. The variable of the relative number of inventor executives is *% IE*. It is calculated as the *IE Num* over the number of executives.

We construct several firm characteristics variables. *Log(asset)* is defined as the natural logarithm of the total asset. *Cash* is defined as cash holdings divided by total assets. *R&D* refers to research and development expense divided by total assets. *Net income* is the total income divided by total assets. *Sales* is the sales scaled by total assets. We also control the executive personal characteristics. *Age* is the age of the executive team. *Male* is an indicator which is one if the executive is a male and zero otherwise. *MBA* is a dummy which is one if an executive owns an MBA degree within a firm. *Science* is an indicator which is one if an executive owns a science or engineering master degree in a firm. All variables used in this paper and their definitions and sources are presented in Appendix A1.

2.4 Summary Statistics

Table 1 presents the summary statistics for the main variables used in the paper. Panel A reports the IPO sample by year. The number of completed and withdrawn IPO cases increases from the beginning of our sample period and reaches the peak in the year 1999 and 2000, dot-com bubble. After the bubble burst, the IPO deals decrease although a mild increase occurs at the end of our sample period. Completed IPO firms own more executives and inventor executives on average and in all years compared to IPO withdrawn firms. With respect to investor executives percentage, the difference is relatively smaller but completed IPO firms still have a higher fraction of investor executives in the management teams. Panel B compares the IPO completed firms and withdrawn firms by Fama–French 12 industry classification. We drop the financial industry so there are only 11 industries left. Like what we see in the statistics comparisons by years in Panel A, we also find that IPO completion firms have a higher number of executives, inventor executives, and the fraction of inventor executives compared to withdrawn firms. We also find a large difference in these statistics across different industries. Business equipment industry has the highest number of IPO deals, both in successful and withdrawn samples while consumer durables industry and utilities industry have the lowest observations. Healthcare industry firms have the largest inventor executives both in absolute and relative number while consumer non-durables industry firms have the lowest. This pattern makes sense because healthcare industry is a knowledge intensive industry. Panel C and D focus on the executives level. Panel C compares some characteristics between inventor executives group and non inventor executives group. We can clearly see there are significant differences between these two groups in a variety of dimensions. Compared to non inventor executives group, inventor executives are

In Panel D, we report the distribution of the cumulative number of patents granted to the inventor executives as at the year 2010. 1,486 executives (21.80%) have one patent and 1,811 executives (26.80%) owns more than 10 patents. The average number of patents an inventor executive has is 10.21. Audrey Goddard, whose id in BoardEx is 1743893 is awarded the maximum number of patents in our sample, which is 605.

Panel E compares the firm characteristics between IPO completion and withdrawn firms. IPO completion firms significantly differ from IPO withdrawn firms with respect to the absolute and relative number of inventor executives before and after IPOs and financial characteristics at the IPO filing year.

3 Empirical Results

3.1 Empirical Strategy

To overcome inherent selection problems, we compare the demand on inventor executives in IPO successful firms with the demand in the firms that withdraw their IPO filings and remain private. We use the following regression model as our baseline regression:

$$y_i^{post} = \alpha + \beta IPO_i + \gamma y_i^{pre} + \mathbf{X}_i'\delta + \mu_t + \vartheta_k + \varepsilon_i \tag{1}$$

where y_i^{post} is the measure of the number of inventor executives in the five years following firm's IPO for firm i. We use two variables: the absolute number (*Num IE*) and the percentage of inventors in the executive team (*% IE*). $\mathbf{X}_i'$ are a vector of control variables. μ_t and ϑ_k are IPO filing year fixed effect and industry fixed effect, respectively. ε_i is the error term.

To allow for a clean inference of the causal impact of an IPO completion on firms' demand on inventor executives, we instrument for IPO completion using two-month NASDAQ returns following the IPO filing following Bernstein (2015).

3.2 Univariate Test Results

Before we jump to the multivariate regression analysis, we first present univariate results to have a basic understanding of the relationship between going IPO and the demand on inventor executives. Figure 1 plots the executives and inventor executives dynamics around the IPO for IPO completed firms and withdrawn firms. From Figure 1a we can see that the size of management teams for both the IPO completed expand when they approach the IPO filing year. However, only the IPO completed firms continue this trend after IPO success while IPO withdrawn firms cut the management team size after IPO failure. We also find a difference in the number of executives between IPO completed firms and withdrawn firms before IPOs. On average, IPO successful firms own more executives than withdrawn firms do. Figure 1b plots inventor executive dynamics. A similar pattern is found. Before IPO filing years, IPO completed firms have more inventor executives compared to IPO withdrawn firms and both types of firms expand their inventor executives size. At the IPO filing years, on average IPO completed firms have one inventor executives and IPO withdrawn firms have about 0.45 inventor executives. After IPO years, for those firms going public successfully, they continue demanding more inventor executives but the number of inventor executives stays steady. With respect to the relative number of inventor executives depicted in Figure 1c, IPO completed firms still have a high fraction of inventor executives. The relative number of inventor executives is stable for IPO completed before and after IPO, around 20%. In contrast, the relative number of inventor executives for IPO withdrawn fluctuates more: there is an increase in the first two years after IPO and then a slight decrease. The reason is that the team size decreases as shown in Figure 1a while the number of inventor executives stays stable as presented in Figure 1b.

3.3 IV Results

Bernstein (2015) shows that the NASDAQ fluctuation during the book building phase is a plausible instrument for IPO completion. In this paper, we also use it as an instrumental variable (IV) to investigate firms' demand on inventor executives after IPOs. We first check the validity of this instrumental variable, i.e., relevance condition and exclusion condition. Then we apply the instrumental variable approach to estimate the effect of going public on firms' demand on inventor executives.

3.3.1 Relevance Condition

Following Bernstein (2015), we examine whether NASDAQ fluctuations are associated with the likelihood of IPO completion. The relevance condition test results are presented in Table 2 Panel A. The dependent variable for all specifications is *IPO*, an indicator which is one if a firm completes IPO and zero otherwise. We include IPO filing year fixed effect and four-digit SIC industry fixed effect in all specifications using OLS. When included, control variables are three-month NASDAQ returns prior to the IPO filing, number and percentage of investor executives in the three years before the IPO filing, VC backed, and Pioneer. The definitions of these variables can be found in Appendix A1. Our results are very similar to the findings in Bernstein (2015).

The estimated coefficient on Postfiling NASDAQ return in column (1), measured as the two-month NASDAQ return after IPO filing days, is 0.708 and significant at 1% level. The economics magnitude is meaningful: one standard deviation (0.103) decrease in Postfiling NASDAQ return translates into 7% decline of the likelihood of IPO completion. In column (2), we include control variables and find that estimation results are very similar. It remains statistically significant and the magnitude is even larger (0.731). Following Bernstein (2015), we next limit our sample in the period before the year 2000. Column (4) and (5) report the regression results with and without control variables. We still find a significantly positive estimated coefficient on postfiling NASDAQ return, although the magnitude is much smaller compared to those in the full sample period. We next apply the NASDAQ return in the whole book building phrase, which is the return from the initial registration statement to the completion or withdrawal date. The estimated coefficients are still positive and significant at 1% level. The last two columns report the results when we use a dummy variable NASDAQ drop. NASDAQ drop is equal to one if two-month NASDAQ returns from the date of the IPO filing are within the bottom 25% of all filers in the same year and zero otherwise. The estimated coefficient on NASDAQ drop is negative and significant at 1%, which is consistent with the findings in the previous specifications. The magnitude of the dummy variable shows that the likelihood of IPO completion decreases about 10% if the two-month NASDAQ return is in the bottom 25% of all IPO firms in the same year.

Besides the regression model, we also apply the nonparametric model. Figure 2 plots the relation between the two-month NASDAQ fluctuations and the probability of the IPO completion. We can see a positive monotonic association between NASDAQ returns and the likelihood of IPO completion when the return is negative. In the positive return domain, the positive relation is still there but the probability of IPO competition is not very sensitive to the NASDAQ returns. When NASDAQ return is larger than 0.2, the relation becomes negative.

Our results in the first stage indicate that NASDAQ return fluctuations after IPO filings are very relevant to the IPO competition. Moreover, the two-month NASDAQ return after IPO filing day seems to be orthogonal to the control variables we consider.

3.3.2 Exclusion Condition

In addition to the relevance condition that NASDAQ returns fluctuations are related to the IPO completion likelihood, a valid instrumental variable should also satisfy the exclusion condition, i.e., NASDAQ returns fluctuations should not affect firms' demand on inventor executives through any channel other than the decision to complete the IPO filing. As discussed in Roberts and Whited (2013), it is impossible to test directly the exclusion condition assumption because the error term is unobservable. To alleviate concerns on this assumption, we provide some empirical evidence following Bernstein (2015).

The first exclusion restriction condition test is the comparison of observable characteristics between firms that experience a NASDAQ drop and other firms filing to go public in the same year. If the two-month NASDAQ return after the firm's IPO filing day is within the bottom 10% (25%) of all filers in a given year, the firm is classified as experiencing a NASDAQ drop.

Similarly, we can classify firms into the top 90% (75%) group. We explore whether significant differences in observable characteristics are found between the bottom and top group firms. The results are reported in Table 2 Panel B. We do not find significant differences between the two sets of firms across a list of observables.

The second exclusion condition test is a placebo test. The rationale is as follows: The violation of the exclusion restriction condition implies that the two-month NASDAQ returns affect firms' demand on inventor executives through channels other than the ownership channel. Such alternative channels should also be apparent when exploring NASDAQ returns outside the book-building phase, when firms' ownership choice is fixed. We use this idea as a placebo test setting by linking firms' post IPO demand on inventor executives on two-month NASDAQ returns other than the post filing two-month NASDAQ returns. The returns other than book-building phase returns include two-month NASDAQ returns one year before the IPO filings and one year after IPO filings. If we could find a significant relationship between those returns and firms' post IPO demand of inventor executives, our IV violates the exclusion restriction condition. The placebo test results are presented in Table 2 Panel C. We find that neither two-month NASDAQ returns one year before IPO filing nor one year after IPO filing is significant related to the firm's demand on inventor executives after IPO. In columns (4) and (5), we repeat the analysis by including both postfiling NASDAQ returns and NASDAQ returns outside the book-building phase. In contrast to the NASDAQ returns following the IPO filing, outside the book-building window they are not correlated with the number of inventor executives. These findings are consistent with the notion that short-run NASDAQ returns affect the number of inventor executives after IPO only through their impact on firms' ownership choice.

3.3.3 IV Estimation Results

After checking the validity of our IV, now we use the instrumental variable approach to examine the effect of going public on firm's demand on inventor executives.

The unit of observation is at the firm level and the dependent variable and the average number of inventor executives (*Num IE*) and relative number of inventor executives in the management team (*% IE*) in the five years after the IPO filing.

The results are presented in Table 3. The dependent variable in column (1) to (3) is the average number of inventor executives in the five years after IPO, and in column (4) to (6) is the average percentage of inventor executives in the five years after IPO. We include control variables and filing year and industry fixed effect in all specifications. The main estimation approach for the instrument variable is two-stage least squares (2SLS). We also apply the generalized method of moments (GMM). For comparison, we include OLS results in this table. The estimation model is indicated at the top of the table.

We first look at the effect of going public on the absolute number of inventor executives after IPO filings. Column (2) reports the 2SLS results. The estimated coefficient of IPO is statistically significant and positive (0.747). When we apply the GMM estimation, the coefficient remains significantly positive and the magnitude is even larger (0.866). More interestingly, the coefficients of IV estimation are both larger than OLS estimation, that is OLS coefficient underestimates the effect of going public on the firm's demand of inventor executives, compared to the IV estimate.

With respect to results of the relative number of inventor executives, we find a similar pattern as those in the number of inventor executives: IV estimations on IPO are significantly positive for both 2SLS and GMM approach and the magnitudes of IV estimation are larger than that of OLS.

4 Potential Channels

The empirical results so far show that going public affects firms' demand on inventor executives: the executives who have both experience of management and innovation. We propose two potential reasons for this finding. These two channels are not mutually exclusive.

The extant empirical evidence from both U.S. and international IPO markets suggests that although IPO firms often offer substantial initial returns, they show poor long-run performance with around 30% of firms either failing or being acquired in five years subsequent to the offering (Ritter and Welch (2002); Ritter (2003)). The transition from a private firm to a public firm induces various challenges for the firm. For example, issuing firms face challenges related to product market competition and technological change (Jain and Kini (2008)). Other challenges include changes in ownership structure and governance mechanisms, increased market monitoring and pressure to meet analyst expectations, and risks related to changes in capital market conditions. All of these challenges threaten the survivability of IPO firms.

Previous literature documents several factors which could affect the IPO survival of IPO firms. We argue that inventor executives could help firms better react to the challenge of the competition after IPO filing. As a result firms could survival longer.

4.1 Product Market Competition

Our first hypothesis posits that IPO firms facing more product market competition demand more inventor executives who could help firms to better handle the competition. To test this idea, we split the sample into low and high product market competition groups and replicate the analysis in Table 3.

The product market competition measure we use is the Herfindahl-Hirschman Index (HHI), a well established product competition measure used in many previous studies. For each year t and Fama–French 49 industry k, we define the HHI as $\sum_{j \in k} s_{jt}^2$, where j represents a firm in industry k, and s is the market share of firm j in the industry. We use the sales to calculate the market share for each firm within the corresponding industry. The higher HHI, the lower the product market competition. For robustness checks, different industry classification codes (e.g., Fama–French 12 industry and SIC four-digit industry classifications) and different market share measures (e.g., the revenue-based market share) are used. We report it in Appendix Table A3 Panel A. The results are very similar.

For each IPO firm, we classify it into the high product market competition group if the *average* five years HHI of its corresponding Fama–French 49 industry after IPO filing year is above the median of all *average* five years industry HHI starting from the same year. Otherwise it is allocated into the low HHI group. Next we repeat the 2SLS estimation in Table 3 for high HHI group sample and low HHI group firms.

The results are presented in Table 4 Panel A. Column (1) and (2) are results for the absolute number of inventor executives and column (3) and (4) are results for relative number of inventor executives. The estimated coefficient of IPO in the low HHI group is positive and significant at 1% level while the coefficient of IPO in the high HHI group is not significant even at 10% level. This result indicates that the baseline result on the relationship between going IPO and demand on inventor executives only exists in the low HHI, i.e., high product market competition industries. We find a similar pattern in the relative inventor executives measure. Although the coefficients of IPO in both groups are positive and significant, the magnitude of the IPO coefficient in the low HHI group is much larger and more significant than that in the high HHI group.

Islam and Zein (2020) argue that a CEO's inventor experience may endow them with valuable innovation-related insights that translate into a superior ability to evaluate, select, and execute innovation-intensive investment projects for the firms they lead. They find that firms led by socalled "Inventor CEOs" are associated with higher quality innovation. It is well recognized that innovation is the key to a firm's development and survival. Therefore it is reasonable to argue that if the firm operates in an innovation intensive industry, the firm faces high competition in innovation. This innovation competition pressure induces firms to invest resources in research and development. One key ingredient of innovation inputs, as found in Islam and Zein (2020), is the executives with inventor experience. Therefore we propose that IPO firms operating in high innovation competition pressure industries demand more executives with innovation skills.

We develop two proxies to measure the industry innovation intensity: Industry Patent Percentage (IPP) and Patent HHI. The idea of IPP is very straightforward. Consider the following example. According to the Noah Stoffman's patent database,[4] firms in the Electronic Computers industry (four-digit SIC is 3571) are granted totally 10,246 patents in the year 2003. On the other hand, firms in Accounting, Auditing, and Bookkeeping Services industry (four-digit SIC is 8721) are granted only one patent in the same year. The statistics show that the variation of the number of patents in different industries are very large. Industries with the high number of patent firms are usually innovation oriented industries and firms within these kinds of industries encounter great innovation competition pressure. IPP captures this simple idea. For industry k at year t, IPP is defined in (2)

$$IPP_{kt} = \frac{\sum_{j \in k} \text{Num Patent}_{jt}}{\sum_{j \in \text{All firms with patents in year } t} \text{Num Patent}_{jt}} \tag{2}$$

The numerator of IPP is the total number of patents granted to all firms in a specific industry and the denominator is the total number of patents in a given year. The higher IPP, the severer the innovation competition.

Our second proxy of the innovation competition is an HHI liked measure. Similar to the definition in the traditional product market competition, Patent HHI for industry k at year t is defined as $\sum_{j \in k} s_{jt}^2$, where j represents a firm in industry k. The key difference from standard HHI is that now s is calculated based on the total number of patents granted to firm j in year t rather than on sales. The interpretation of Patent HHI is the same as the standard HHI: the higher Patent HHI, the less competition in that industry. In the main analyses, we use four-digit SIC industry classification to calculate IPP and Patent HHI. For robustness, we also use other industry classifications, e.g., three-digit, two-digit SIC, Fama–French 49, and Fama–French 12 industry classifications. We report the results in Appendix Table A3 Panel B. The results are

[4] https://host.kelley.iu.edu/nstoffma/

very similar.

We apply the same method used in Table 4 Panel A. Firm sample are split into two groups according to IPP (Patent HHI). A firm whose *average* five years HHI of its corresponding four-digit SIC industry after IPO filing year is above the median of all *average* five years industry IPP (Patent HHI) starting from the same year. Table 4 Panel B reports the results. The dependent variable for the first four columns is *Num IE* and the last four columns is *% IE*. The sample of each column is shown at the top of the table. Column (1) and (2) compare the IPO coefficients for the low IPP and high IPP groups. We find that both IPO coefficients are positive but only significant in the high IPP group. The magnitude difference is large (1.038 verse 0.539). Column (3) and (4) show the results for the high and the low Patent HHI groups. The coefficients of IPO are also positive but only significant at the low Patent HHI group. Although the IPO coefficient is significant only at 10% for the low Patent HHI group, the magnitude difference is very large (1.981 vs. 0.139). The results are consistent under these two different innovation competition pressure measures: firms encounter the high innovation competition pressure demand more inventor executives, which supports our hypothesis.

Interestingly we do not find a significant result for the relative number of inventor executives. The coefficients of IPO in column (5) and (6) are same but not significant. While the IPO coefficient for the low Patent HHI group is larger than that in the high Patent HHI group, both are not significant either.

4.2 Survival after IPO

The change of ownership for a firm from a private firm to a public firm threatens the survival of the newly public firms. To overcome these challenges, for example, the product market and innovation competition discussed above, firms may need high quality executives. If this hypothesis is correct, we should observe a positive relationship between the number of inventor executives and firms' survivability after IPOs. To formally test this idea, we apply the survival analysis methodology.

4.2.1 Hazard and Survival Functions

We firstly apply the non parametric method to estimate the hazard and survival functions for firms with different sizes of inventor executives. Figure 3a and Figure 3b plot the Kaplan-Meier survival estimates and Nelson-Aalen cumulative hazard estimates, respectively. For both graphs, we split the firms into three groups according to the average number of inventor executives five years after IPO fillings. The bottom tertile is the group with the lowest number of investor executives and the top tertile is the group with the highest number of inventor executives.

From Figure 3a we can see that the survival function of IPO firms with a larger number of inventor executives is above that of firms with a small number of inventor executives. The gap widens as the time elapses after the issue. The probability of surviving five years after the issue is about 95% for firms with a high number of inventor executives, while this number for firms with the low number of inventor executives firms is about 75%. The middle group is in between, about 87%. After five years, the probability of survival for the lowest inventor executives group decreases faster compared to high inventor executives group firms. We also run the log-rank test for the equality of survival functions for these three groups and the result shows that the estimated survival curves of the three groups are different at the 1% significance level.

In contrast to findings in the survival function shown in Figure 3a, Nelson-Aalen cumulative hazard rate as shown in Figure 3b for the highest inventor executives group is lowest compared to that for the lowest group. The middle group hazard estimate curve is in the middle. The gap also becomes widen as time goes.

Overall, the plots in Figure 3a and Figure 3b show a clear pattern that firms with large number of inventor executives have a lower risk profile and a higher survival profile compared to firms with a small number of inventor executives after going public. This result provides evidence suggesting that inventor executives could improve the survival profiles of IPO issuers.

4.2.2 Cox Proportional Hazard Model

The non parametric results discussed above provide some evidence on the importance of inventor executives on the firm's survival profile, but it does not consider other compounding factors. Therefore we use Cox proportional hazard model which estimates the hazard ratios. The estimation results are presented in Table 5.

The estimated coefficients in column (1) and (3) for *Num IE* are both negative and statistically significant at 1% level, suggesting that the demand of inventor executives could decrease the hazard rate. Firms with more number of inventor executives have a lower probability of failure and a longer time to survive in the periods following the offering. Column (2) and (4) present the hazard ratios. The magnitudes of *Num IE* are similar, both are around 0.7. This figure is economically meaningful.

We do not find a statistically significant estimated coefficient on *% IE*, and the signs of *% IE* are opposite in column (5) and (7).

In summary, survival analysis results from hazard function and Cox proportional model suggest that inventor executives are positively associated with the survival probability of firms after IPO filings. To overcome the threat after IPOs, firms have the incentive to hire more inventor executives, a special type of people with both experiences of innovation and management.

5 Firm Performance

We so far document the effect of going public on firms' demand on inventor executives and examine two potential reasons. In this section we link the number of inventor executives to firms' performance. We consider three types of performance: stock market performance which focuses on stock returns, operating performance which is measured by return on assets (ROA), and R&D performance which is measured by the quantity and quality of firms' patents. The sample of all these tests is restricted to IPO completed firms. The sample period is from the IPO filing year to five years after the IPO year.

5.1 Stock Market Performance

Table 6 presents the results for the relation between the number of inventor executives and stock market performance. In Panel A, we compare the five-year post-IPO buy-and-hold abnormal returns (BHAR) for firms with the high and low level of the number of inventor executives. For each IPO firm, the returns are calculated by compounding monthly returns, where abnormal returns are the simple difference between IPO five-year average returns and the corresponding benchmark. The benchmark returns include S&P 500, NYSE/AMEX/NASDAQ, and NASDAQ. Firms are classified into two groups according to the number of inventor executives. A firm is allocated into the High IE group if its average number of inventor executives in the five years after IPO is above the median and Low IE group otherwise. From Panel A we find that firms with larger number of inventor executives perform better in terms of higher five-year BHAR under different benchmark returns and weights. We also notice that (i) low IE group BHAR are all negative and significant at 1% level; (ii) some BHAR for the high IE group is also significantly negative, e.g., equal weighted BHAR is −0.164 when the benchmark is NASDAQ returns, and (iii) some BHAR is positive but insignificant, e.g., value weighted BHAR is 0.086 when the benchmark is S%P 500.

Panel B reports the risk adjusted returns for firms with different sizes of inventor executives. We split the sample into two groups according to the number of inventor executives. A firm is allocated into Low IE group if its average number of inventor executives in the five years after IPO is below the median level, otherwise it is assigned into the high IE group. For each group of firms, we regress the daily excess returns (RETRF) on market risk premium (RMRF), i.e., CAPM model and Fama–French three factors, i.e., RMRF, SMB, and HML. Daily Fama–French three factors data are downloaded from Kenneth French's website. The first two columns report the CAPM estimation results and the last two columns report the Fama–French three factors model. We can find that the constants for the high IE groups are positive and statistically significant at 1% for both CAPM and Fama–French three factors model while the constants are not significant and almost equal to zero for low IE group.

The results in Table 6 suggests that after going IPO, firms with more inventor executives experience a better stock market returns.

5.2 Operating Performance

Table 7 reports the regression results on the relationship between the number of inventor executives and firm's operating performance measured by return on assets (ROA).

The sample is restricted to IPO completed firms and within five years after IPO filling. All specifications include year and four-digit SIC industry code. Relevant control variables are included in all regressions following Gow et al. (2016). In column (1) and (2) the dependent variable is current year ROA. The estimated coefficient for *Num IE* is 0.011 and significant at 1% level while the coefficient of *% IE* is not significant. *Num IE* is positively associated with firm's current year ROA and the magnitude is economically meaningful. One standard deviation increase in *Num IE* (1.57) leads to increase in ROA $1.574 \times 0.011 = 0.017$. This effect is large considering the mean of ROA is -0.052 (about 33% relative to the absolute value average ROA). In column (3) and (4) we replace the contemporaneous ROA by next year ROA as the dependent variable. The estimation results are similar to those in the first two columns: the coefficient on *Num IE* is positive and statistically significant at 1% and the coefficient of *% IE* is not significant even at 10% level.

Next we turn to the change of ROA. In column (5) and (6), the dependent variable ΔROA_{t+1} is defined as the ROA in year $t + 1$ minus ROA in year t. All independent variables are contemporaneous values. We also find a significantly positive coefficient on *Num IE* while *% IE* still insignificant. The economic significance of 0.006 is relatively large. If *Num IE* increases by one standard deviation (1.57), ROA change increases by $1.57 \times 0.006 = 0.009$, which is about 20% of the mean of ROA change.

5.3 Innovation Performance

Table 8 reports the regression results on the relationship between the number of inventor executives and firm's innovation performance measured by the number of patents, the citation of patents, and the value of the patents.

The sample is restricted to IPO completed firms after the IPO filing year. Control variables, year fixed effects, and four-digit SIC industry fixed effect are included in all specifications. The dependent variables in the column (1) to (2) are *Num patent* which is counted as the total number of patents granted to a firm in a given year. The *Num IE* coefficient is 0.642 and significant at 1% level, suggesting that the more inventor executives in a firm, the more patents granted to the firm. The magnitude is very large: one standard deviation increase in *Num IE* (1.485) is associated with 0.953 more patents granted to the firm, which is about $0.953/1.752 = 54\%$ relative to the average patent numbers granted to a firm in a year. In contrast to the previous results, *% IE* also plays a positive role in firms' patents, although the statistical significance is only at 10%.

In column (3) and (4), the dependent variable is *Num citation* which is measured as the average citation of patents granted to the firm in a given year. We find the positive and significant estimated coefficients for both *Num IE* and *% IE*. The effect is also economically significant. Take the coefficient of *Num IE* as an example: one standard deviation increase in *Num IE* is associated with 0.813 more citations per patent, which is about $0.813/4.478 = 18\%$ relative to average citations per patent.

The dependent variable in column (5) to (6) is *Patent value* which is defined as the average value of patents granted to the firm in a given year. The value of the patent is measured by the methodology in Kogan et al. (2017). We only find a positive and significant coefficient for *Num IE* but an insignificantly positive coefficient for *% IE*. As the effect of *Num IE* on other innovation performance measures, the effect of *Num IE* is economically meaningful as well: if *Num IE* increases by one standard deviation, Patent value increases by around 0.427, which is about $0.427/1.093 = 39\%$ relative to the average value per patent in a firm.

Previous literature finds that the distributions of patents and citations are right skewed. To overcome this concern, in the robustness tests, we transform the absolute value of the dependent variables into natural logarithm of one plus corresponding patent performance measures and rerun the regression as we do in Table 8. The results are very similar.

In summary, the results in Table 8 show a consistently positive relationship between the number of inventor executives, especially the absolute number of inventor executives, and firm's innovation performance measured by the quantity and quality of patents.

6 Inventor Executive Level Analysis

Our data set allows us to track the working history of inventor executives and their innovation activities. To further understand the mobility of inventor executives around the IPO we provide executive level analysis in this section. We investigate whether inventor executives continue to file patents during their tenure as executives, especially during the post-IPO period. If so, which firm factors are associated with the innovation activities?

We provide the descriptive results in Figure 4 which plots the dynamics of inventor executives innovation activities around the IPO. We limit our sample to IPO completed firms with at least one inventor executive. Interestingly we find that a sizeable fraction of inventor executives continue to work on innovation during their tenure after the IPO. We call them "active" inventor executives. From the graph we can see that condition on that a firm has at least one inventor executive, about 30% of these inventor executives still file patents in the window five years before and after the IPO.

A natural question is which factors are associated with the active inventor executives. In other words, what are the determinants of these innovation activities? This question could help us better understand firms' demand on inventor executives. For example, if we observe a positive relationship between the competition pressure a firm encounters and the probability of active inventor executives in the firm, it suggests that inventor executives play an important role during tough times.

Table 9 reports the determinants of active inventor executives. We regress $\mathbf{1}\{\text{Num active IE}\}$ on a variety of lagged firm variables, where $\mathbf{1}\{\text{Num active IE}\}$ is a dummy variable equalling one if a firm has at least one active inventor executive in a year and zero otherwise. We estimate the model by logit model and linear probability model. In the first two columns we use all IPO completed firms and the sample period is from the IPO filing year and five years after IPOs.

Then we limit the sample to those firms with at least one inventor executives in column (3) and (4). Sample and estimation models are reported at the top of the table. There are some interesting findings. First, product market competition pressure measured by the industry HHI index is positively related to the inventor executive innovation activities after the IPO. This result further supports our analysis in the potential channel on product market competition which argues that inventor executives could help firms better handle the competition form rivals by their superior ability on both the management and innovation. Second, the probability of being active inventor executives is negatively related to some performance measure, e.g., ROA, the stock market return, and the revenue. The interpretation of this finding is similar to the product market competition idea: inventor executives are more active in innovation activities when the firms are in the tough time. Third, the estimation coefficient on Tobin's Q is significantly positive across all specifications.

7 Conclusion

This paper examines the effect of going public on human capital mobility. We look at this question from a different perspective: firms' human capital demand side. Specially, we examine the effect of going public on firms' demand on inventor executives, a special type of human capital with both the experience of innovation and management. Using IV method and a manually constructed executive-patent data set, we find that firms demand more inventor executives after IPOs. The effect is pronounced for firms with higher product market and innovation competition pressure. We also find that the number of inventor executives is positively related to firms' survival probability, stock market performance, operating performance, and innovation performance. Inventor executive level analysis reveals that inventor executives still pay attention to innovation activities by filing patents during their tenure as executives after IPOs.

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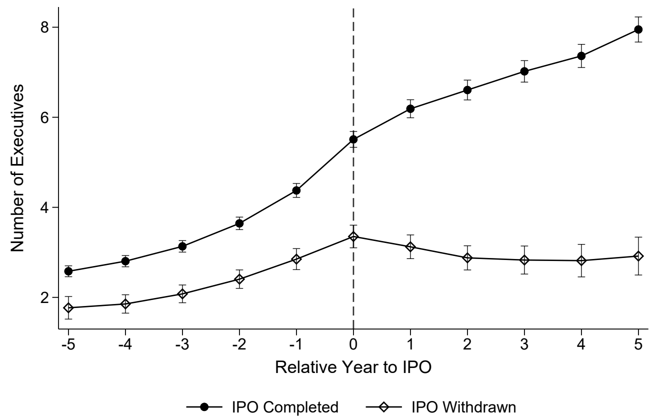
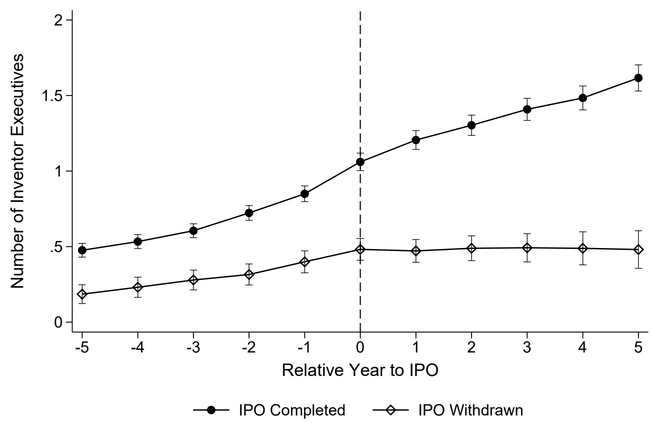
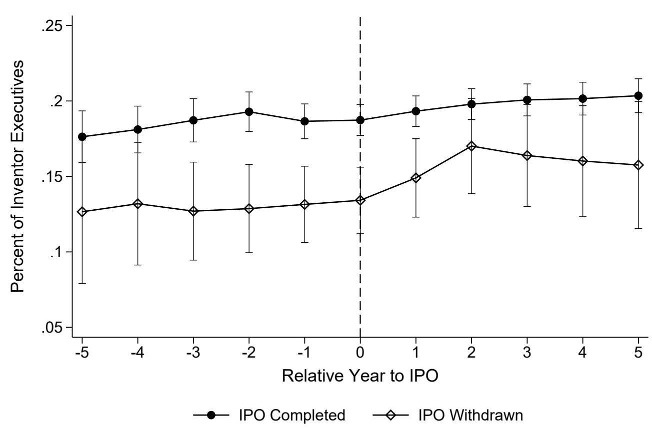


(a) Number of Executives



(b) Number of Inventor Executives



(c) Percentage of Inventor Executives

Figure 1: Inventor Executives Dynamics around IPO

This figure plots the dynamics of executives and inventors executives around IPO event time for IPO completed firms and withdrawn firms.

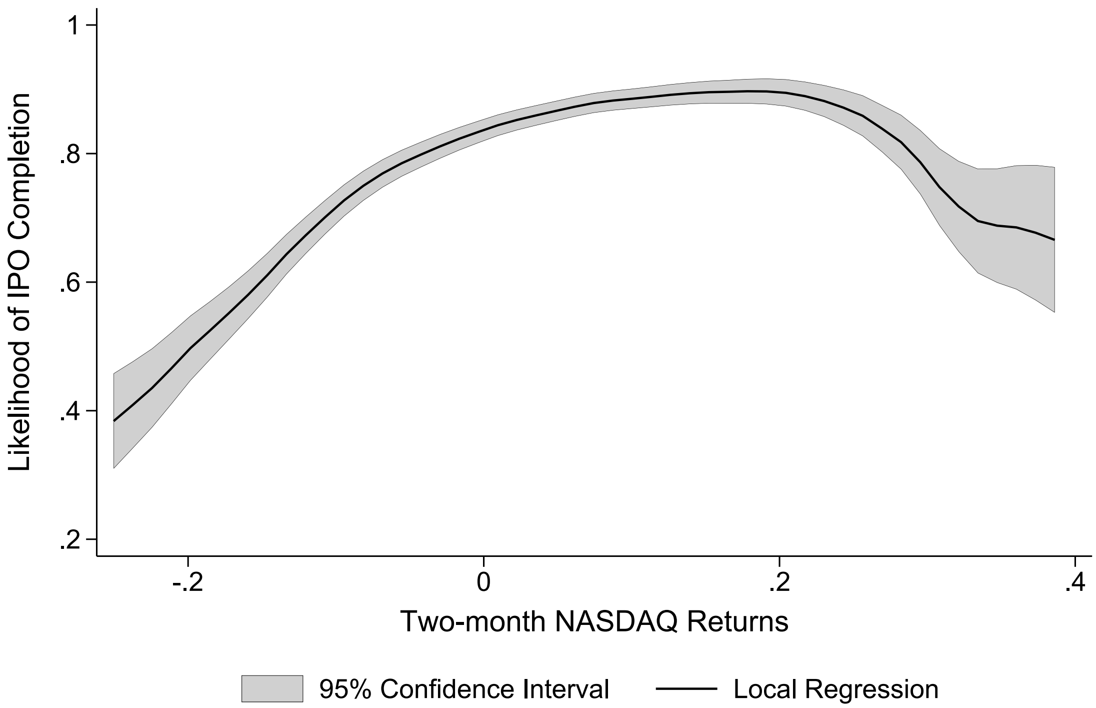
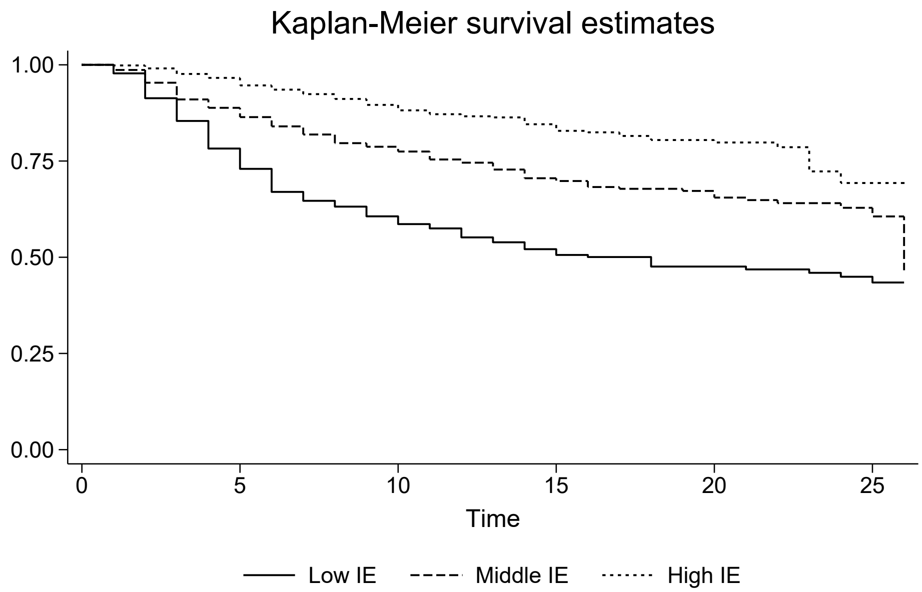
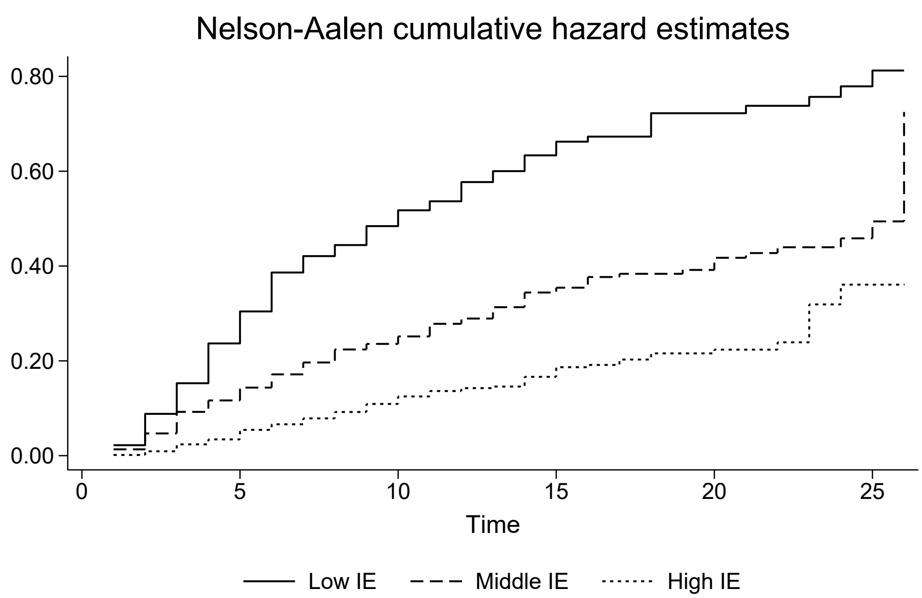


Figure 2: Two-month NASDAQ fluctuations and likelihood of IPO Completion

This figure plots the nonparametric estimation result between the two-month NASDAQ return after the IPO filing and the IPO completion likelihood.



(a) Survival Estimates of IPO firms with a high IE level or a low IE



(b) Survival Function of IPO firms with a high IE level or a low IE

Figure 3: IPO Firms Survival Analysis

This figure plots the survival analysis estimates for IPO firms with high investor executives number versus low investor executive number.

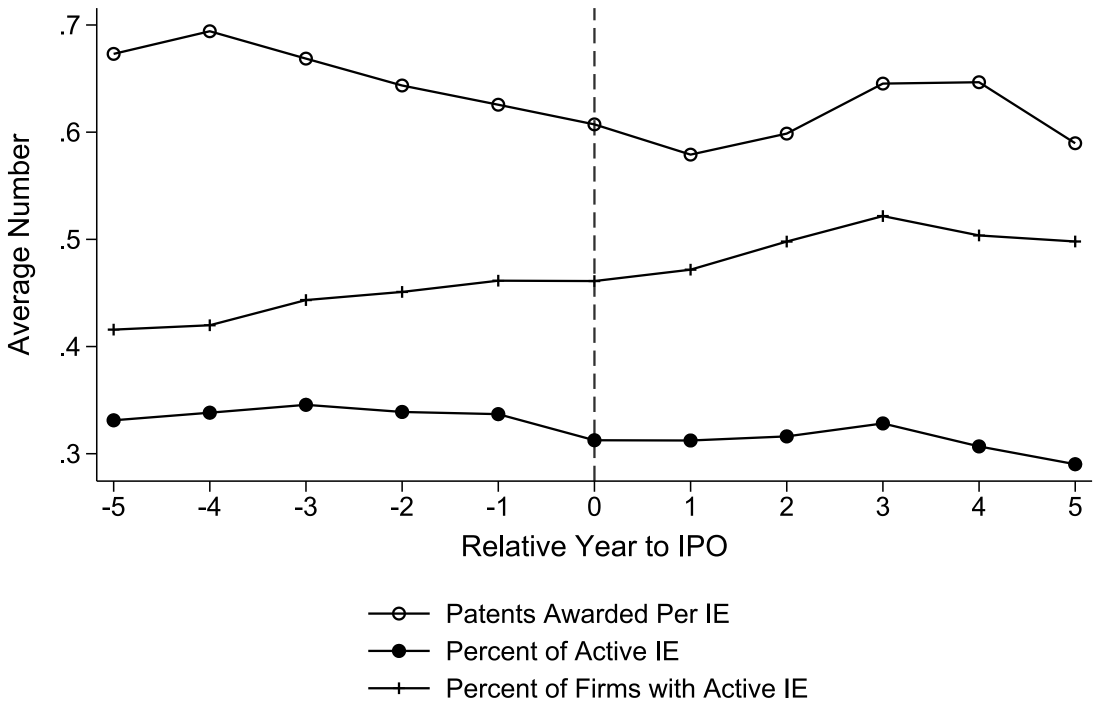


Figure 4: Inventor Executives Innovation Activity around IPO

This figure plots the dynamics of inventor executives innovation activities around IPO. Sample firms are restricted to IPO completed firms with at least one inventor executive.

Table 1: Summary Statistics

This table reports the main variables used in this paper. Panel A reports the IPO sample year distribution. Panel B reports the IPO sample by Fame-French 12 industry classification. Panel C reports the summary statistics for the investor executives and non investor executives. Panel D reports the number of patents distribution. Panel E reports the summary statistics of firm characteristics and IPO characteristics for IPO completed firms and withdrawn firms. All variables are defined in the Appendix A1. All continuous variables are winsorized at 1% level.

Panel A: IPO sample by year

	Completed				Withdrawn			
Year	N	Num Exe	Num IE	% IE	N	Num Exe	Num IE	% IE
1994	219	3.09	0.49	0.16	1	2.75	0.00	0.00
1995	237	3.58	0.59	0.16	4	3.30	0.55	0.26
1996	385	3.69	0.64	0.17	41	1.66	0.22	0.11
1997	224	3.99	0.77	0.20	41	1.72	0.16	0.08
1998	138	5.14	0.76	0.13	45	1.90	0.15	0.07
1999	249	6.30	1.15	0.18	48	2.79	0.38	0.13
2000	202	5.84	1.53	0.26	206	2.68	0.42	0.16
2001	42	6.91	1.41	0.21	15	3.10	0.53	0.20
2002	50	8.26	1.54	0.20	15	3.53	0.42	0.16
2003	44	7.72	1.51	0.21	3	4.32	0.40	0.06
2004	129	7.97	1.85	0.24	35	4.10	0.72	0.17
2005	116	8.16	1.73	0.21	20	3.12	0.63	0.22
2006	125	8.11	1.71	0.23	13	3.58	0.60	0.14
All	2,160	5.05	0.96	0.19	487	2.41	0.37	0.14

Panel B: IPO Sample by Fama–French 12 industry

	Completed				Withdrawn			
FF-12 Industry	N	Num Exe	Num IE	% IE	N	Num Exe	Num IE	% IE
Consumer NonDurables	76	4.18	0.64	0.17	9	2.22	0.11	0.02
Consumer Durables	36	6.14	0.97	0.20	2	1.50	0.00	0.00
Manufacturing	149	3.94	0.73	0.20	24	1.63	0.38	0.19
Energy	66	5.21	0.77	0.15	7	1.86	0.29	0.18
Chemicals	31	5.81	1.29	0.22	4	1.50	0.25	0.08
Business Equipment	764	4.94	0.99	0.19	201	2.65	0.35	0.12
Telephone and Television	103	5.19	0.85	0.17	36	2.39	0.33	0.12
Utilities	22	5.82	1.36	0.26	2	2.50	0.50	0.13
Wholesale and Retail	214	4.21	0.50	0.11	54	2.02	0.07	0.02
Healthcare	347	5.13	1.52	0.27	70	2.41	0.60	0.25
Other	352	4.98	0.73	0.13	78	2.54	0.35	0.14

Panel C: Investor executive and non inventor executive characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	Non Inventor Executive		Inventor Executive		(2) − (4)	
	N	Mean	N	Mean	Difference	t-value
CEO	202,645	0.12	45,573	0.15	-0.03	-19.67
CFO	202,645	0.15	45,573	0.11	0.04	19.73
Tenure	201,389	6.53	44,020	6.76	-0.23	-7.79
Age	149,038	47.55	36,646	49.63	-2.08	-38.03
Male	202,485	0.84	45,522	0.96	-0.12	-66.87
MBA	202,645	0.19	45,573	0.17	0.02	9.20
MS	202,645	0.28	45,573	0.36	-0.08	-34.13

Panel D: Distribution of cumulative number of patents granted to inventor executives

Cumulative num of patents up to 2010	Num of IE	Percent	Cumulative Percent
1	1,487	21.78%	21.78%
2	927	13.58%	35.35%
3	636	9.31%	44.67%
4	488	7.15%	51.82%
5	376	5.51%	57.32%
6	278	4.07%	61.39%
7	212	3.10%	64.50%
8	217	3.18%	67.68%
9	210	3.08%	70.75%
10	184	2.69%	73.45%
>10	1,813	26.55%	100.00%
Total	6,828	100.00%	

Panel E: IPO completed firm and withdrawn firm characteristics

	Completed				Withdrawn					
Variable	N	Mean	Median	SD	N	Mean	Median	SD	Difference	t-value
Inventor executive measures in the three years before IPO filing										
Num IE before	2,160	487	0.61	0.00	0.93	0.26	0.00	0.55	0.34	7.82
% IE before	2,160	487	0.16	0.00	0.25	0.11	0.00	0.24	0.05	4.19
Inventor executive measures in the five years after IPO filing										
Num IE	2,160	487	1.22	1.00	1.38	0.41	0.00	0.65	0.81	12.70
% IE	2,160	487	0.19	0.14	0.22	0.14	0.00	0.24	0.05	4.70
Financial information at IPO filing year										
Log(Asset)	2,160	487	4.49	4.36	1.46	3.29	3.13	1.66	1.20	15.87
R&D	2,160	487	0.08	0.02	0.15	0.17	0.03	0.27	-0.09	-9.65
Cash	2,160	487	0.27	0.19	0.26	0.28	0.14	0.29	-0.01	-0.42
Sales	2,160	487	0.90	0.68	0.85	1.04	0.59	1.22	-0.14	-3.11
Net income	2,160	487	-0.09	0.01	0.31	-0.42	-0.20	0.63	0.33	17.20
IPO characteristics										
Postfiling NASDAQ returns	2,143	484	0.05	0.05	0.09	-0.01	-0.01	0.13	0.07	13.04
Prefiling NASDAQ returns	2,143	484	0.13	0.12	0.13	0.16	0.11	0.20	-0.03	-4.16
Firm age	2,052	384	15.81	8.00	20.67	9.03	4.00	13.41	6.79	6.19
Underwriter rank	2,103	470	7.38	8.00	2.12	7.96	8.00	1.53	-0.58	-5.60
VC backed	2,160	487	0.52	1.00	0.50	0.38	0.00	0.48	0.15	5.86
Pioneer	2,157	487	0.05	0.00	0.23	0.03	0.00	0.18	0.02	1.72

Table 2: Instrument Validity Tests

This table reports the instrumental variable validity test results. Panel A reports the relevance condition results. The dependent variable is a dummy variable *IPO* that equals one if a firm completes the IPO filing, and zero otherwise. *Postfiling NASDAQ returns* are the two-month returns after the IPO filing date. *Book-building NASDAQ returns* are calculated from the date of the initial registration statement to the completion or withdrawal date. *NASDAQ drop* is a dummy variable that is equal to one if the *two-month NASDAQ returns* from the date of the IPO filing are within the bottom 25% of all filers in the same year and zero otherwise. In columns (3) and (4) the sample is restricted to IPO filings before 2000. Panel B and Panel C report the exclusion condition test results. Panel B presents differences in firm characteristics and the size of inventor executives between IPO filers that experience a NASDAQ drop and other filers in the same year. A firm is said to have experienced a NASDAQ drop if its two-month NASDAQ returns following the IPO filing is at the bottom of the distribution of all IPO filers in the same year. Bottom 10% (25%) refers to all firms that experience the lowest 10% (25%) NASDAQ returns of all IPO filers within a year. Top 90% (75%) refers to the remaining firms. Panel C reports a placebo test to assess the validity of the instrumental variable exclusion condition. The dependent variable is the average number of inventor executives in the five years after the IPO filing. *Postfiling NASDAQ returns* are the two-month NASDAQ returns calculated from the IPO filing date. *Year before NASDAQ returns* are the two-month NASDAQ returns calculated from a year before the IPO filing. *Year after NASDAQ returns* are the two-month NASDAQ returns calculated from a year after the IPO filing. Control variables are three-month NASDAQ returns prior to the IPO filing, number of investor executives in the three years before the IPO filing, VC backed, and Pioneer. All continuous variables are winsorized at 1% level. Standard errors are clustered at the firm level. t-statistics are reported within parentheses under the estimates. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

Panel A: Relevance condition

	IPO							
	(1) All	(2) All	(3) Pre-2000	(4) Pre-2000	(5) All	(6) All	(7) All	(8) All
Postfiling NASDAQ returns	0.708***	0.731***	0.427***	0.411***				
	(9.35)	(9.73)	(4.01)	(3.89)				
Book-building NASDAQ returns					0.902***	0.567***		
					(10.28)	(7.85)		
NASDAQ drop							-0.107***	-0.114***
							(-6.13)	(-6.50)
Control variables		Y		Y		Y		Y
Filing Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
N	2,447	2,447	1,435	1,435	1,443	2,447	2,465	2,447
Adj. R^2	0.19	0.26	0.07	0.13	0.13	0.25	0.18	0.24
F-statistic	87.44	47.72	16.06	19.50	105.67	41.78	37.57	38.26

Panel B: NASDAQ drops and firm characteristics

NASDAQ Returns Threshold:	Bottom 10%	Top 20%	Difference	t-value	Bottom 25%	Top 75%	Difference	t-value
Financial information at IPO filing								
Log(Asset)	4.26	4.46	0.20	1.53	4.21	4.38	0.05	0.46
R&D	0.09	0.10	0.00	0.33	0.10	0.10	0.01	0.74
Cash	0.28	0.26	-0.02	-1.14	0.29	0.27	-0.01	-0.32
Sales	1.02	0.88	-0.14	-1.81	0.98	0.86	-0.13	-2.00
Net income	-0.13	-0.14	-0.00	-0.06	-0.17	-0.14	-0.03	-0.95
IPO characteristics								
Firm age	15.94	15.87	-0.06	-0.04	14.97	14.78	-1.33	-0.93
Underwriter rank	7.56	7.34	-0.22	-1.24	7.61	7.35	-0.10	-0.73
VC backed	0.44	0.53	0.09	2.31	0.49	0.51	0.07	2.20
Pioneer	0.04	0.05	0.01	0.69	0.05	0.06	0.01	0.99
Inventor executive measures in the three years before IPO filing								
Num IE before	0.50	0.70	0.20	2.55	0.53	0.62	0.10	1.55
% IE before	0.14	0.18	0.04	1.84	0.15	0.17	0.02	1.25

Panel C: Placebo test

	Num IE				
	(1)	(2)	(3)	(4)	(5)
Postfiling NASDAQ returns	0.548***			0.535***	0.541***
	(2.73)			(2.65)	(2.62)
Year before NASDAQ returns		-0.217		-0.164	
		(-0.96)		(-0.73)	
Year after NASDAQ returns			-0.136		-0.024
			(-0.76)		(-0.13)
Control variables	Y	Y	Y	Y	Y
Filing Year FE	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y
N	2,447	2,447	2,447	2,447	2,447
Adj. R^2	0.54	0.53	0.53	0.53	0.53
F-statistic	291.19	289.03	288.92	242.69	242.55

Table 3: IV Estimation

This table reports the instrumental variable estimation results on the effect of going IPO on firm's demand on inventor executives. In column (1)–(3), the dependent variable is the average number of inventor executives in the five years after IPO. In column (4)–(5), the dependent variable is average percentage of inventor executives five years after IPO. In columns (1) and (4) the model is estimated using OLS, in column (2) and (5) it is estimated using 2SLS, and in column (3) and (6) it is estimated using GMM. The instrumental variable is *Postfiling NASDAQ returns*, which is the two-month returns after the IPO filing date. Control variables include three-month NASDAQ returns prior to the IPO filing, number and percentage of investor executives in the three years before the IPO filing, VC backed, and Pioneer. All continuous variables are winsorized at 1% level. Robust standard errors are applied. t-statistics are reported within parentheses under the estimates. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

	Num IE			% IE		
	(1) OLS	(2) 2SLS	(3) GMM	(4) OLS	(5) 2SLS	(6) GMM
IPO	0.648***	0.747***	0.866***	0.030**	0.100*	0.119**
	(13.51)	(2.80)	(3.21)	(2.47)	(1.89)	(2.11)
Num IE before	0.854***	0.846***	0.835***			
	(18.92)	(17.12)	(17.39)			
% IE before				0.445***	0.436***	0.453***
				(18.89)	(18.72)	(19.42)
Prefiling NASDAQ returns	-0.015	-0.014	-0.009	0.016	0.016	0.019
	(-0.11)	(-0.11)	(-0.07)	(0.57)	(0.58)	(0.71)
VC backed	0.075	0.060	0.032	0.012	0.001	-0.005
	(1.64)	(1.13)	(0.62)	(1.41)	(0.13)	(-0.44)
Pioneer	0.024	0.017	-0.004	-0.020	-0.025	-0.011
	(0.19)	(0.14)	(-0.04)	(-0.86)	(-1.11)	(-0.53)
Filing Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
N	2,447	2,627	2,627	2,447	2,627	2,627
Adj. R^2	0.56	0.55	0.52	0.36	0.36	0.29

Table 4: Competition and Demand on Investor Executives

This table reports the results of the regressions examining the relationship between the competition and the numbers of inventor executives after IPO. Panel A is the results for product market competition measured by *HHI*. *HHI* for an industry is calculated as the summation of squared firm's market shares where the market share is measured by the sales. Panel B is the results for innovation competition measured by Industry Patent Percent (*IPP*), which is calculated as the number of patents issued by firms in an industry divided by the total number of patents issued by firms in that year. In both panels, the dependent variable for the first three columns is the number of inventor executives *Num IE* and the second three columns is the percentage of inventor executives after IPO *% IE*. In column (1)–(2) and (3)–(4), I split the sample into two subsamples according to the HHI index or IPP. If a firm operates in an industry whose *HHI* (*IPP*) in the firm's IPO filing year is below the median of all industry *HHI* (*IPP*) in that year, the firm is assigned into the low group, otherwise it is assigned into high group. *IPO* is a dummy variable which is one if a firm completes its IPO and zero otherwise. All columns are estimated using 2SLS. All variables are defined in the Appendix. All continuous variables are winsored at 1% level. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

Panel A: Product market competition

	Num IE		% IE	
	(1)	(2)	(3)	(4)
	Low HHI	High HHI	Low HHI	High HHI
IPO	1.454***	0.454	0.258**	0.138*
	(2.63)	(1.22)	(2.13)	(1.88)
Num IE before	0.997***	0.781***		
	(15.48)	(8.17)		
% IE before			0.505***	0.390***
			(12.50)	(10.54)
Prefiling NASDAQ returns	-0.082	-0.161	0.030	-0.015
	(-0.32)	(-0.77)	(0.57)	(-0.38)
VC backed	-0.073	0.285***	-0.013	0.012
	(-0.97)	(3.20)	(-0.77)	(0.67)
Pioneer	0.226	0.064	0.052	-0.024
	(1.40)	(0.27)	(1.30)	(-0.76)
Filing Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
N	924	917	924	917
Adj. R^2	0.59	0.49	0.29	0.31

Panel B: Innovation competition

	Num IE				% IE			
	(1) Low IPP	(2) High IPP	(3) Low Patent HHI	(4) High Patent HHI	(5) Low IPP	(6) High IPP	(7) Low Patent HHI	(8) High Patent HHI
IPO	0.539	1.038***	1.981*	0.139	0.115	0.115	0.108	0.041
	(1.18)	(2.59)	(1.90)	(0.34)	(1.29)	(1.40)	(0.74)	(0.46)
Num IE before	0.712***	0.894***	0.737***	0.874***				
	(6.04)	(18.27)	(7.01)	(8.28)				
% IE before					0.437***	0.438***	0.413***	0.454***
					(11.37)	(12.97)	(11.77)	(10.96)
Prefiling NASDAQ returns	0.157	-0.443*	-0.342	-0.173	0.011	-0.003	0.096	-0.069
	(0.71)	(-1.94)	(-0.86)	(-0.88)	(0.22)	(-0.06)	(1.38)	(-1.50)
VC backed	0.147*	-0.023	-0.097	0.181**	-0.008	-0.004	-0.030	0.014
	(1.80)	(-0.23)	(-0.58)	(2.00)	(-0.43)	(-0.22)	(-1.09)	(0.69)
Pioneer	0.162	0.007	0.072	-0.314	0.007	-0.037	0.014	-0.040
	(0.63)	(0.04)	(0.34)	(-1.57)	(0.13)	(-1.07)	(0.21)	(-1.27)
Filing Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
N	946	906	748	744	946	906	748	744
Adj. R^2	0.42	0.61	0.51	0.47	0.30	0.37	0.35	0.33

Table 5: Cox Proportional Hazards Model of Probability of Failure

The table reports the estimation of Cox proportional hazards model of probability of failure and time to failure. All variables are defined in the Appendix A1. All continuous variables are winsorized at 1% percentiles level. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

	Coefficient	Hazard ratio	Coefficient	Hazard ratio	Coefficient	Hazard ratio	Coefficient	Hazard ratio
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Num IE	-0.348**	0.706	-0.302**	0.739				
	(-2.48)		(-2.01)					
% IE					-0.522	0.593	0.440	1.553
					(-0.61)		(0.46)	
Log(Asset)	-0.043	0.958	-0.084	0.919	-0.144	0.866	-0.165	0.848
	(-0.29)		(-0.47)		(-0.93)		(-0.87)	
R&D	-0.476	0.621	0.208	1.231	-0.629	0.533	0.292	1.339
	(-0.67)		(0.21)		(-0.88)		(0.28)	
Cash	-1.876**	0.153	-2.145**	0.117	-2.051**	0.129	-2.158**	0.116
	(-2.07)		(-2.08)		(-2.19)		(-2.07)	
Sales	0.296**	1.344	0.275	1.316	0.314**	1.369	0.227	1.255
	(2.28)		(1.30)		(2.47)		(1.09)	
Income	-1.602***	0.201	-1.437***	0.238	-1.560***	0.210	-1.436***	0.238
	(-7.00)		(-4.01)		(-6.90)		(-3.79)	
Log(1+Firm age)	0.065	1.067	0.055	1.057	0.068	1.071	0.108	1.115
	(0.38)		(0.24)		(0.38)		(0.46)	
Underwriter rank	-0.031	0.970	-0.058	0.943	-0.034	0.967	-0.056	0.946
	(-0.44)		(-0.57)		(-0.48)		(-0.54)	
VC	0.120	1.128	0.029	1.029	0.060	1.062	-0.008	0.992
	(0.42)		(0.08)		(0.20)		(-0.02)	
High tech industry	0.044	1.045	-24.996***	0.000	0.004	1.004	-25.535***	0.000
	(0.15)		(-17.66)		(0.01)		(-17.38)	
Year FE			Y				Y	
Industry FE			Y				Y	
N	5,784	5,784	5,784	5,784	5,784	5,784	5,784	5,784

Table 6: Inventor Executives and Stock Market Performance

This table reports the relationship between the number of investor executives and stock market performance after IPO. Panel A reports the five-year buy-and-hold abnormal returns on IPOs (both equal-weighted and value-weighted) compared with alternative benchmarks. For each IPO, the returns are calculated by compounding monthly returns, where abnormal returns are the simple difference between IPO five-year average returns and the corresponding benchmark. Pane B reports risk-adjusted market returns in the five years following the IPO of publicly traded firms. *RMRF* is the value-weighted market return on all NYSE/AMEX/ NASDAQ firms (RM) minus the risk-free rate (RF), which is the one-month Treasury bill rate. *SMB* (small minus big) is the difference each month between the return on small firms and big firms. *HML* (high minus low) is the difference each month between the return on a portfolio of high book-to-market stocks and the return on a portfolio of low book-to-market stocks. Columns (1) and (2) present results for the CAPM regressions, and columns (3) and (4) report results of the Fama–French three-factor regressions. Robust standard errors are reported in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively. A firm is allocated into the High IE group if its average number of inventor executives in the five years after IPO is above the median and Low IE group otherwise.

Panel A: Five-year post-IPO buy-and-hold returns versus various benchmarks

	S&P 500		NYSE/AMEX/NASDAQ		NASDAQ	
	Low IE	High IE	Low IE	High IE	Low IE	High IE
Equal Weighted	-0.482***	-0.096	-0.372***	-0.184**	-0.401***	-0.164**
	(-7.68)	(-1.28)	(-5.96)	(-2.37)	(-6.47)	(-2.13)
Value Weighted	-0.562***	0.086	-0.461***	0.098	-0.663***	0.134*
	(-8.93)	(1.17)	(-7.39)	(1.33)	(-10.51)	(1.84)

Panel B: Risk-adjusted return

	RETRF			
	(1)	(2)	(3)	(4)
	Low IE	High IE	Low IE	High IE
Constant	0.000	0.005***	0.000	0.005***
	(0.49)	(9.08)	(0.47)	(8.51)
RMRF	1.363***	1.566***	1.206***	1.341***
	(92.07)	(104.33)	(79.35)	(86.10)
SMB			0.902***	1.072***
			(38.28)	(38.24)
HML			-0.040	-0.395***
			(-1.62)	(-16.70)
R^2	0.08	0.11	0.10	0.14

Table 7: Investor Executives and Operating Performance

This table reports the relationship between the size of investor executives and return on assets. The sample is restricted to IPO completed firms and the sample period is within five years after the IPO filling year. The dependent variables in the columns (1)–(2) are *ROA* measured as EBITDA divided by lagged total assets. In column (3)–(4), the dependent variables are one-year forward *ROA*. In column (5)–(6), the dependent variable ΔROA_{t+1} is calculated as the *ROA* in year $t+1$ minus *ROA* in year t. Year and four-digit SIC industry fixed effects are included in all specification. All variables are defined in the Appendix. All continuous variables are winsorized at 1% level. Standard errors, clustered at firm level are reported in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

	ROA_t		ROA_{t+1}		ΔROA_{t+1}	
	(1)	(2)	(3)	(4)	(5)	(6)
Num IE	0.011***		0.008***		0.006**	
	(2.79)		(2.90)		(2.53)	
% IE		-0.002		-0.007		-0.006
		(-0.07)		(-0.30)		(-0.32)
Log(Asset)	0.008	0.011**	0.030***	0.032***	0.029***	0.031***
	(1.38)	(2.02)	(5.72)	(6.01)	(6.15)	(6.42)
Tobin's Q	-0.018***	-0.018***	-0.011***	-0.011***	-0.008**	-0.008**
	(-3.90)	(-3.87)	(-2.95)	(-2.93)	(-2.49)	(-2.47)
Cash	-0.318***	-0.323***	-0.089***	-0.092***	-0.033	-0.035
	(-6.04)	(-6.09)	(-3.05)	(-3.11)	(-1.25)	(-1.32)
Sales growth	0.055***	0.056***	-0.005	-0.005	-0.017***	-0.016***
	(8.12)	(8.16)	(-1.19)	(-1.13)	(-3.52)	(-3.49)
Net income	0.673***	0.672***	0.638***	0.637***	0.508***	0.507***
	(21.39)	(21.34)	(17.83)	(17.79)	(15.62)	(15.60)
Leverage	0.177***	0.172***	0.045	0.042	0.010	0.007
	(6.42)	(6.14)	(1.54)	(1.40)	(0.36)	(0.26)
ROA					-0.820***	-0.819***
					(-53.67)	(-53.57)
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
N	10,479	10,479	8,408	8,408	8,408	8,408
Adj. R^2	0.40	0.40	0.58	0.58	0.74	0.74

Table 8: Inventor Executives and Innovation Performance

This table reports the relationship between firms' patent quantity and quality and the investor executives. The sample is restricted to IPO completed firms after the IPO filing year. The dependent variables in the columns (1)–(2) are *Num patent* which is counted as the total number of patents granted to a firm in a given year. In column (3)–(4), the dependent variable is *Num citation* which is measured as the average citation of patents granted to the firm in a given year. In column (5)–(6), the dependent variable is *Patent value* which is defined as the average value of patents granted to the firm in a given year. The value of the patent is measured by the methodology in Kogan et al. (2017). The main independent variables are *Num IE* and *% IE*. All variables are defined in the Appendix. All continuous variables are winsorized at 1% level. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

	Num patent		Num citation		Patent value	
	(1)	(2)	(3)	(4)	(5)	(6)
Num IE	0.648***		0.536***		0.288***	
	(6.11)		(3.98)		(5.95)	
% IE		0.689		2.866***		0.045
		(1.64)		(3.24)		(0.24)
Log(Asset)	0.924***	1.104***	0.999***	1.170***	0.743***	0.820***
	(7.58)	(8.51)	(6.35)	(7.56)	(9.65)	(10.29)
R&D	4.125***	4.756***	5.926***	6.297***	1.565***	1.863***
	(4.65)	(5.15)	(3.86)	(4.07)	(3.53)	(4.06)
Cash	-0.011	0.050	3.666***	3.679***	0.437*	0.469*
	(-0.03)	(0.13)	(4.00)	(3.99)	(1.77)	(1.89)
Net income	0.050	0.120	0.081	0.080	0.135	0.173
	(0.19)	(0.46)	(0.16)	(0.16)	(0.94)	(1.20)
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
N	11,910	11,910	11,910	11,910	11,910	11,910
Adj. R^2	0.24	0.23	0.18	0.18	0.16	0.16

Table 9: Determinants of Active Inventor Executives

This table reports the determinants of active inventor executives. An inventor executive is defined as the active inventor executives if the executives file a patent in the executive tenure year. The sample is restricted to IPO completed firms after the IPO filing year. The dependent variables a dummy variable **1**{Num active IE > 0} which is one if a firm has at least one active inventor executives in a year and zero otherwise. All independent variables are one year lagged. The sample and estimation model are reported at the top of the table. All variables are defined in the Appendix. All continuous variables are winsorized at 1% level. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

	1{Num active IE > 0}			
	All	All	Num IE > 0	Num IE > 0
	Logit	OLS	Logit	OLS
	(1)	(2)	(3)	(4)
HHI	-0.259	-0.102**	-0.352*	-0.129*
	(-1.64)	(-2.00)	(-1.90)	(-1.95)
Log(Asset)	0.030	0.020***	0.003	0.013
	(1.10)	(2.73)	(0.08)	(1.44)
ROA	-0.201	-0.055*	-0.140	-0.018
	(-1.45)	(-1.70)	(-0.75)	(-0.41)
Stock annual return	-0.089***	-0.014*	-0.063*	-0.010
	(-2.93)	(-1.96)	(-1.77)	(-1.08)
Stock volitility	8.002***	1.259***	5.948***	0.935*
	(5.16)	(3.24)	(3.02)	(1.83)
Tobin's Q	0.044***	0.007**	0.061***	0.011***
	(3.01)	(2.26)	(3.32)	(2.84)
Sales growth	-0.003	0.002	0.003	0.006
	(-0.11)	(0.34)	(0.09)	(0.79)
Revenue	-0.136***	-0.014	-0.158***	-0.031*
	(-2.90)	(-1.15)	(-2.74)	(-1.88)
R&D	0.334	0.025	0.314	0.055
	(1.16)	(0.38)	(0.87)	(0.67)
Cash	0.143	0.041*	0.131	0.043
	(1.64)	(1.95)	(1.23)	(1.64)
Num IE	0.559***	0.094***	0.463***	0.076***
	(21.47)	(18.59)	(14.35)	(13.19)
Filing Year FE		Y		Y
Industry FE		Y		Y
N	6,956	6,941	4,732	4,710
Adj. R^2		0.20		0.15
Pseudo R^2	0.14		0.09	

Appendix

Table A1: Variable Definitions and Sources

This table reports the definition of variables and their data sources. The acronym for some data source is listed below:

- Harvard Patent Database: PID
- Jay Ritter's website (https://site.warrington.ufl.edu/ritter/ipo-data/): JR
- Noah Stoffman's website (https://host.kelley.iu.edu/nstoffma/): NS

Variable	**Definition**	**Source**
Baseline Analysis		
Executive	Dummy variable which is one if an employee has one of the following role titles: 1. CEO 2. President 3. Chairman 4. CXO 5. VPs 6. Division heads and zero otherwise.	BoardEx
Inventor	Dummy variable which is one if an employee owns at least one patent and zero otherwise.	PID
IE	Dummy variable which is one if an executive owns at least one patent and zero otherwise.	BoardEx; PID
Num IE	The number of inventor executives for a firm in a given year.	BoardEx; PID
% IE	The percentage of inventor executives in the executives team for a firm in a given year.	BoardEx; PID
IPO	Dummy variable which is one if a firm goes to public successfully and zero otherwise.	SDC
Log(Asset)	Natural logarithm of total assets [AT].	Compustat; EDGAR
R&D	Research and development expense [XRD] divided by total assets [AT].	Compustat; EDGAR
Cash	Cash holdings [CHE] divided by total assets [AT].	Compustat; EDGAR
Net income	Net income [NI] divided by total assets [AT].	Compustat; EDGAR
Sales	Sales [Sale] divided by total assets [AT].	Compustat; EDGAR
CEO	Dummy variable which is one if an executive's title is CEO and zero otherwise.	BoardEx
CFO	Dummy variable which is one if an executive's title is CFO and zero otherwise.	BoardEx
Tenure	Executive tenure in years.	BoardEx
Age	Executive age in years.	BoardEx
Male	Dummy variable which is one if an executive is a male and zero otherwise.	BoardEx

MBA	Dummy variable which is one if an executive owns an MBA degree and zero otherwise.	BoardEx
Science	Dummy variable which is one if an executive owns a science or engineering degree and zero otherwise.	BoardEx
HHI	Herfindahl-Hirschman Index where the market share is calculated based on sales.	Compustat
IPP	Industry patent percentage which is calculated as the number of patents issued by firms in an industry divided by the total number of patents issued by firms in that year.	NS
Patent HHI	A Herfindahl-Hirschman Index like index where the share is calculated based on the number of patents.	NS
IV Analysis		
Prefiling NASDAQ returns	The three-month NASDAQ returns preceding to the IPO filing date.	CRSP
Postfiling NASDAQ returns	The two-month NASDAQ returns calculated from the day of the IPO filing.	CRSP
Book-building NASDAQ returns	The NASDAQ returns calculated from the date of the initial registration statement to the completion or withdrawal date.	CRSP
VC backed	Dummy variable which is one if a firm is venture backed and zero otherwise.	JR
Pioneer	A dummy variable captures the location of a filer within the IPO wave. Following Benveniste et al. (2003), a filer is considered as a pioneer if its filing is not preceded by an IPO filing in the same Fama–French 48 industry in the previous 180 days.	SDC
Survival Analysis		
Delist	Dummy variable which is one if a firm is delisted within 5 years after the offering and zero otherwise.	CRSP
Firm age	Firm age in years measured as the difference between the firm's IPO year and its founding year.	JR
Internet firm	Dummy variable which is one if a firm is an internet-based firm and zero otherwise.	JR
Underwriter rank	A ranking of the lead underwriter on a scale of zero to nine, where nine is the highest underwriter prestige. The rating that covers the particular time period when the firm went public is used.	JR
Firm Performance Analysis		
ROA	Earnings before interests, taxes, depreciation and amortization [EBITDA] dividend by lagged total assets [AT].	Compustat

Tobin's Q	Book assets [AT] minus book equity [SEQ] and deferred taxes [TXDB] plus market value of equity [CSHO× PRCC_F] over total assets [AT].	Compustat
Sales growth	Annual percentage increase in sales [$\text{SALE}_t/\text{SALE}_{t-1}$].	Compustat
Leverage	Total debt [DLTT + DLC] minus cash and cash equivalents ([CHE] divided by total assets [AT].	Compustat
Num patent	The number of patents issued by a firm in a certain year.	NS
Num citation	The average citation of patents granted to the firm in a given year.	NS
Patent value	The average value of patents granted granted to the firm in a given year which is measured by the methodology in Kogan et al. (2017).	NS

Table A2: Sample Construction

This table reports the sample construction procedure for the empirical analysis.

	Completed	Withdrawn	Total
U.S. IPO between 1994 and 2006	4,905	3,248	8,153
Excluding financial firms and firms with more than one IPO	3,784	1,122	4,906
Matched to BoardEx	2,551	648	3,199
Matched to Compustat/S-1 filings	2,160	487	2,647

Table A3: Robustness Tests on Product Market Competition

This table reports the robustness check results of Table 4. Panel A replicates the regression specifications in Table 4 Panel A and uses different industry classifications and market sale measures to calculate HHI index. The industry classifications and market share measures are reported in the first left column. Pane B replicates the regression specifications in Table 4 Panel B and uses different industry classifications to calculate IPP and Patent HHI. For brevity we only report the coefficients of IPO and drop other coefficients. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% level, respectively.

Panel A: Product market competition robustness checks

	Num IE		% IE	
	(1)	(2)	(3)	(4)
	Low HHI	High HHI	Low HHI	High HHI
Fama–French 49 + Sale	1.454***	0.454	0.258**	0.138*
	(2.63)	(1.22)	(2.13)	(1.88)
Fama–French 49 + Revenue	1.542**	0.224	0.200*	0.078
	(2.33)	(0.83)	(1.80)	(1.19)
Fama–French 12 + Sale	0.683**	1.193	0.188***	0.184
	(2.45)	(1.41)	(3.03)	(1.10)
Fama–French 12 + Revenue	0.611*	0.688	0.188**	0.128
	(1.81)	(1.40)	(2.46)	(1.22)
Four-digit SIC + Sale	0.560*	0.698	0.114*	0.191
	(1.85)	(0.75)	(1.66)	(1.12)
Four-digit SIC + Revenue	1.503***	0.207	0.232**	0.061
	(2.95)	(0.60)	(2.20)	(0.86)

Panel B: Innovation competition robustness checks

	Num IE				% IE			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Low IPP	High IPP	Low Patent HHI	High Patent HHI	Low IPP	High IPP	Low Patent HHI	High Patent HHI
Four-digit SIC	0.539	1.038***	1.981*	0.139	0.115	0.115	0.108	0.041
	(1.18)	(2.59)	(1.90)	(0.34)	(1.29)	(1.40)	(0.74)	(0.46)
Three-digit SIC	0.589	0.795**	1.399**	0.343	-0.036	0.179**	0.127	0.060
	(1.47)	(2.11)	(2.03)	(0.75)	(-0.43)	(2.42)	(1.12)	(0.64)
Two-digit SIC	0.109	0.950***	0.764	0.672**	0.004	0.147**	0.094	0.115
	(0.19)	(3.09)	(1.46)	(2.05)	(0.03)	(2.44)	(1.01)	(1.61)
Fama–French 49	0.866*	0.719**	1.048*	0.421	0.052	0.141**	0.095	0.063
	(1.82)	(2.18)	(1.95)	(0.59)	(0.53)	(2.15)	(1.09)	(0.44)
Fama–French 12	0.797	0.629**	0.760**	0.473	-0.010	0.202***	0.188***	-0.059
	(1.59)	(1.99)	(2.00)	(1.01)	(-0.11)	(2.79)	(2.64)	(-0.65)