Diffusers of Entrepreneurship*

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Abstract

We examine an emerging phenomenon that talented employees leave successful entrepreneurial firms to join less mature ones. Using a unique person-level dataset and a comprehensive sample of private firms from the U.S. Census Bureau, we find that such "entrepreneurial diffusers", by potentially passing on entrepreneurial knowledge, innovative culture, and institutional wisdom, enhance their new employers' likelihood of successful exits. Further, these diffusers are motivated by the entrepreneurial spirit of risk-taking instead of monetary gains. Finally, we find that the departure of entrepreneurial diffusers contributes to the long-run IPO underperformance documented in the prior literature. Our paper offers new insights into a labor market channel of the cross-firm diffusion of entrepreneurship, which is critical to the sustainability of a vibrant entrepreneurial ecosystem.

Key words: Entrepreneurship, Diffusion, IPOs, Sell-outs, Innovation, Human Capital

JEL number: G32, G34, J24, J63, M13

1. Introduction

Entrepreneurship is a country's engine for long-term growth. For decades, the generations of success stories in the Silicon Valley, from Google to Facebook to recent "unicorns" such as Uber and Airbnb, have grabbed the headlines of major media, inspired young talents to start their own ventures, and motivated researchers to explore the underlying economic forces that are conducive to a sustainable and vibrant entrepreneurial ecosystem. While much of the research to date has been focusing on the operations and financing of start-up companies on a standalone basis, an equally or even more important question is how the entrepreneurial spirit, innovative culture, institutional wisdom, and technological knowledge of these successful start-ups are passed on from one start-up to other young ventures in the economy. Understanding the nature and mechanisms of such entrepreneurship "diffusion" is important because the collective success of a country's entrepreneurial ventures is critical to its economic growth and wealth creation. However, despite their importance, the channels through which entrepreneurship diffuses in an economy are underexplored in the literature.

In this paper, we aim to fill in the gap by examining the flow of human capital from mature entrepreneurial firms that have just successfully "exited" (in the form of initial public offerings, i.e., IPOs, or sell-outs) to less mature private start-ups, and exploring the motives and consequences of such labor movement.[1] The exodus of key employees after entrepreneurial firms' successful exits has been a prevalent phenomenon in the Silicon Valley. For instance, shortly after Google went public in August 2004, 100 of the first 300 employees hired left the company,

[1] Although there might be other ways to characterize the success of an entrepreneurial firm such as its growth rate or the ability to obtain venture capital investments, we use its exit event (i.e., an IPO or sell-out) to determine whether it is mature or not because such events are generally viewed as the clearest signals of entrepreneurial success. See previous literature such as Poulsen and Stegemoller (2008), Bayar and Chemmanur (2012), Chemmanur et al. (2018), Bowen, Fresard, and Hoberg (2020) for a more detailed discussion on why and when private entrepreneurial firms choose to "exit", i.e., to change ownership structures to allow early equity investors such as entrepreneurs and venture capitalists to cash out.

carrying away the institutional wisdom, entrepreneurial culture, and mentorship techniques as well as the financial capital they have earned during their days at Google. Many of these leavers continue their entrepreneurial pursuits by either starting their own businesses or joining other young start-ups, rather than enjoying an early retirement life or moving to another public corporation for job stability and promotion.[2] The same pattern of human capital flow also occurs to other successful entrepreneurial ventures such as Intel, PayPal, Facebook, and Uber, and has become a part of Silicon Valley's culture.[3] In this paper, we provide a detailed look into such labor movement culture and examine whether it facilitates the diffusion of entrepreneurship throughout the economy. Specifically, we focus on the group of employees who leave newly public or acquired entrepreneurial ventures to join other private firms that have not reached the point of exiting. As these people help diffuse the entrepreneurial knowledge and technological knowhow from their previous successful entrepreneurial experience to new startups in the economy (e.g., by serving as team-leaders or mentors), we defined them as "entrepreneurial diffusers".

Our paper mainly aims to answer four related research questions. First, who are these entrepreneurial diffusers, and specifically, do they have better "entrepreneurial quality" (i.e., the essential characteristics required for entrepreneurial successes) than those employees who choose to stay at the current employers or join other publicly traded companies? As entrepreneurial quality is hard to measure in practice, we will mainly examine an employee's past innovation activities to gauge the degree of his or her creativity and risk-taking spirit, which are both required qualities

[2] A case in point is Vibhu Mittal, who was a senior scientist at Google and one of its first 100 employees. Leaving Google soon after its IPO to fulfil his dream of revolutionizing education, Mr. Mittal helped found a new start-up, Root-1, which makes neuroscience-based games to improve language learnings at elementary schools. Similarly, Gokul Rajaram, once regarded as the "godfather" of Google AdSense, left Google post its IPO to start Chai Labs, which was later acquired by Facebook.

[3] For example, Peter Thiel, who left PayPal after its sell-out to eBay in October 2002, found a new software company Palantir and invested in many other start-ups. Elon Musk is another famous example, who left PayPal to join the newly established Tesla and found SpaceX and a few other new ventures.

for achieving entrepreneurial successes. Second, we examine whether these entrepreneurial diffusers add value to the new start-ups they join by increasing the latter's innovation potential and likelihood of successful exits. The answer to this question has important welfare implications because it indicates whether the diffusion of entrepreneurship from successful ventures to new start-ups can contribute to the sustainability and succession of an entrepreneurial ecosystem.[4] Third, we investigate the motives of entrepreneurial diffusers to switch their jobs amid early career success. In particular, we will examine two mutually non-exclusive incentives, namely, their desire to make a big fortune through the value spike in their wages or employee stocks/options by joining another successful entrepreneurial firm (i.e., the monetary incentive), and their preference to work in an adventurous and exploratory environment instead of a mature and mundane public firm (i.e., the entrepreneurial spirit incentive).[5] Finally, we examine the consequences of the departure of entrepreneurial diffusers for their original employers.

To answer these questions, we need to overcome several empirical hurdles mainly arising from data limitations. First, in order to examine whether entrepreneurial diffusers contribute to the success of new start-ups that they join, we need to observe not only those that successfully exit afterwards but also those that do not. This is difficult to achieve because most commercial databases, such as Compustat and CRSP, focus primarily on publicly traded firms. For those databases that include some private firms, they only cover a small subset of the population without

[4] The value of working for previously successful entrepreneurial ventures has been widely recognized by business practitioners. For example, Carolyn Betts-Fleming, the chief executive of Betts Recruiting, a leading recruiting firm based in San Francisco, predicted in 2019 that there would be a new wave of departing talents to establish their own start-ups or get hired for senior positions at other young ventures. The explanation she offered for her prediction is that "the track record of riding a wave at a company from nothing to IPO in a short period is a very valuable asset to have."

[5] It is worth noting that there could be other potential motives of entrepreneurial diffusers. We focus on the two major incentives that are widely discussed among practitioners and well-motivated by the literature (to be discussed later).

sufficient information.[6] To tackle this problem, we make use of the Longitudinal Business Database (LBD) maintained by the U.S. Census Bureau, which covers the entire universe of business establishments in the U.S., public or private.

Second, we need person-level data on the entrepreneurial diffusers that include their employment history and basic demographic characteristics that influence their risk attitudes (e.g., age, gender, and ethnicity). However, most commercial databases on person-level data only cover top executives or board directors. To overcome this difficulty, we exploit another dataset from the U.S. Census Bureau, namely, the Longitudinal Employer-Household Dynamics (LEHD) dataset, which contains individual employees' quarterly employment status and demographic information for over 95% of the private sector employment in all U.S. states. By matching LEHD to LBD, we are able to identify entrepreneurial diffusers, as well as the firms they leave and the firms that they subsequently join. Further, the LEHD database contains information on employees' earnings, which include base salary as well as other forms of compensation that are taxed as ordinary income, such as bonuses, stocks, stock options, and profit distributions (see, e.g., Tate and Yang (2015), and Aldatmaz, Ouimet, and Van Wesep (2018)), which allows us to effectively capture all types of labor income gains when studying the diffusers' incentives.

Third, to study the entrepreneurial quality of the diffusers, we need information on their past innovation activities. Since the Census datasets mentioned above (i.e., LBD and LEHD) do not provide such information, we make use of the individual inventor data from the Harvard

[6] For example, VentureXpert only covers private firms that are backed by venture capital (i.e., the top of the cream in the vast population of entrepreneurial ventures) and Capital IQ mostly covers large private firms that are mandated by the U.S. Securities and Exchange Commission (SEC) to disclose financial information (see, e.g., Gao, Hsu, and Li (2018)). Similarly, SDC contains transaction-level information only for those private firms that are ready to exit in the form of IPOs or sell-outs, but not for those that do not successfully reach the exiting stage.

Business School (HBS) Patenting Database, which contains information about each inventor's patenting activities as well as his/her employer when a given patent is filed.

While both of our main data sources (i.e., the Census data and the inventor data) have their own limitations, they are complementary in helping us analyze our research questions. Although the entrepreneurial diffusers identified from the Census data do not necessarily engage in innovation activities as the inventors do, they may possess other talents such as technical, marketing, mentoring/advising, or management skills that could benefit the new start-ups they join. Meanwhile, using inventors' patenting activities to track down their employment history is imperfect, but allows us to gauge the entrepreneurial quality of a subset of important, technology-savvy diffusers. Hence, integrating these two data sources in our analysis allows us to provide unique insights on the human capital channel of entrepreneurship diffusion.[7]

Using the inventor data, we first find that the innovation quality of entrepreneurial diffusers, in terms of the number of patents they generate, the average number of citations received by each of the patents, the average originality of the patents, and the number of exploratory patents they generate, is higher than that of "stayers" (i.e., those inventors who choose to stay at the newly exited firms), "leavers to public firms" (i.e., those who leave for public firms), and even new-hires. Thus, entrepreneurial diffusers seem to be the best talents among all types of employees in the newly exited firms, and the loss of these talents cannot be easily replaced by hiring new employees. These results suggest that entrepreneurial diffusers possess the creativity and the risk-taking spirit required for entrepreneurial success.

[7] Our empirical design thus reflects the complementarity of the two data sources. For research questions that both can shed light on, we show parallel results to demonstrate that our findings are robust to using either data source. For questions that only one data source can help answer, we just rely on the unique information from that particular source.

We next turn to the Census data and examine whether and how these entrepreneurial diffusers add value to the new start-ups they join. If such employees possess valuable human capital and pass on their skills, vision, and entrepreneurial spirit to the start-ups they join, then the latter's likelihood of successful exiting, in the form of either IPOs or sell-outs, should increase in the fraction of entrepreneurial diffusers among the firms' workforces. To mitigate concerns of selection effects, e.g., entrepreneurial diffusers are capable of identifying and joining firms with higher exiting likelihoods to start with or higher-quality firms are better able to pursue and hire such experienced people, we ideally want exogenous shocks (e.g., natural experiments such as regulatory changes) to a start-up's fraction of employees who are entrepreneurial diffusers, but such shocks are hard to come by. Compared to the analysis of public firms, studies on private firms suffer more from data limitation, which makes a clean identification strategy even more challenging. Therefore, we try our best to mitigate the concerns for endogeneity by matching exiting firms to non-exiting ones on the basis of key observable characteristics (available for the private firms in our sample) that are likely to be associated with firm quality such as their VC-backing status, which is commonly used as a comprehensive proxy for unobservable firm quality (see, e.g., Hochberg, Ljungqvist, and Lu (2007), Kerr, Lerner, and Schoar (2011), and Dimmock, Huang, and Weisbenner (2019)). Specifically, we match non-exiting private firms to the exiting ones on year, industry, size, age, VC-backing status, and whether they operate multiple establishments, and then compare their subsequent exiting likelihoods. Using the matched sample, we find that a one percentage point increase in the fraction of the start-ups' employees who are entrepreneurial diffusers (i.e., those who had left newly exited firms and moved to private firms in the past) is associated with a 3.3 percentage point increase in the firms' likelihood to successfully

exit. This result suggests that entrepreneurial diffusers are likely to add value to the new start-ups they join.

Further, we investigate the motives of entrepreneurial diffusers to leave the newly exited firms and join other start-ups. To test the monetary incentive, we use the Census data to examine the change in labor income of entrepreneurial diffusers after they move to private firms. We find that, compared to stayers and leavers to public firms, entrepreneurial diffusers do not experience a significantly higher labor income growth, in both the short run and the long run. The results suggest that entrepreneurial diffusers do not jump to private firms to pursue personal wealth gains, which is inconsistent with the monetary incentive hypothesis.[8] This finding echoes anecdotal evidence that young start-ups simply cannot compete on salary with the likes of Google and Facebook. For example, when one startup in the Silicon Valley tried to hire a Google programmer by offering a $500,000 salary, the programmer turned down the offer because he could make $3 million annually in cash and restricted stock units (see "Silicon Valley tech workers living the startup dream again," *CIO*, March 7, 2014).[9]

To test the entrepreneurial spirit incentive, we perform two analyses. First, we use the inventor data to examine the post-exit innovation activities of entrepreneurial diffusers relative to stayers and leavers to public firms. We find that, in the five years after their original employers' exits, entrepreneurial diffusers file more patents and receive more citations per patent than their matched stayers and leavers to public firms. The patents filed by entrepreneurial diffusers are also more original and more exploratory in nature than those filed by other inventors. These results

[8] In contrast, leavers to public firms experience significantly higher labor income growth compared to stayers, in both the short and the long run, suggesting that those who leave the exited firms and join other public firms do so to pursue monetary benefits.

[9] These results are also consistent with the previous literature showing that people pursue entrepreneurship for nonpecuniary reasons such as the desire for autonomy and the tolerance for risk (see, e.g., Hamilton (2000); Hvide and Panos (2014); Ouimet and Zarutskie (2014); Roach and Sauermann (2015); and Cassar and Meier (2018)).

suggest that, by moving to private firms, entrepreneurial diffusers are able to keep engaging in innovation activities, which are explorative and risky in nature. Second, we use the Census data to examine whether an employee's ex-ante job risk tolerance is associated with his or her tendency of becoming an entrepreneurial diffuser. Following He, Shu, and Yang (2020), we use an employee's household labor income diversification to measure his or her job risk tolerance. Intuitively, if an employee's household labor income is more diversified, the employee will be more tolerant of labor income risk arising from an entrepreneurial job, and thus be more willing to move to a new start-up. Consistent with this prediction, we find a significantly positive association between the employees' household labor income diversification and their tendency to become entrepreneurial diffusers. Taken together, the results from both the inventor data and the Census data are consistent with the entrepreneurial spirit hypothesis.

In the final part of our paper, we examine how the departure of entrepreneurial diffusers affects newly public firms' post-IPO performance.[10] We find that, using both the Census data and the inventor data, the fraction of employees/inventors who leave a newly public firm after the IPO to join other private firms is negatively associated with the firm's post-IPO operating performance and stock returns. To mitigate concerns for endogeneity due to either reverse causality (i.e., entrepreneurial diffusers predict the future bad performance and thus choose to leave) or omitted variables (e.g., organizational features that lead to both bad performance and an exodus of talented employees), we conduct a two-stage least squares (2SLS) analysis, where the instrument, motivated by Gao, Hsu, and Li (2018), is the change in the fraction of patents in an IPO firm's industry that are generated by private (as opposed to public) firms. Intuitively, this instrument

[10] For this analysis, we do not examine the post-exit performance for acquired start-up firms because after the sell-out, these exited firms will be integrated into the acquirers, which are typically much larger. Thus, their combined performance after the acquisition will be largely determined by the acquirers rather than the acquired start-ups that lose entrepreneurial diffusers.

captures the change in the quality of the entrepreneurial environment (in terms of overall innovation intensity) that private firms can offer relative to public firms in the same industry. An enhanced entrepreneurial environment offered by private firms will be more likely to attract entrepreneurial diffusers who chase after entrepreneurial spirit and make them more willing to jump to private firms after their employers' IPOs. Using this instrumental variable analysis, we again find a negative effect of the entrepreneurial diffusers' departure on post-IPO performance, further illustrating the valuable human capital possessed by such employees. This result also suggests that the loss of talented employees with entrepreneurial experience and spirit might be one underexplored explanation for the well-known IPO long-run underperformance puzzle (e.g. Ritter (1991), Jain and Kini (1994), Teoh, Welch, and Wong (1998), and Chemmanur and Paeglis (2005)).

While previous literature on the importance of human capital shows that skilled employees can significantly enhance the value and performance of their *current* employers, our paper focuses on how such employees can benefit their *next* employers by diffusing the contributing factors of entrepreneurial success from their current workplace to new startups in the economy. Our study also extends the entrepreneurship literature by focusing on a human capital flow channel through which entrepreneurship is diffused. In our setting, the transfer of entrepreneurial knowledge from one startup to another is achieved via inter-firm labor flow rather than family inheritance or business advice from common financiers such as venture capitalists. To the best of our knowledge, this paper is the first to document and explore in detail the emerging phenomenon of entrepreneurial diffusers, which creates a new conversation for future research.[11]

[11] Given that we are the first to study this new phenomenon with insufficient data on private firms (in comparison to public firms), we acknowledge that our tests on the relation between entrepreneurial diffusers and firm value might still suffer from endogeneity concerns despite the various empirical approaches currently adopted. Future studies could try to overcome the data hurdles and explore better identification strategies.

2. Related literature

Our paper is related to several strands of literature. First, it contributes to the literature that studies the importance of human capital for firms. For example, Eiling (2013), Donangelo (2014), Israelsen and Yonker (2017), Kuehn, Simutin, and Wang (2017), and Shen (2018) document that human capital as well as labor mobility adds critical value to publicly traded firms and thus influences asset prices.[12] Focusing on newly public firms, Chemmanur and Paeglis (2005) show that firms' post-IPO performance is positively associated with their management quality. Further, Bernstein (2015) documents that the departure of inventors after IPOs partly contributes to the decline in innovation by newly public firms, and Babina, Ouimet, and Zarutskie (2020) find that the departure of high-wage employees to startups after a successful IPO triggers the industrial diversification of the IPO firm. In addition, recent studies have also started to explore the value of human capital for private entrepreneurial firms both theoretically (e.g., Bayar and Chemmanur (2011) and He and Li (2016)) and empirically (e.g., Bayar and Chemmanur (2012), Chemmanur et al. (2018), Dimmock, Huang, and Weisbenner (2019), and Gu, Huang, Mao, and Tian (2020)). While the above literature shows that skilled employees can significantly enhance the value and performance of their *current* employers, our paper focuses on how such employees can benefit their *next* employers by diffusing the entrepreneurial knowledge and technological knowhow from their current workplace to new startups in the economy. Meanwhile, we also find that the departure of such entrepreneurial diffusers reduces a firm's future performance.

Second, our paper is related to the large literature on the determinants of entrepreneurship (see the comprehensive reviews by Agarwal and Shah (2014) and Parker (2018)). In particular, this line of research finds that founders of young startups can obtain their entrepreneurial spirit,

[12] Similarly, Chemmanur, Kong, Krishnan, and Yu (2019) and Liu, Mao, and Tian (2017) show that human capital is a key driving force of public firms' innovation productivity.

knowledge, skills, and experience from venture capitalists (e.g., Hellmann and Puri (2002, 2015), Samila and Sorenson (2011), Chemmanur, Krishnan, and Nandy (2011), Tian (2011), Chemmanur, Loutskina, and Tian (2014)), social contacts (e.g., Lerner and Malmendier (2013), and Guiso, Pistaferri, and Schivardi (2020)), or family members (e.g., Lindquist, Sol, and van Praag (2015), Laspita et al. (2012), Hvide and Oyer (2019), Vladasel et al. (2020)), which motivate them to start their own businesses and contribute to the startups' subsequent growth. Our study extends this strand of literature mainly in two ways. First, while the majority of studies focus on whether the exposure to entrepreneurial knowledge, skill, and experience encourages people to found new ventures (i.e., the extensive margin), we analyze how entrepreneurial diffusers, after deciding to establish or join new startups (either as *founders* or *hires*), help shape the performance of the firms they establish/join (i.e., the intensive margin). Second, we focus on a human capital flow channel through which entrepreneurship is diffused. In our setting, the transfer of the contributing factors of entrepreneurial success from one startup to another is achieved via inter-firm labor flow rather than family inheritance, social network, or business advice from common financiers such as venture capitalists.[13]

Further, our paper contributes to the recent literature on the interaction between mature firms and younger firms in the economy. For example, Matray (2020) finds that private firms generate more patents after public firms located in the same geographical area experience an increase in their innovation output, and that inventor movement between the two types of firms is one important channel for this local spillover effect. While this paper focuses on patenting

[13] Our paper is also broadly related to the literature on the performance of serial entrepreneurs, i.e., those who repeatedly start new businesses (e.g., Gompers et al. (2010), Zhang (2011), Parker (2013), Lafontaine and Shaw (2016), and Nahata (2019)). We contribute to this literature in two dimensions. First, we study not only those who repeatedly found new ventures, but also those who repeatedly work for entrepreneurial firms as rank-and-file employees. Second, instead of purely focusing on startup performance as previous literature does, we also study the incentives of entrepreneurial diffusers as well as the effect of their departure on their original employers.

outcomes at the firm level, our paper examines a broader spectrum of corporate outcomes (including the likelihood for successful exits and post-exit stock/operating performance) and is the first to document the characteristics and incentives of individual entrepreneurial diffusers. In another related paper, Ma, Murfin, and Pratt (2020) find that younger firms tend to purchase vintage physical capital from older firms located in the same geographic area, which is mutually beneficial. While this paper studies the flow of tangible assets (i.e., physical capital) from older firms to younger firms, we focus on the flow of intangible assets (more specifically, human capital) between the two. Further, unlike the two papers mentioned above, we do not confine the interaction between mature firms and younger firms to a given geographical area.

Finally, our paper contributes to the accounting and finance literature on IPO performance. For example, Ritter (1991) and Jain and Kini (1994) show that firms underperform in the long run after their IPOs. Teoh, Welch, and Wong (1998) and Leone, Rock, and Willenborg (2007) find that corporate disclosure decisions are important determinants of IPO performance. Chemmanur and Paeglis (2005) find that firms with higher management quality have lower IPO underpricing and higher long-run stock returns. Further, Willenborg and McKeown (2001) and Bochkay et al. (2018) find that going-concern uncertainties of IPO firms are associated with IPO initial returns. We contribute to this line of research by documenting the loss of valuable human capital as another important determinant of post-IPO performance.

3. Data and Sample Construction

We obtain the data of U.S. IPOs and private-target acquisitions (i.e., sell-outs) from the Securities Data Company (SDC) database. Following previous IPO literature (e.g., Chemmanur and He 2011; Chemmanur et al. (2018)), we remove all IPOs related to equity carve-outs, American depositary receipts, American depositary shares, global deposit receipts, global deposit

shares, units, trust receipts, and trust units. For the sample of private-target acquisitions, we remove all deals that are reverse takeovers, spin-offs, recapitalizations, self-tenders, exchange offers, repurchases, minority stake purchases, acquisitions of remaining interest, privatizations, divestitures, asset sales, deals whose target and acquirer belong to the same parent company, and deals whose status is defined as "incomplete" by the SDC. We restrict our sample to IPOs and acquisitions that are completed between 1990 and 2007 because our data on individual employees, i.e., the Longitudinal Employer-Household Dynamics (LEHD) program from the U.S. Census Bureau, cover the period of 1990-2008 and we need at least one year to track the employees' job status after the completion of the deals.

We obtain individual employees' job history and demographic information from the LEHD program, which covers over 95% of the employment in the private sector of all states in the U.S.[14] Employees' quarterly earnings and employment information are obtained from the Employment History File (EHF). Individual characteristics, including age, gender, race, and education, are obtained from the Individual Characteristics File (ICF). In addition, the title 26 data from the LEHD program identify each person's household through tax return information (primarily the 1040 tax forms), which allows us to calculate the separate contribution of each family member towards household labor income and thus the family-level income diversification. Our LEHD sample includes 26 participating states, which agree to share their data with us as external (i.e., non-Census) researchers under the Local Employment Dynamics federal-state partnership.[15]

We match employers in the LEHD data to IPO and acquired private firms from the SDC data in three steps. First, we match the IPO and acquired firms to the Longitudinal Business

[14] See Abowd et al. (2009) for a comprehensive overview of the LEHD data.
[15] The 26 LEHD states in our sample are Arizona, California, Colorado, Delaware, Georgia, Hawaii, Idaho, Illinois, Indiana, Louisiana, Maryland, Maine, New Jersey, New Mexico, Nevada, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Washington, and Wisconsin.

Database (LBD) maintained by the U.S. Census Bureau, which contains establishment-level data for virtually the entire universe of U.S. firms. This step is achieved via a combination of name-and-address matching and manual checking, following Chemmanur et al. (2020). In the second step, we match employers in the LEHD database to LBD establishments by Employer Identification Number (EIN), industry, state, and county, using the Business Register Bridge (BRB) file maintained by the U.S. Census Bureau. We then aggregate employees of all establishments that belong to the same firm using LBD's firm identifier, "FIRMID". In the third step, we match the LEHD data to the SDC data using the link files created in the first step. The matched sample contains about 289,000 employees from 1,200 IPO firms and about 642,000 employees from 3,300 acquired private firms.[16]

For empirical tests using the LEHD sample with firm-level dependent variables, we further require that at least 90 percent of a firm's workforce (measured by either the number of employees or total payroll in LBD) is covered by its establishments in the 26 states for which we have LEHD data, following He, Shu, and Yang (2020). This restriction reduces the sample size to about 550 IPOs and 1,250 sell-outs.

Data on inventors, including their employers, patents, and citations, are obtained from the Harvard Business School (HBS) Patenting Database constructed by Li et al. (2014). Following standard practice in the literature, we treat the assignee of an inventor's patent as her employer. We then adopt a two-step procedure to match IPO firms from the SDC database to assignees in the HBS patenting database. First, we match an IPO firm's CUSIP from the SDC database to PERMNO using the link file provided by the Center for Research in Security Prices (CRSP). We then match the IPO firm's PERMNO to patent assignees using the link file provided by Kogan et

[16] These numbers are rounded according to the disclosure requirement by the U.S. Census Bureau.

al. (2017). To match acquired private firms from the SDC database to patent assignees, we use a combination of name matching algorithms and manual checking. We further require an IPO (acquired) firm to have at least one patent filed in the year before the IPO date (deal completion date). In addition, we drop the inventors whose employment records cannot be tracked after their employers' exit dates. These inventors include the ones who do not file any patents or only file patents for non-corporate assignees (i.e., governments, universities, and individuals) after the exit dates.[17] The matched inventor sample consists of 4,357 inventors from 814 IPO firms and 2,209 inventors from 524 acquired private firms.

Finally, we obtain post-IPO stock return data from CRSP. Information on IPO firms' post-issuance operating performance and financial conditions is obtained from Compustat. Data used to calculate stock options granted to rank-and-file employees are obtained from Execucomp.

4. Variable Definitions

4.1 Identifying Entrepreneurial Diffusers

To identify entrepreneurial diffusers in the LEHD sample, we begin by identifying all full-time employees in private firms that have newly exited (through IPOs or sell-outs). Following the literature (e.g., Babina, et al. (2019)), we define an employee *i* as a full-time employee of firm *j* in quarter *t* if the employee's wage from firm *i* in quarter *t* is above or equal to the federal minimum wage in that quarter and the employee also has non-zero wage from firm *i* in quarter *t-1* and *t+1*. Using this method, we identify, for a private firm exiting in quarter *t*, all its full-time employees in quarter *t-1*. We then divide the pool of full-time employees into several categories based on their employment status after quarter *t* (i.e., the exiting quarter). For IPO firms, if an employee starts to work full-time for another private (public) firm in any quarter between *t+1* and *t+4*, we

[17] We supplement the HBS Patenting Database with the PatentsView database (available at https://www.patentsview.org/download/), which contains additional information on the assignees' identities.

define her as an "entrepreneurial diffuser" ("leaver to public firm"), meaning that she quits the job in the newly exited firm and moves to another private (public) firm during the one-year period post the exit.[18] If the employee still works for the IPO firm in quarter *t+4*, we define her as a "stayer". For acquired firms, we define an employee as an entrepreneurial diffuser (leaver to public firm) if she starts to work full-time for another private (public) firm other than the merged firm in any quarter between *t+1* and *t+4*. If the employee works for the merged firm in quarter *t+4*, she is identified as a stayer. Additionally, we identify an employee as a new hire of an IPO firm (merged firm) if she does not have any wage records from the IPO firm (either the acquired firm or acquiring firm) before the IPO date (takeover completion date) and starts to work full-time for the IPO firm (merged firm) in any quarter between quarters *t+1* and *t+4*.

To study how entrepreneurial diffusers affect private firms' likelihood of successfully exiting, we construct a sample of exited firms and matched remaining private firms.[19] For each firm in quarter -1 (i.e., the quarter immediately before the exiting quarter), we calculate *LnDiffuser* as the natural logarithm of one plus the number of entrepreneurial diffusers in the firm, *PctDiffuser* as the fraction of entrepreneurial diffusers in the firm's workforce, and *PctEarnDiffuser* as the fraction of the firm's total payroll earned by the entrepreneurial diffusers. We calculate the variables *LnEmpLeaveToPubExp*, *PctEmpLeaveToPubExp*, and *PctEarnLeaveToPubExp* in similar ways to control for the presence of employees with the experience of leaving newly-exited firms but moving to public firms instead of private firms before joining the firms in this sample.

To study how the departure of entrepreneurial diffusers affects newly public firms' post-IPO performance, we calculate the fraction of these firms' pre-IPO full-time employees (at quarter

[18] Following Chemmanur et al. (2020), we identify public firms in the Census data by matching the Census data to Compustat data and IPO data. Firms that are neither public nor exiting in a given year are treated as private firms.
[19] We describe the matching procedure in Section 5.3.

-1) who move to private firms within one year after the IPO dates (*PctDiffuserLeft*). For this test, we also calculate and control for the fraction of pre-IPO employees who move to public firms within one year after the IPO dates (*PctLeaverToPub*) as well as the ratio of the number of new employees hired during the same post-IPO window to the number of pre-IPO employees at quarter -1 (*PctNewHire*).

To identify entrepreneurial diffusers in the inventor sample, we first find all the inventors who file at least one patent for an exited firm within one year before its exit date (i.e., the IPO date or the deal completion date for sell-outs). These inventors can be assumed to work for the exited firm prior to the exit. Then, for an IPO firm, we follow Bernstein (2015) to define such inventors as entrepreneurial diffusers (leavers to public firms) if they file at least one patent for another private (public) firm in the year after the IPO date.[20] For an acquired firm, we define its pre-exit inventors as entrepreneurial diffusers (leavers to public firms) if they file at least one patent for another private (public) firm other than the merged firm in the year after the deal completion date. Stayers are defined as those inventors who are neither diffusers nor leavers to public firms, and who have not filed any patents for other firms before filing at least one patent for the exited firms after the exit date.[21] In addition, we identify an inventor as a new hire of an IPO firm if she has never filed a patent for the firm before the IPO date and files at least one patent for the IPO firm in the year after the IPO date. Similarly, we identify an inventor as a new hire of the merged firm after an acquisition if she has never filed a patent for the target or the acquirer before the deal completion date and files at least one patent for the merged firm in the year after the deal completion date.

[20] If the assignee of a patent has a valid PERMNO in the linking file provided by Kogan et al. (2017), we treat it as a public firm. Otherwise it is treated as a private firm.
[21] Our results are robust to treating all inventors who are not diffusers or leavers to public firms as stayers.

In the post-IPO performance tests using the inventor sample, we calculate, for each IPO firm, the fraction of pre-exit inventors who move to private firms within one year after the IPO (*PctDiffuserLeft*), the fraction of inventors who move to public firms within one year after the IPO (*PctLeaverToPub*), and the ratio of the number of new inventors hired within one year after the IPO to the number of pre-exit inventors (*PctNewHire*).

4.2 Control Variables in the LEHD Sample

For the employee-level tests using the LEHD sample, we construct several control variables using employee characteristics. *LnTenure* is defined as the natural logarithm of an employee's tenure (in terms of quarters) in the exited firm. *LnAge* is defined as the natural logarithm of an employee's age (in terms of years). *LnEdu* is defined as the natural logarithm of an employee's education level (in terms of years). *LnEarn* is defined as the natural logarithm of an employee's quarterly earnings (in terms of 2007 dollars) from the exited firm.[22] Employees' gender and race are also controlled for in regression analyses as fixed effects. All the above variables are measured at quarter -1 (i.e., the quarter right before the firm's exit date).

For the firm-level tests using the LEHD sample, we aggregate employees' demographic characteristics to the firm level. *LnAvgTenure*, *LnAvgAge*, *LnAvgEdu*, *LnAvgEarn* are defined as the natural logarithm of average tenure, age, education, and quarterly earnings of a firm's employees, respectively. *PctMale* (*PctWhite*) is defined as the fraction of male (white) employees in a firm. In addition, we control for the natural logarithm of the total number of employees (*LnEmp*) and the natural logarithm of firm age (*LnFirmAge*), measured as one plus the difference between a given year and the year when a firm's first establishment was founded.

[22] Employee earnings reported in the LEHD data include all forms of monetary compensation that are taxed as ordinary income, such as gross wages and salaries, bonuses, stocks, stock options, tips and other gratuities, and meals and lodging (see, e.g., Tate and Yang (2015), Aldatmaz, Ouimet, and Van Wesep (2018), and He, Shu, and Yang (2020)).

4.3 Post-IPO Performance

We use two measures, post-IPO buy-and-hold abnormal returns (*BHAR*) and returns on assets (*ROA*), to capture the newly public firms' post-IPO performance. Following Ritter (1991) and Ritter and Welch (2002), we calculate buy-and-hold abnormal returns from the IPO date to one, three, and five years after (*AR1yr*, *AR3yr*, and *AR5yr*, respectively) using the following equation:

$$AR_{0,T}^{i} = \prod_{t=1}^{T\times 12}(1 + r_t^i) - \prod_{t=1}^{T\times 12}(1 + r_t^{vw}), \quad (1)$$

where $AR_{0,T}^{i}$ is the post-IPO *BHAR* for firm *i* over the *T*-year period after the IPO date; r_t^i is the stock return of firm *i* in month *t* after the IPO date; and r_t^{vw} is the return of CRSP value-weighted index in month *t* after the IPO date.[23] To measure the IPO firms' post-IPO operating performance, we first calculate *ROA* for each IPO firm in year *T* (*T=1, 3,* or *5*) after the IPO date as its net income in year *T* divided by its average total assets over years *T-1* and *T*. Then we calculate the average *ROA* for the one, three, and five years (*ROA1yr*, *ROA3yr*, and *ROA5yr*, respectively) after the IPO date for each firm.[24]

Following the literature, we construct a set of firm-level control variables that might be correlated with post-IPO performance. *LnProceeds* is the natural logarithm of IPO proceeds (in terms of million dollars). IPO initial return (*IR*), i.e., underpricing, is calculated as the percentage change from the offer price to the closing price of the first trading day after the IPO. *VC* is a dummy variable that equals one if a firm is backed by venture capital at the time of the IPO, and zero otherwise. Tobin's Q (*TobinQ*) is calculated as the market value of assets divided by the book value of assets at the first fiscal year end post the IPO. *LnMV* is the natural logarithm of the market

[23] Our results are robust to using CRSP equal-weighted index returns as the benchmark to calculate abnormal returns.
[24] Our results are qualitatively similar if we use operating income before depreciation as the numerator or if we use total assets in year *T-1* or year *T* as the denominator when calculating ROA.

value of equity at the first fiscal year end post the IPO. Industry-adjusted research and development ratio (*RDadj*) is the IPO firm's R&D expenses scaled by total assets in the first fiscal year post the IPO minus the mean R&D-to-assets ratio in the firm's three-digit NAICS industry over the same window. *IndVCPct* is the fraction of firms in the IPO firm's three-digit NAICS industry that are backed by venture capital. *LnIndIPOVol* is the natural logarithm of total IPO volume in the IPO firm's three-digit NAICS industry in its IPO year. In addition, we control for stock options granted to rank-and-file employees which might be correlated with both post-IPO performance and the employees' willingness to leave the firms. Following Call, Kedia, and Rajgopal (2016) and Aldatmaz, Ouimet, and Van Wesep (2018), we calculate *IndRFOption* as the number of shares in options granted to rank-and-file employees scaled by total number of shares outstanding of a firm, averaged to the three-digit NAICS industry level.

5. Empirical Tests

5.1 Summary Statistics

We first report the summary statistics for our LEHD sample. To minimize the effect of outliers on our regression analysis, we winsorize all continuous variables at their 1st and 99th percentiles. Panel A of Table 1 presents the summary statistics at the individual-employee level. Among the 931,000 pre-exit full-time employees from IPO or acquired private firms in our sample, 11.1 percent move to private firms within one year post the exits and become entrepreneurial diffusers. Meanwhile, 4.8 percent of these employees move to public firms during the same window and the remaining (84.1 percent) stay with their original employers (i.e., the exited firms). On average, the pre-exit employees in our sample have been working in the exited firms for 9.4 quarters. The average age, education level, and quarterly earnings of these employees are 39.7 years, 14.6 years, and $11,015 dollars, respectively.

Panel B of Table 1 presents the summary statistics at the firm level for the LEHD sample, which consists of about 11,000 exited firms and matched remaining private firms. Among these firms, 16.4 percent exit through IPOs or sell-outs. The measures for the presence of entrepreneurial diffusers in these firms prior to the exits, *LnDiffuser*, *PctDiffuser*, and *PctEarnDiffuser*, have averages of 0.054, 0.001, and 0.001, respectively.[25] The presence of employees with the previous experience of leaving exited firms to join public firms is less than that of the entrepreneurial diffusers, as the averages of *LnEmpLeaveToPubExp*, *PctEmpLeaveToPubExp*, and *PctEarnLeaveToPubExp* are 0.013, <0.001, and <0.001, respectively. Firms in this sample have on average about 21.2 employees right before the exits. The average age of the firms is about 9.7 years in the year prior to the exits. The average age and education level of the employees are 40.4 years and 14.7 years, respectively. On average, 54.4 percent of a firm's employees are male, and 70.7 percent of a firm's employees are white.

5.2 Innovation Quality of Entrepreneurial Diffusers

Although the LEHD sample allows us to track the employment status of individual employees in newly exited firms and gauge the demographic characteristics of these employees, it is hard to infer the entrepreneurial quality (i.e., the essential characteristics required for entrepreneurial successes) of these employees based on the LEHD data alone. The inventor data, on the other hand, track the number of patents filed and citations received by the individual inventors. Such information can be used to infer their innovative behavior and thus their creativity and risk-taking spirit, which are both required qualities for achieving entrepreneurial successes (see, e.g., Chemmanur et al. (2019) and Islam and Zein (2020)). Therefore, we turn to the inventor

[25] The small mean fraction of entrepreneurial diffusers is mostly driven by the large fraction of start-ups without any such employees, which is similar to the right-skewed distribution of innovation activities in the economy due to the large population of zero-patenting firms.

sample to examine the quality difference between entrepreneurial diffusers and other employees in the exited firms. To measure an inventor's innovation quantity and quality, we calculate the average number of patents filed per year (*Patents*), the average number of citations received per patent (*CitePat*), the average originality score of the patents (*Originality*), and the average number of exploratory patents filed per year (*Exploratory*) by the inventor in the five years before the exit date of her employer. Following Hirshleifer, Hsu, and Li (2018), we calculate *Originality* as the average number of unique technological classes cited by an inventor's patents. A higher *Originality* score indicates that an inventor's patents deviate more from the current technology trajectories. Following Gao, Hsu, and Li (2018), Brav et al. (2018), and Lin, Liu, and Manso (2020), we define a patent as an "exploratory" patent if 80% or more of its citations are not cited by a firm's existing patents or the citations made by those patents. A larger number of exploratory patents filed by an inventor indicates that the inventor is more capable of acquiring new knowledge. Both *Originality* and *Exploratory* capture an inventor's willingness and capacity to explore beyond her existing knowledge, which reflects her entrepreneurial ability and spirit.

Table 2 compares the innovation quality by entrepreneurial diffusers (*EntreDiffuser*) and those by employees in other categories.[26] On average, an entrepreneurial diffuser files 2.09 patents per year before the exit date, which is significantly greater than those filed by leavers to public firms (*LeaverToPub*) or by stayers (*Stayer*), reflecting the higher innovation productivity of diffusers. Similarly, the average number of citations received by the patents of entrepreneurial diffusers (28.97) is also significantly larger than those received by the patents of stayers (24.16), which indicates that diffusers generate better-quality patents than those inventors who stay in the

[26] Among the 6,566 pre-exit inventors, 11.9 percent (782 inventors) move to private firms and thus are defined as entrepreneurial diffusers, 5.6 percent (365 inventors) move to public firms, and 82.5 percent (5,419 inventors) stay with the exited firms. This distribution is generally comparable to that of the LEHD sample.

exited firms. Further, the patents by entrepreneurial diffusers have significantly higher *Originality* (9.39) and are more exploratory (0.34) than those by leavers to public firms or stayers, which suggests that diffusers are more adventurous in nature and more capable than other inventors to explore new technological domain. More importantly, although the newly exited firms hire a large number of inventors after the exits, the newly hired inventors (*NewHire*) have significantly worse track records in terms of innovation (i.e., fewer patents and citations per patent) and innovative originality (i.e., patents with lower originality scores and fewer exploratory patents) than entrepreneurial diffusers, further suggesting that the loss in IPO firms' key human capital due to the departure of entrepreneurial diffusers is hard to replace.

Taken together, the results in this section suggest that entrepreneurial diffusers are among the better talents of the exited firms (in terms of creativity and risk-taking spirit), and that the loss of these talents cannot be easily replaced by hiring new employees.

5.3 Entrepreneurial Diffusers and Start-up Firms' Likelihood to Successfully Exit

As entrepreneurial diffusers possess valuable human capital and pass on their skills, vision, and entrepreneurial spirit to the start-ups they join, we hypothesize that private firms' likelihood to successfully exit through IPOs or sell-outs is positively associated with the presence of entrepreneurial diffusers among these firms' workforces. To mitigate the concern of a selection effect, i.e., entrepreneurial diffusers are capable of identifying and joining firms with higher exiting likelihoods to start with, we match a sample of non-exiting private firms to the exiting ones along several important dimensions. Specifically, for each firm *i* exiting in year *t*, we find all the private firms that remain private in year *t-1*, and are in the same three-digit NAICS industry, state, size group, and age group as the exiting firm.[27] We further require the matched non-exiting firms to

[27] Following Davis et al. (2014), we classify firms into 12 size groups based on their employment: (1) 1-4 employees, (2) 5-9 employees, (3) 10-19 employees, (4) 20-49 employees, (5) 50-99 employees, (6) 100-249 employees, (7) 250-

have the same VC-backing status and multi-unit status (i.e., whether the firm is a single-establishment or multi-establishment firm) as the exiting firm. Finally, for each exiting firm *i*, we retain five eligible matched non-exiting firms that are the closest to firm *i* in terms of size (measured by the total number of employees).[28] Then we estimate the following linear probability model using the final matched sample:

$$EntrepreneurialExit_i = \alpha + \beta_1 Diffuser_i + \beta_2 LeavePubExp_i + \beta_3 LnEmp_i + \beta_4 LnFirmAge_i + \beta_5 LnAge_i + \beta_6 LnEdu_i + \beta_7 PctMale_i + \beta_8 PctWhite_i + MatchedPair + \varepsilon_i, \quad (2)$$

where *EntrepreneurialExit* is a dummy variable that equals one if a private firm *i* exits through IPO or sell-out in year *t*, and zero otherwise. *Diffuser* captures the presence of entrepreneurial diffusers working for firm *i* in quarter *t-1* (i.e., the quarter immediately prior to the exiting quarter), and can be one of the three measures discussed earlier: *LnDiffuser*, *PctDiffuser*, or *PctEarnDiffuser*. We control for the presence of employees with experience of leaving to public firms, *LeavePubExp*, in similar ways. All other control variables, defined in Section 4.2, are measured either at year *t-1* (for the firm characteristics) or quarter *t-1* (for the employee characteristics). We include matched-pair fixed effects, which fully absorb industry, year, and state fixed effects as well as their

499 employees, (8) 500-999 employees, (9) 1,000-2,499 employees, (10) 2,500-4,999 employees, (11) 5,000-9,999 employees, and (12) 10,000 or more employees. We classify firms into five age groups: (1) 0-5 years, (2) 6-10 years, (3) 11-15 years, (4) 16-20 years, and (5) 21 or more years.

[28] We acknowledge that the matching procedure cannot fully eliminate concerns for endogeneity problems. Ideally, we want the matched remaining-private firms to have exactly the same quality (along both observable and unobservable dimensions) as that of the exited firms. However, such a perfectly matched sample is practically impossible to construct due to the lack of data on private firms' quality. This is in sharp contrast to the case of publicly traded firms, for which various measures of firm quality are readily available. Therefore, we can only rely on the limited information in our datasets and try our best to mitigate the concerns for endogeneity by selecting matched firms on the basis of observable characteristics that are likely to be associated with quality such as their VC-backing status, which has been commonly used by researchers as a comprehensive proxy for both observable and unobservable firm quality (see, e.g., Hochberg, Ljungqvist, and Lu (2007), Kerr, Lerner, and Schoar (2011), and Dimmock, Huang, and Weisbenner (2019)).

multiplicative combinations (as the matching is done at the industry-state-year level). These fixed effects also control for the effects of VC-backing status, age, size, and multi-unit status on exiting likelihoods. To account for possible within-industry correlations in errors, we cluster standard errors at the three-digit NAICS industry level.

Table 3 presents the results of estimating Equation (2). We find that private firms with more entrepreneurial diffusers are more likely to successfully exit through IPOs or sell-outs, consistent with the hypothesis that entrepreneurial diffusers help their new employers (i.e., the less mature start-ups) to achieve entrepreneurial success. The coefficient on *PctDiffuser* in Column (2) indicates that a one standard deviation increase in the fraction of entrepreneurial diffusers in a firm's workforce is associated with a 1.9 percentage point (about 12% of the mean exiting likelihood) increase in the firm's likelihood to successfully exit, which is economically significant. The regression results also show that the presence of employees with previous experience of leaving newly exited firms to public firms is positively associated with firms' exit likelihood as well, but such correlations are statistically insignificant. As to the control variables, we find that younger firms, larger firms, as well as firms with younger employees, higher educated employees, more male employees, and more white employees are more likely to successfully exit.

Overall, results in this section suggest that entrepreneurial diffusers indeed add value to the new start-ups they join.

5.4 Incentives of Entrepreneurial Diffusers

In this section, we explore the motives of entrepreneurial diffusers to quit the exited firms and move to other private firms. Specifically, to test the monetary incentive hypothesis, we use the LEHD sample to study the association between the employees' decisions to leave the exited firms and their post-exit short-term and long-term monetary gains. To test the entrepreneurial spirit

hypothesis, we first use the inventor sample to study the association between the inventors' decisions to leave the exited firms and their post-exit engagement in innovation activities. Second, we use the LEHD sample to study whether and how the employees' income risk tolerance is associated with their choice between private and public firms conditional on leaving the exited firms.

5.4.1 The Monetary Incentive

The monetary incentive hypothesis suggests that, after a private firm exits through going public or getting acquired, entrepreneurial diffusers would move to other private firms to pursue monetary benefits in the form of either higher wages or greater value appreciation of employee stocks/options resulting from the potential successful exits of their new employers. To test this hypothesis, we use the LEHD sample, which covers all pre-exit employees (i.e., entrepreneurial diffusers, leavers to public firms, and stayers) of exited firms to study these employees' post-exit monetary gains. As noted before, these employee earnings include all types of labor income from a particular employer such as base salary, bonuses, stocks, stock options, and profit distributions. Specifically, we estimate the following OLS regression using the LEHD sample:

$$
\begin{aligned}
CareerOutcome_i &= \alpha + \beta_1 EntreDiffuser_i + \beta_2 LeaverToPub_i + \beta_3 LnTenure_i + \beta_4 LnAge_i \\
&+ \beta_5 LnEdu_i + \beta_6 LnEarn_i + Deal + Male + White \\
&+ \varepsilon_i, \qquad (3)
\end{aligned}
$$

where *CareerOutcome* measures the post-exit career outcomes in terms of monetary gains for an employee *i* whose employer exits in year *t*. These outcomes are captured by two empirical measures. The first measure, *EarnGap*, is the difference between an employee's post-exit quarterly earnings and her pre-exit quarterly earnings (in thousands, 2007 dollars). The pre-exit quarterly

earnings are an employee's earnings from the exited firm in quarter -1 (i.e., the quarter immediately before the exit date). The post-exit quarterly earnings of an entrepreneurial diffuser or a leaver to public firm are her full-time quarterly earnings from the new employer that she moves to. A stayer's post-exit quarterly earnings are her earnings from the exited firm in the fourth quarter after the exit. The second measure, *LnEarnPost*, captures the long-run wealth effect of employees' career decisions. For an entrepreneurial diffuser or a leaver to public firm, *LnEarnPost* is defined as the natural logarithm of her average quarterly earnings (in thousands, 2007 dollars) in the five years after leaving the exited firms. For a stayer, this variable is defined as the natural logarithm of her average quarterly earnings in the five years starting from the fourth quarter after her employer's exit date. *EntreDiffuser* (*LeaverToPub*) is a dummy variable that equals one if an employee moves to a private (public) firm within one year after her original employer's exit, and zero otherwise. The coefficient of *EntreDiffuser* (*LeaverToPub*) thus compares the career outcomes (monetary gains) of entrepreneurial diffusers (leavers to public firms) to those of the stayers, which comprise the omitted (base) group in the regressions. The control variables are defined in Section 4.2 and measured at quarter -1. We include deal (IPO or sell-out) fixed effects, which fully absorb all time-varying firm-level characteristics as well as any trends in labor income at the macro (time or industry) level. We also include indicator variables for whether an employee is male or white in the regressions, but do not report the coefficients to comply with the disclosure rule of the Census Bureau. Standard errors are clustered at the deal level.

Table 4 presents the results of estimating Equation (3). Column (1) uses *EarnGap* as the dependent variable, while Columns (2) uses *LnEarnPost* as the dependent variable. As can be seen, entrepreneurial diffusers do not have a significant increase in earnings compared to stayers, in either the short run or the long run, whereas leavers to public firms have a significant increase in

earnings compared to stayers. The F-tests for the difference between the coefficients of *EntreDiffuser* and *LeaverToPub* are significant at the 1% level in both columns. Taken together, the two columns show that entrepreneurial diffusers do not experience a large gain in labor income, in either the short or long run, compared to employees who make other career decisions. These results suggest that pursuing monetary benefits is unlikely to be the primary reason for entrepreneurial diffusers to move to private firms after their original employers' successful exits.

5.4.2 The Entrepreneurial Spirit Incentive

Literature shows that, after a private firm goes public or gets acquired by another firm, it exhibits a decrease in creative activities such as innovation (see, e.g., Aggarwal and Hsu (2014), Bernstein (2015), Cunningham, Ederer, and Ma (2020), Gao, Hsu, and Li (2018), and Dambra and Gustafson (2020)), which might trigger the departure of talented employees who desire autonomy and an entrepreneurial environment. Hence, the entrepreneurial spirit hypothesis postulates that, entrepreneurial diffusers, who are more explorative, risk tolerant, and adventurous in nature, might move to private firms in the pursuit of entrepreneurial spirit if their original employers focus more on routine businesses after successfully exiting.

To test the entrepreneurial spirit hypothesis, we first compare the post-exit innovation activities of entrepreneurial diffusers and those of the other inventors. Given that entrepreneurial diffusers have higher pre-exit innovation quality (as shown earlier), we conduct a matched-sample analysis to control for their pre-exit innovation activities. Specifically, for each entrepreneurial diffuser whose employer exits in year *t*, we find all the leavers to public firms and stayers whose employers also exit in year *t*, and whose difference with the entrepreneurial diffuser in terms of the average number of patents filed per year in the five years before exits is no more than one. By doing so, we compare entrepreneurial diffusers to inventors in other categories with similar pre-

exit innovation quality. For those matched entrepreneurial diffusers and other categories of inventors, we first calculate each individual's average number of patents filed per year (*PatentsPostExit*), average number of citations received per patent (*CitePatPostExit*), average originality score per patent (*OriginalityPostExit*), and average number of exploratory patents filed per year (*ExploratoryPostExit*) in the five years after exits. Then, for each entrepreneurial diffuser, we calculate the differences between her four innovation-activity measures mentioned above with the median values of these measures of her matched inventors.

Table 5 reports the average differences in post-exit innovation activities between entrepreneurial diffusers and matched inventors in other categories. We also report the t-statistics on the significance of these differences. As can be seen, entrepreneurial diffusers file 0.58 more patents annually than their matched leavers to public firms in the five years after exits. The patents filed by entrepreneurial diffusers have higher quality too, as their citations per patent is 2.90 higher than those of the matched leavers to public firms. The patents filed by entrepreneurial diffusers are also more original, as their average *Originality* is 1.74 higher than that of the leavers to public firms. All these three differences are significant at the 1% level. In addition, entrepreneurial diffusers generate significantly more patents, receive significantly higher citations, and generate significantly more original and exploratory patents than their matched stayers as well.

While the results in Table 5 suggest that entrepreneurial diffusers move to private firms to pursue entrepreneurial spirit, the results in Table 4 show that they do not experience a large wealth gain by doing so. The entrepreneurial diffusers for the IPO sample even have a relatively lower labor income growth after leaving the newly public firms. Thus, whether and how entrepreneurial diffusers consider the tradeoffs between nonpecuniary benefits (entrepreneurial spirit) and pecuniary benefits is a question worth exploring. In other words, if entrepreneurial diffusers could

anticipate the potential loss in future labor income if they move to private firms to pursue entrepreneurial spirit, what makes them willing to do so? To provide a partial answer to this question, we study the association between employees' job risk tolerance and their decisions to move to private firms after original employers' recent exits.

Previous literature has shown that entrepreneurial activities are associated with entrepreneurs' attitudes toward risk. For example, Weller and Wenger (2015) find that people with more diversified household income are more likely to be entrepreneurs. He, Shu, and Yang (2020) argue that an employee is more risk tolerant towards her job if her household labor income is more diversified (i.e., the weight of the employee's labor income in her total household labor income is lower). In our context, if an employee's household labor income is more diversified, her household will have more income sources other than the employee's labor income from her job. In that case, the potential loss in future labor income from the employee if she moves to a private firm will have a smaller negative effect on her household's expected total wealth, which better enables the employee to pursue entrepreneurial spirit. Hence, we use household labor income diversification to proxy for individual employees' job risk tolerance, and predict that such household labor income diversification is positively associated with an employee's likelihood to move to private firms (rather than mature public firms). To test this prediction, we estimate the following linear probability model using the LEHD sample of employees from both IPO firms and acquired private firms:

$$
\begin{aligned}
EntreDiffuser_i &= \alpha + \beta_1 EntreRiskTaking_i + \beta_2 LnTenure_i + \beta_3 LnAge_i + \beta_4 LnEdu_i \\
&+ \beta_5 LnEarn_i + Male + White + Year + Industry + Deal \\
&+ \varepsilon_i, \qquad (4)
\end{aligned}
$$

where *EntreDiffuser* is a dummy variable that equals one if an employee is an entrepreneurial diffuser, and zero if the employee is a leaver to public firms. We exclude stayers in this analysis as we want to study the association between employees' ex-ante job risk tolerance and their choices of destination firms (i.e., private firms or public firms) conditional on the decision to leave the exited firms. Following He, Shu, and Yang (2020), for each entrepreneurial diffuser or leaver to public firm, we calculate *JobRiskTolerance* as the difference between her household's total labor income and her earnings from the exited firm scaled by her household's total labor income.[29] Higher *JobRiskTolerance* means the employee's household labor income is more diversified, which makes the employee more tolerant to her labor income risk.[30] The control variables are defined in Section 4.2, and similar to *JobRiskTolerance*, are all measured at quarter -1 (i.e., the quarter immediately before the exit dates). As in previous tables, we control for each employee's gender and race using untabulated dummies for male and white. We also include various combinations of fixed effects (such as year, three-digit NAICS industry, and exit-deal fixed effects) in our regressions. Standard errors are clustered by exit deals (i.e., IPOs or sell-outs).

Table 6 reports the results. In all model specifications, including the most stringent model of Column (4) that includes deal fixed effects, *JobRiskTolerance* has a significantly positive coefficient, suggesting that employees who are more tolerant to labor income risk are more likely to move to private firms rather than public firms after their original employers' exits, which is consistent with the entrepreneurial spirit hypothesis.

5.5 Entrepreneurial Diffusers and Their Original Employers' Post-IPO Performance

[29] Household identification information, which largely comes from the 1040 tax return data, is available from year 2000 onwards in the LEHD data, which reduces our sample size in this analysis.

[30] It is worth noting that *JobRiskTolerance* is not a measure of employees' innate (i.e., genetically determined) risk attitudes which impact their general behaviors, but rather a measure of resource-based risk attitudes (i.e., employees and their households' abilities to maintain their level of consumption when facing negative labor income shocks from a focal job).

In this section, we investigate the association between the departure of entrepreneurial diffusers and their original employers' post-IPO performance.[31] Using the LEHD sample, we estimate the following OLS regression:

$$
\begin{aligned}
PostIPOPerformance_i &= \alpha + \beta_1 PctDiffuserLeft_i + \beta_2 PctLeaverToPub_i + \beta_3 PctNewHire_i \\
&+ \beta_4 LnProceeds_i + \beta_5 IR_i + \beta_6 VC_i + \beta_7 TobinQ_i + \beta_8 LnMV_i + \beta_9 RDadj_i \\
&+ \beta_{10} IndVCPct_i + \beta_{11} LnIndIPOVol_i + \beta_{12} IndRFOption_i + \beta_{13} LnEmp_i \\
&+ \beta_{14} LnFirmAge_i + \beta_{15} LnAvgTenure_i + \beta_{16} LnAvgAge_i + \beta_{17} LnAvgEdu_i \\
&+ \beta_{18} LnAvgEarn_i + Industry + Year + \varepsilon_i, \qquad (5)
\end{aligned}
$$

where $PostIPOperformance_i$ is either firm *i*'s buy-and-hold abnormal return (*BHAR*) or its average *ROA* in the one-, three-, or five-year windows after its IPO. *PctDiffuserLeft* (*PctLeaverToPub*) is the fraction of a firm's pre-exit employees who move to private (public) firms within one year after IPO. All other variables are defined in Section 4.3. $LnProceeds$ and *IR* are measured at the time of the IPO; other firm-level characteristics are measured at the end of the first year post IPO; and employee characteristics are measured at quarter *t-1* (for the employee characteristics). We include industry fixed effects (at the three-digit NAICS level) and year fixed effects in the model. Standard errors are clustered at the industry level.

Panel A of Table 7 reports the results. Columns (1)-(3) use one-, three-, and five-year post-IPO *BHAR* as the dependent variables, respectively. Columns (4)-(6) use one-, three-, and five-year post-IPO average annual *ROA* as the dependent variables, respectively. We redact the

[31] We only study IPOs rather than acquired private firms in this section mainly due to two reasons. First, after sell-outs, the exited firms will be integrated into the acquirers, which are typically much larger. Thus, their combined performance after the acquisition will be largely determined by the acquirers rather than the acquired start-ups that lose entrepreneurial diffusers. Second, the IPO sample allows us to control for various firm characteristics that might be correlated with post-exiting performance, whereas there are no readily available financial data on the characteristics of acquired private firms.

regression coefficients of control variables in Columns (4)-(6) due to the disclosure restriction of the U.S. Census Bureau. The results show that both post-exit *BHAR* and *ROA* are negatively associated with the fraction of entrepreneurial diffusers leaving an IPO firm. Moreover, the economic magnitude of this impact increases over time, especially for abnormal returns. For example, a one standard deviation increase in the fraction of entrepreneurial diffusers (i.e., 0.046) is associated with a 0.11 (=0.046×6.126/2.679) standard deviation decrease in the five-year post-IPO *BHAR* but only a 0.06 (=0.046×1.114/0.813) standard deviation decrease in the one-year post-IPO *BHAR*. Meanwhile, the fraction of leavers to public firms is not significantly associated with post-IPO performance, except for the one-year *BHAR*, suggesting that the departure of leavers to public firms is not as costly to the newly exited firms as that of entrepreneurial diffusers. Interestingly, the fraction of new hires is insignificantly related to post-IPO BHAR but has a significantly negative association with post-IPO ROA, which possibly reflects the higher labor expenses but no greater labor productivity following the expansion after IPOs.

We further estimate a similar model to Equation (5) using the inventor sample to explore the impact of entrepreneurial diffusing inventors on IPO firms' post-IPO performance. *PctDiffuserLeft*, *PctLeaverToPub*, and *PctNewHire* are now calculated using inventors instead of the LEHD employees. We control for *LnInventor*, the natural logarithm of the number of inventors (instead of employees), and drop employee demographics from the control list as these variables cannot be calculated for the inventor sample.

Consistent with the results using the LEHD sample, Panel B of Table 7 shows that the fraction of entrepreneurial diffusing inventors (i.e., those leaving for private firms) also has a significantly negative association with their original employers' post-IPO performance, especially over the long run. In terms of economic magnitudes, a one standard deviation increase in the

fraction of entrepreneurial diffusers (i.e., 0.213) is associated with a 0.09 (=0.213×0.934/2.127) standard deviation decrease in the five-year post-IPO *BHAR* and a 0.11 (=0.213×0.169/0.332) standard deviation decrease in the five-year average annual *ROA*. Again, the fraction of inventors leaving to public firms is not significantly associated with post-IPO performance. However, the fraction of newly hired inventors now positively predicts post-IPO *ROA*.

For ease of exposition and interpretation, we also plot in Figure 1 the decrease in *BHAR* one-, three-, and five-year post the IPOs associated with a one-standard-deviation increase in the fraction of entrepreneurial diffusers for both the LEHD sample and the inventor sample. As can be seen, the decrease in shareholder value associated with the departure of entrepreneurial diffusers increases over the post-IPO time horizon.

However, the above OLS analysis of the correlation between entrepreneurial diffusers and post-IPO performance is subject to endogeneity concerns. On the one hand, IPO firms that suffer from worse post-IPO performance may choose to fire their employees, including diffusers. This concern is partially mitigated as we measure the long run performance at three or five years after the IPOs) whereas the departure of entrepreneurial diffusers is defined in the first year post the IPOs. On the other hand, the entrepreneurial diffusers (i.e., those who leave for private firms right after the IPOs) might be able to anticipate negative future firm performance and thus choose to leave the newly exited firms in advance. If this is the case, however, we should also expect a significantly negative association between the fraction of leavers to public firms and post-IPO performance, which we do not find. As a result, reverse causality seems not to be a severe concern for our analysis.

Nevertheless, omitted variables (e.g., organizational features that lead to both bad performance and an exodus of talented employees) might still plague our causal inference. Hence,

we conduct a two-stage least squares (2SLS) analysis for the inventor sample. Our instrument, following the spirit of Gao, Hsu, and Li (2018), is the change in the fraction of patents filed by private firms (as opposed to public firms) in an IPO firm's three-digit NAICS industry. Intuitively, this instrument captures the change in the quality of the entrepreneurial environment (in terms of overall innovation intensity) that private firms can offer relative to public firms in the same industry. An enhanced entrepreneurial environment offered by private firms will be more likely to attract entrepreneurial diffusers who chase after entrepreneurial spirit (shown in Section 5.4) and make them more willing to jump to private firms after their employers' IPOs. Therefore, we use *ChgPctPatentsPrv*, the change in the share of innovation activities (in terms of patent filings) that are conducted by private firms in an industry, to predict the fraction of inventors who move to private firms shortly after IPOs. The details of the construction of this instrument are provided in Appendix B. [32]

Table 8 presents the results of the 2SLS analysis. Column (1) reports the first-stage regression. As we predicted, *ChgPctPatentsPrv* has a significantly positive effect on the fraction of entrepreneurial diffusers: a one percentage point greater change in the fraction of patents assigned to private firms in an IPO firm's industry leads to a 1.45 percentage point increase in the fraction of leaving entrepreneurial diffusers. Our instrument is also unlikely to suffer from weak instrument problems, as the Kleibergen-Paap Wald test on weak instruments has an F-statistic of 12.001. Columns (2)-(4) and (5)-(7) report the second-stage regressions using post-IPO *BHAR* and *ROA*, respectively, as the dependent variables. Consistent with our OLS results in Table 7, the

[32] It is worth noting that we cannot apply the same 2SLS design to the analysis of the association between the presence of entrepreneurial diffusers and private firms' likelihood of successfully exiting (i.e., the tests reported in Table 3). The reason is that diffusers in a private firm's workforce could have joined the firm at multiple time points and from multiple industries, which prohibits the use of an industry-level time-varying instrumental variable (such as *ChgPctPatentsPrv*).

instrumented fraction of entrepreneurial diffusers significantly reduces firms' post-IPO long-term *BHAR* and *ROA*. These results suggest that the loss of human capital due to the departure of entrepreneurial diffusers has a causal negative impact on their original employers in terms of operating performance and shareholder value.

Taken together, the results in this section suggest that the departure of entrepreneurial diffusers is costly to their original employers. This result also suggests that the loss of talented employees with entrepreneurial experience and spirit might be one underexplored explanation for the well-known IPO long-run underperformance puzzle (e.g. Ritter (1991), Jain and Kini (1994), Teoh, Welch, and Wong (1998), and Chemmanur and Paeglis (2005)).

6. Conclusion

This paper studies the emerging phenomenon that many talented employees leave successfully exited entrepreneurial firms (via IPOs or sell-outs) to join less mature start-ups. Using both the unique data from the U.S. Census Bureau and a sample of individual inventors, we find that such entrepreneurial diffusers seem to be the best talents among all types of employees in the newly exited firms, and the loss of these talents cannot be easily replaced by hiring new employees. These diffusers also add value to their new employers by enhancing the latter's likelihood of successful exits. Further analyses reveal that entrepreneurial diffusers are more likely to be motivated by the pursuit of entrepreneurial spirit instead of monetary gains. Finally, we find that the departure of entrepreneurial diffusers contributes to the long-run IPO underperformance documented by accounting and finance researchers.

Overall, these results indicate that entrepreneurial diffusers represent a valuable form of human capital and contribute to the cross-firm diffusion of entrepreneurship, which is critical to the sustainability of a vibrant entrepreneurial ecosystem. Unlike previous literature that focuses on

how skilled employees can enhance the value and performance of their *current* employers, our paper shows how such employees can benefit their *next* employers by diffusing the entrepreneurial knowledge and technological knowhow from their current workplace to new startups in the economy. To the best of our knowledge, we are the first to identify a human capital flow channel through which entrepreneurship is diffused, which creates a new conversation in the entrepreneurial finance literature. Future research could extend this line of inquiry in various dimensions. First, it might be fruitful to explore more potential incentives of entrepreneurial diffusers (other than the monetary incentive and the entrepreneurial spirit incentive studied here). Second, by overcoming the data hurdles on private firms and adopting better identification strategies, future studies could strengthen the causal link between entrepreneurial diffusers and firm performance. Finally, given our findings that entrepreneurial diffusers positively relate to the success of the startups they join but negatively affect the value of the firms they leave, future studies could try to evaluate the overall welfare implications of diffusers for the entire entrepreneurial market in an economy.

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Appendix A: Variable Definition

Employee-level Variables:

EntreDiffuser: A dummy variable that equals one if an employee of an IPO or acquired private firm moves to another private firm in the year after her original employer's exit date, and zero otherwise.

LeaverToPub: A dummy variable that equals one if an employee of an IPO or acquired private firm moves to another public firm in the year after her original employer's exit date, and zero otherwise.

Stayer: A dummy variable that equals one if an employee of an IPO or acquired private firm moves to another public firm in the year after her original employer's exit date, and zero otherwise.

LnTenure: The natural logarithm of an employee's tenure (in terms of quarters) in the exited firm, measured at the quarter right before her employer's exit date.

LnAge: The natural logarithm of an employee's age (in terms of years), measured at the quarter right before her employer's exit date.

LnEdu: The natural logarithm of an employee's education level (in terms of years), measured at the quarter right before her employer's exit date.

LnEarn: The natural logarithm of an employee's quarterly earnings (in terms of 2007 dollars), measured at the quarter right before her employer's exit date. The LEHD earnings data include all forms of monetary compensation that are taxed as ordinary income, such as gross wages and salaries, bonuses, stocks, stock options, tips and other gratuities, and meals and lodging.

NewHire: A dummy variable that equals one if an employee is hired by an IPO firm in the year after the IPO date or by a merged firm in the year after the merger completion date, and zero otherwise.

Patents: The average number of patents filed per year by an inventor from an exited firm in the five years before the exit date.

CitePat: The average number of citations received per patent by an inventor from an exited firm in the five years before the exit date.

EarnGap: The difference between the post-exit quarterly earnings and the pre-exit quarterly earnings (in terms of 2007 dollars) of an employee from an exited firm. The LEHD earnings data include all forms of monetary compensation that are taxed as ordinary income, such as gross wages and salaries, bonuses, stocks, stock options, tips and other gratuities, and meals and lodging.

LnEarnPost: The natural logarithm of the average quarterly earnings in the five years after exit of an employee from an exited firm. The LEHD earnings data include all forms of monetary compensation that are taxed as ordinary income, such as gross wages and salaries, bonuses, stocks, stock options, tips and other gratuities, and meals and lodging.

PatentsPostExit: The average number of patents filed per year by an inventor from an exited firm in the five years after the exit date.

CitePatPostExit: The average number of citations received per patent by an inventor from an exited firm in the five years after the exit date.

JobRiskTolerance: The difference between an employee's household total labor income and her earnings from the exited firm scaled by her total household labor income.

Firm-level Variables:

EntrepreneurialExit: A dummy variable that equals one if a private firm exits through going public or getting acquired in year t, and zero if the firm remains private in the year.

LnDiffuser: The natural logarithm of the number of entrepreneurial diffusers in a firm.

PctDiffuser: The fraction of a firm's employees who are entrepreneurial diffusers.

PctEarnDiffuser: The fraction of a firm's total payroll earned by entrepreneurial diffusers.

LnEmpLeavePubExp: The natural logarithm of the number of employees in a firm who have previous experiences of moving from an exited firm to a public firm in the year after the exit date.

PctEmpLeavePubExp: The fraction of a firm's employees who have previous experiences of moving from an exited firm to a public firm in the year after the exit date.

PctEarnLeavePubExp: The fraction of a firm's total payroll earned by employees who have previous experiences of moving from an exited firm to a public firm in the year after the exit date.

LnEmp: The natural logarithm of the total number of employees in a firm.

LnFirmAge: The natural logarithm of a firm's age in year t, measured as one plus the difference between t and the year when the firm's first establishment was founded.

LnAvgAge: The natural logarithm of employees' average age (in terms of years).

LnAvgEdu: The natural logarithm of employees' average age (in terms of years).

PctMale: The fraction of male employees in a firm.

PctWhite: The fraction of white employees in a firm.

AR1yr: The post-IPO one-year buy-and-hold abnormal return (using CRSP value-weighted index return as the benchmark) of an IPO firm, calculated using monthly returns.

AR3yr: The post-IPO three-year buy-and-hold abnormal return of an IPO firm.

AR5yr: The post-IPO five-year buy-and-hold abnormal return of an IPO firm.

ROA1yr: The return to assets (*ROA*), defined as net income (NI) divided by the average of total assets (AT) and lagged total assets, for the year post the IPO.

ROA3yr: The average annual *ROA* over the three-year period post the IPO.

ROA5yr: The average annual *ROA* over the five-year period post the IPO.

PctDiffuserLeft: The fraction of an IPO firm's employees who move to private firms after the IPO date.

PctLeaverToPub: The fraction of an IPO firm's employees who move to public firms after the IPO date.

PctNewHire: The number of employees hired by an IPO firm in the year after the IPO date scaled by the number of employees working for the IPO firm in the quarter before the IPO date.

IR: The percentage difference between the closing price on the IPO day and the offering price.

LnProceeds: The natural logarithm of IPO proceeds (in terms of million dollars).

VC: A dummy variable that equals one if a firm is backed by venture capital at the time of the IPO, and zero otherwise.

TobinQ: The market value of equity (PRCC_F×CSHO) plus book value of assets (AT) minus book value of equity (CEQ) minus deferred taxes (TXDB) divided by the book value of assets (AT) at the first fiscal year end post the IPO.

LnMV: The natural logarithm of the market value of equity (PRCC_F×CSHO) at the first fiscal year end post the IPO.

RDadj: An IPO firm's R&D expenses (XRD) scaled by total assets (AT) in the first fiscal year post the IPO subtracting the mean R&D expenses scaled by total assets in the firm's three-digit NAICS industry over the same window.

IndVCPct: The fraction of firms in an IPO firm's three-digit NAICS industry that are backed by venture capital.

LnIndIPOVol: The natural logarithm of the total IPO volume in a firm's three-digit NAICS industry in its IPO year.

IndRFOption: The number of shares in options granted to rank-and-file employees scaled by the total number of shares outstanding of a firm, averaged to the three-digit NAICS industry level.

LnAvgTenure: The natural logarithm of average tenure (in terms of quarters) of a firm's employees.

LnAvgEarn: The natural logarithm of quarterly earnings (in terms of 2007 dollars), of a firm's employees

LnInventor: The natural logarithm of the total number of inventors in a firm.

PctPatentsPrv: The change in the fraction of patents assigned to private firms in a three-digit NAICS industry from year -1 to 0.

Appendix B: Construction of *ChgPctPatentsPrv*, the Instrument for the 2SLS Analysis

We calculate the change in the fraction of patents assigned to private firms in an industry as the instrumental variable for the fraction of employees leaving for private firms after their original employers' IPO. The empirical difficulty of calculating such measure is that it is hard to identify the industry classification of patent assignees that are private firms. Therefore, we construct the measure in five steps using classifications of patents filed by public firms in an industry to identify the industry's knowledge base.[33]

In the first step, for an IPO firm *i* in industry *j* (at the three-digit NAICS level) and year *t*, we identify all the patents assigned to public firms in industry *j* in year *t*.

In the second step, we define industry *j*'s "major patent classes" in year *t* as all the patent classes under which the number of patents assigned to public firms in industry *j* and year *t* is greater than or equal to five percent of total number of patents assigned to these public firms in year *t*.[34] The major patent classes of an industry identify the knowledge base of the industry, which consists of patents that are likely to be assigned to a typical firm in the industry.[35]

In the third step, we identify all the patents in industry *j*'s major patent classes that are assigned to private firms in year *t*. We treat these patents as patents assigned to private firms in industry *j* and year *t*.

In the fourth step, we calculate the fraction of patents assigned to private firms in industry *j* and year *t* as the number of patents assigned to private firms divided by the total number of patents assigned to private firms and public firms in industry *j* and year *t*.

In the fifth step, we calculate the change in fraction of patents assigned to private firms in industry *j* from year *t-1* to *t* (*ChgPctPatentsPrv*).

[33] We use patent classifications under the United States Patent Classification (USPC) system, obtained from the HBS Patenting Database.

[34] Our results are robust if we use one percent or ten percent as the threshold when defining major patent classes.

[35] Note that one patent class may be identified as the major patent class of more than one industry. This is not a significant problem as our definition of entrepreneurial diffusers is not limited to those who move to private firms within the IPO firms' industry. If an inventor possesses knowledge and skills that can be used in another industry, she could choose to move to private firms in that industry as well.

Table 1: Summary Statistics

This table reports the summary statistics of variables for the LEHD sample. Panel A reports the summary statistics at the employee-level for 931,000 employees from IPO firms and acquired private firms. Panel B reports the summary statistics at the firm-level for 11,000 IPO firms, acquired private firms, and their matched non-exiting private firms. The statistics are rounded following the disclosure requirement by the U.S. Census Bureau. The definitions of all variables are presented in Appendix A.

Panel A: Summary Statistics at the Employee Level

Variables	Mean	Std	N
EntreDiffuser	0.111	0.313	931,000
LeaverToPub	0.048	0.215	931,000
Stayer	0.841	0.365	931,000
LnTenure	2.241	0.922	931,000
LnAge	3.681	0.281	931,000
LnEdu	2.680	0.170	931,000
LnEarn	9.307	0.654	931,000

Panel B: Summary Statistics at the Firm Level

Variables	Mean	Std	N
EntrepreneurialExit	0.164	0.370	11,000
LnDiffuser	0.054	0.203	11,000
PctDiffuser	0.001	0.006	11,000
PctEarnDiffuser	0.001	0.006	11,000
LnEmpLeaveToPubExp	0.013	0.095	11,000
PctEmpLeaveToPubExp	<0.001	0.001	11,000
PctEarnLeaveToPubExp	<0.001	0.001	11,000
LnEmp	3.052	1.401	11,000
LnFirmAge	2.272	0.754	11,000
LnAvgAge	3.699	0.156	11,000
LnAvgEdu	2.689	0.078	11,000
PctMale	0.544	0.296	11,000
PctWhite	0.707	0.279	11,000

Table 2: Innovation Quality of Entrepreneurial Diffusers and Other Inventors

This Table reports and compares the innovation quality of entrepreneurial diffusers, leavers to public firms, stayers, and new hires. *Patents* is the average number of patents filed per year by an inventor. *CitePat* is the average number of citations received per patent. *Originality* is the average number of unique technological classes cited per patent. *Exploratory* is the average number of exploratory patents filed per year. All variables are calculated over the five-year window before the exit. In addition, we report the differences among inventor categories along with the associated t-statistics. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

	EntreDiffuser	*LeaverToPub*	*Stayer*	*NewHire*	*Difference (t-statistics)*		
	(1)	(2)	(3)	(4)	(1)-(2)	(1)-(3)	(1)-(4)
Patents	2.090	1.431	0.876	0.086	0.659***	1.214***	2.004***
					(5.095)	(12.588)	(21.057)
CitePat	28.970	28.699	24.164	20.809	0.271	4.806***	8.161***
					(0.101)	(3.600)	(6.094)
Originality	9.396	8.303	8.363	6.656	1.094***	1.033***	2.740***
					(2.724)	(3.628)	(9.427)
Exploratory	0.342	0.332	0.291	0.042	0.010*	0.051***	0.299***
					(1.713)	(14.448)	(89.051)

Table 3: Entrepreneurial Diffusers and Private Firms' Likelihood to Exit

This table presents the linear probability regressions on the association between private firms' likelihood to exit and the presence of entrepreneurial diffusers in these firms. For each private firm that goes public or gets acquired in year *t*, we find all the private firms that remain private in year *t*, and are in the same three-digit NAICS industry, state, size group, and age group with the exiting firm. We further require the matched non-exiting firms to have the same VC-backing status and multi-unit status as the exiting firm. Finally, for each exiting firm *i*, we retain five eligible matched non-exiting firms that are the closest to firm *i* in terms of size. The dependent variable, *EntrepreneurialExit*, is a dummy variable that equals one if a private firm *i* exits through IPO or sell-out in year *t*, and zero otherwise. *LnDiffuser* is the natural logarithm of one plus the number of entrepreneurial diffusers in a firm. *PctDiffuser* is the fraction of entrepreneurial diffusers in a firm's workforce. *PctEarnDiffuser* is the fraction of a firm's total payroll earned by entrepreneurial diffusers. All other variables are defined in Appendix A. Each regression includes a separate intercept. We include matched-pair fixed effects in all regressions. Standard errors are clustered by three-digit NAICS industry. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dep. Var.	*EntrepreneurialExit*		
	(1)	(2)	(3)
LnDiffuser	0.089***		
	(3.923)		
PctDiffuser		3.239***	
		(3.925)	
PctEarnDiffuser			2.743***
			(4.033)
LnEmpLeaveToPubExp	0.083		
	(1.569)		
PctEmpLeaveToPubExp		4.140	
		(1.042)	
PctEarnLeaveToPubExp			4.375
			(1.118)
LnEmp	0.079***	0.082***	0.082***
	(6.838)	(6.768)	(6.785)
LnFirmAge	-0.119***	-0.119***	-0.119***
	(-5.323)	(-5.406)	(-5.374)
LnAvgAge	-0.046	-0.047*	-0.047*
	(-1.660)	(-1.693)	(-1.692)
LnAvgEdu	0.417***	0.417***	0.419***
	(6.344)	(6.417)	(6.388)
PctMale	0.083**	0.083**	0.083**
	(2.019)	(2.004)	(2.010)
PctWhite	0.058*	0.058*	0.058*
	(1.907)	(1.907)	(1.919)

Pair Fixed Effects	Yes	Yes	Yes
Observations	11,000	11,000	11,000
R-squared	0.064	0.064	0.063

Table 4: Decisions to Become Entrepreneurial Diffuser and Post-exit Labor Income

This table presents the OLS regressions on the association between employees' decisions to become entrepreneurial diffusers and post-exit labor income in the LEHD sample. *EarnGap* is the difference between an employee's post-exit quarterly earnings and her pre-exit quarterly earnings (in terms of thousands, 2007 dollars). *LnEarnPost* is the natural logarithm of the average quarterly earnings (in thousands, 2007 dollars) of an employee in the five years post the exit. *EntreDiffuser* (*LeaverToPub*) is a dummy variable that equals one if an employee moves to a private (public) firm within one year after her original employer's exit, and zero otherwise. We report the F-statistics and the associated P-values for the difference between the coefficients of *EntreDiffuser* and *LeaverToPub*. The control variables are defined in Appendix A. Each regression includes a separate intercept. We include deal fixed effects, male-employee fixed effects, and white-employee fixed effects in the regressions. Standard errors are clustered by exit deals. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dep. Var.	*EarnGap*	*LnEarnPost*
	(1)	(2)
EntreDiffuser	-0.005	0.008
	(-0.050)	(1.115)
LeaverToPub	0.259**	0.031***
	(2.224)	(5.467)
LnTenure	-0.067*	-0.007***
	(-1.865)	(-3.599)
LnAge	0.268***	-0.076***
	(3.551)	(-13.340)
LnEdu	1.054***	0.093***
	(12.540)	(21.680)
LnEarn	-1.206***	0.783***
	(-4.385)	(76.900)
F-statistics	6.637	11.680
P-value	0.010	0.001
Male Fixed Effects	Yes	Yes
White Fixed Effects	Yes	Yes
Deal Fixed Effects	Yes	Yes
Observations	931,000	931,000
R-squared	0.158	0.796

Table 5: Decisions to Become Entrepreneurial Diffuser and Post-exit Innovation Activities

This table presents the average differences in post-exit innovation activities between entrepreneurial diffusers and their matched inventors in other categories. For each entrepreneurial diffuser whose employer exits in year *t*, we find all the leavers to public firms and stayers whose employers also exit in year *t*, and whose difference with the entrepreneurial diffuser in terms of average number of patents filed per year in the five years before exits is no more than one. We then calculate the average number of patents filed per year (*PatentsPostExit*), the average number of citations received per patent (*CitePatPostExit*), the patents' average originality score (*OriginalityPostExit*), and the average number of exploratory patents filed per year (*ExploratoryPostExit*) by each inventor in the five years after exits. We report the average differences between an entrepreneurial diffuser's innovation activity measures mentioned above and those of her matched inventors in other categories. In addition, we report the t-statistics on whether the differences are significantly different from zero. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Difference	Variable	N	Mean	t-statistics
EntreDiffuser - LeaverToPub	*PatentsPostExit*	670	0.584***	8.485
	CitePatPostExit	670	2.900***	4.174
	OriginalityPostExit	670	1.744***	5.229
	ExploratoryPostExit	670	-0.006	-1.507
EntreDiffuser - Stayer	*PatentsPostExit*	742	1.004***	16.713
	CitePatPostExit	742	5.645***	9.162
	OriginalityPostExit	742	2.798***	8.183
	ExploratoryPostExit	742	0.081***	17.761

Table 6: Employee Risk Tolerance and Entrepreneurial Diffusing

This table presents the linear probability regressions on the association between employees' job risk tolerance and their choices of destination firms conditional on the decision to leave the exiting firms, using the LEHD sample of employees from both IPO firms and acquired private firms. The dependent variable, *EntreDiffuser*, is defined as a dummy variable that equals one if an employee is an entrepreneurial diffuser, and zero if the employee is a leaver to public firms. *JobRiskTolerance* is defined as the difference between an employee's total household labor income and her earnings from the exited firm scaled by her household's total labor income. The control variables are defined in Appendix A. Each regression includes a separate intercept. All columns include male-employee fixed effects and white-employee fixed effects. In addition, we include year fixed effects in Column (1), three-digit NAICS industry fixed effects in Column (2), year and industry fixed effects in Column (3), and deal fixed effects in Column (4). Standard errors are clustered by deals. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dep. Var.	*EntreDiffuser*			
	(1)	(2)	(3)	(4)
JobRiskTolerance	0.022*	0.019**	0.018**	0.013*
	(1.765)	(2.339)	(2.261)	(1.816)
LnTenure	0.008	0.006	0.004	0.003
	(0.802)	(0.874)	(0.638)	(0.672)
LnAge	0.074***	0.059***	0.054***	0.041***
	(4.092)	(4.255)	(3.995)	(3.432)
LnEdu	-0.005	-0.010	-0.004	0.005
	(-0.350)	(-0.876)	(-0.349)	(0.529)
LnEarn	-0.026*	-0.047***	-0.046***	-0.039***
	(-1.914)	(-5.161)	(-5.029)	(-4.034)
Male Fixed Effects	Yes	Yes	Yes	Yes
White Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	No	Yes	No
Industry Fixed Effects	No	Yes	Yes	No
Deal Fixed Effects	No	No	No	Yes
Observations	94,000	94,000	94,000	94,000
R-squared	0.023	0.074	0.077	0.170

Table 7: Entrepreneurial Diffusers and Their Original Employers' Post-IPO Performance

This table presents the OLS regressions on the association between the departure of entrepreneurial diffusers and their original employers' post-IPO performance. Panel A reports the results in the LEHD sample. We redact the regression coefficients of control variables in Columns (4)-(6) due to the disclosure restriction by the U.S. Census Bureau. Panel B reports the results in the inventor sample. Columns (1)-(3) in both panels report the regressions using firms' buy-and-hold abnormal returns in the one, three, and five years after IPO (*AR1yr*, *AR3yr*, and *AR5yr*, respectively) as the measure of post-IPO performance. Columns (4)-(6) in both panels report the regressions using firms' average *ROA* in the one, three, and five years after IPO (*ROA1yr*, *ROA3yr*, and *ROA5yr*, respectively) as the measure of post-IPO performance. *PctDiffuserLeft* (*PctLeaverToPub*) is the fraction of a firm's pre-exit employees who move to private (public) firms within one year after IPO. All other variables are defined in Appendix A. Each regression includes a separate intercept. We include industry fixed effects (at the three-digit NAICS level) and year fixed effects in the regressions. Standard errors are clustered by three-digit NAICS industry. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Entrepreneurial Diffusers and Their Original Employers' Post-IPO Performance in the LEHD Sample

Dep. Var.	*AR1yr*	*AR3yr*	*AR5yr*	*ROA1yr*	*ROA3yr*	*ROA5yr*
	(1)	(2)	(3)	(4)	(5)	(6)
PctDiffuserLeft	-1.114*	-4.343***	-6.126**	-0.885***	-1.068***	-0.951***
	(-1.942)	(-3.530)	(-2.301)	(-3.327)	(-5.094)	(-4.125)
PctLeaverToPub	-2.670***	-1.689	3.099	-0.171	-0.548	-0.405
	(-2.925)	(-1.241)	(0.996)	(-0.425)	(-1.357)	(-1.291)
PctNewHire	-0.002	0.027	-0.006	-0.024*	-0.027*	-0.037***
	(-0.052)	(0.185)	(-0.032)	(-1.690)	(-1.827)	(-3.100)
IR	-0.227***	-0.178***	0.123	+*	+	+**
	(-5.595)	(-2.726)	(0.445)			
LnProceeds	0.244	-0.755	0.196	+	+	+
	(0.959)	(-0.896)	(0.323)			
VC	0.078	0.173*	-0.148	-	-	-
	(1.112)	(1.723)	(-0.507)			
TobinQ	0.071***	0.025	0.014	+	+**	+*
	(9.373)	(0.930)	(0.703)			
LnMV	-0.182**	-0.013	-0.244	-	-	-
	(-2.624)	(-0.062)	(-1.398)			
RDadj	-0.055	-0.336	0.769	-***	-***	-***
	(-0.413)	(-1.322)	(0.721)			
IndVCPct	-13.360***	-23.930**	-65.860**	-***	-***	-***
	(-4.044)	(-2.019)	(-2.540)			
LnIndIPOVol	-0.026	-0.078	0.110	+	+	+
	(-0.624)	(-0.655)	(0.618)			
IndRFOption	7.515	13.860	-67.160	-	-	-

	(0.583)	(0.463)	(-0.794)			
LnEmp	0.130***	0.512***	0.736***	+***	+***	+***
	(3.186)	(3.830)	(2.911)			
LnFirmAge	0.006	-0.230	-0.676*	+**	+***	+***
	(0.173)	(-1.259)	(-1.903)			
LnAvgTenure	-0.065	0.306	0.691**	+	+*	+*
	(-1.493)	(1.342)	(2.328)			
LnAvgAge	0.531*	1.648*	2.801*	-	+	+
	(1.901)	(1.759)	(1.975)			
LnAvgEdu	-0.791	-0.543	-1.038	-	-	-
	(-1.286)	(-0.245)	(-0.204)			
LnAvgEarn	0.377***	0.316	0.541	+***	+***	+***
	(3.981)	(0.935)	(1.351)			
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	550	550	550	550	550	550
R-squared	0.365	0.244	0.223	0.632	0.61	0.592

Panel B: Entrepreneurial Diffusers and Their Original Employers' Post-IPO Performance in the Inventor Sample

Dep. Var.	*AR1yr*	*AR3yr*	*AR5yr*	*ROA1yr*	*ROA3yr*	*ROA5yr*
	(1)	(2)	(3)	(4)	(5)	(6)
PctDiffuserLeft	-0.188	-0.695**	-0.934**	-0.138*	-0.152**	-0.169**
	(-1.701)	(-2.473)	(-2.479)	(-1.989)	(-2.299)	(-2.629)
PctLeaverToPub	0.274	-0.498	-0.979	-0.121	-0.097	-0.068
	(0.584)	(-0.560)	(-0.846)	(-0.991)	(-1.218)	(-0.885)
PctNewHire	0.010	0.022	0.042	0.025**	0.019**	0.013
	(0.493)	(0.591)	(0.731)	(2.620)	(2.155)	(1.533)
IR	-0.481***	-0.330***	-0.244***	-0.014	-0.017	-0.010
	(-3.672)	(-3.603)	(-4.188)	(-0.976)	(-1.152)	(-1.087)
LnProceeds	-0.023	-0.161	-0.189	0.076	0.062	0.050
	(-0.137)	(-0.611)	(-0.485)	(1.492)	(1.554)	(1.643)
VC	-0.063	0.190	0.286	-0.056	-0.039	-0.027
	(-0.609)	(1.234)	(1.103)	(-1.308)	(-1.174)	(-0.903)
TobinQ	0.076***	0.014	0.010	-0.001	-0.005**	-0.003
	(7.164)	(0.886)	(0.863)	(-0.650)	(-2.907)	(-1.698)
LnMV	0.050	0.291	0.191	-0.041	-0.008	0.004
	(0.335)	(1.284)	(0.604)	(-0.807)	(-0.195)	(0.155)
RDadj	-0.618	-0.569	-0.876	-1.146***	-0.990***	-1.014***
	(-1.682)	(-0.664)	(-1.521)	(-7.258)	(-8.496)	(-8.863)
IndVCPct	-0.242	-0.882*	-0.958	-0.060	-0.108	-0.130
	(-1.264)	(-1.818)	(-1.529)	(-0.630)	(-1.143)	(-1.282)
LnIndIPOVol	-0.033	-0.273**	-0.028	0.023	0.010	0.006
	(-0.683)	(-2.455)	(-0.164)	(1.485)	(0.618)	(0.304)
IndRFOption	6.968	-11.664	-17.984	-5.665*	-4.314*	-3.888*
	(1.355)	(-0.962)	(-1.098)	(-2.072)	(-1.933)	(-2.048)
LnInventor	0.044	0.031	0.133	0.054**	0.041*	0.033*
	(0.834)	(0.290)	(1.041)	(2.507)	(2.139)	(1.988)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	697	697	697	697	697	697
R-squared	0.297	0.141	0.092	0.370	0.364	0.370

Table 8: 2SLS Analysis on the Impact of Entrepreneurial Diffusers on Their Original Employers' Post-IPO Performance

This table reports the 2SLS regressions on the impact of entrepreneurial diffusers on their original employers' post-IPO performance in the inventor sample. The instrumental variable, *ChgPctPatentsPrv*, is the change in the fraction of patents filed by private firms (as opposed to public firms) in an IPO firm's three-digit NAICS industry. *PctDiffuserLeft* is the fraction of a firm's pre-exit employees who move to private firms within one year after IPO. *FittedPctDiffuserLeft* is the fitted value of *PctDiffuserLeft* obtained from the first-stage regression. All other variables are defined in Appendix A. Column (1) reports the first-stage regression and the Kleibergen-Paap Wald F-statistic on the weak instrument test. Columns (2)-(4) report the regressions using firms' buy-and-hold abnormal return in the one, three, and five years after IPO (*AR1yr*, *AR3yr*, and *AR5yr*, respectively) as the measure of post-IPO performance. Columns (5)-(7) report the regressions using firms' average *ROA* in the one, three, and five years after IPO (*ROA1yr*, *ROA3yr*, and *ROA5yr*, respectively) as the measure of post-IPO performance. Each regression includes a separate intercept. We include industry fixed effects (at the three-digit NAICS level) and year fixed effects in the regressions. Standard errors are clustered by three-digit NAICS industry. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

	1st Stage	2nd Stage					
Dep. Var.	*PctDiffuserLeft*	*AR1yr*	*AR3yr*	*AR5yr*	*ROA1yr*	*ROA3yr*	*ROA5yr*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ChgPctPatentsPrv	1.450***						
	(3.464)						
FittedPctDiffuserLeft		-0.353	-7.917***	-3.577**	-0.714	-1.167**	-0.949**
		(-0.318)	(-3.350)	(-2.006)	(-1.541)	(-2.523)	(-2.366)
PctLeaverToPub	-0.153**	0.250	-1.555*	-1.366	-0.205**	-0.246**	-0.183*
	(-2.542)	(0.735)	(-1.744)	(-1.314)	(-2.131)	(-2.487)	(-1.903)
PctNewHire	0.010	0.011	0.093	0.067	0.030***	0.029***	0.021*
	(1.280)	(0.516)	(1.213)	(1.076)	(2.848)	(2.703)	(1.903)
IR	0.007	-0.480***	-0.289**	-0.229***	-0.010	-0.012	-0.005
	(0.402)	(-4.041)	(-2.068)	(-3.915)	(-0.694)	(-1.028)	(-0.431)
LnProceeds	-0.017	-0.025	-0.257	-0.224	0.068	0.049	0.040
	(-0.553)	(-0.162)	(-0.740)	(-0.596)	(1.193)	(0.927)	(1.171)
VC	-0.001	-0.063	0.190	0.286	-0.056	-0.040	-0.027
	(-0.043)	(-0.652)	(0.670)	(1.046)	(-1.294)	(-0.858)	(-0.761)
TobinQ	-0.002	0.076***	0.001	0.005	-0.002	-0.007***	-0.005**
	(-1.325)	(8.017)	(0.045)	(0.403)	(-1.045)	(-2.842)	(-2.052)
LnMV	-0.002	0.049	0.250	0.176	-0.045	-0.014	-0.000
	(-0.060)	(0.352)	(0.761)	(0.540)	(-0.777)	(-0.262)	(-0.002)
RDadj	0.084	-0.605*	0.042	-0.652	-1.097***	-0.904***	-0.948***
	(0.839)	(-1.744)	(0.041)	(-1.034)	(-6.417)	(-5.282)	(-6.695)
IndVCPct	-0.027	-0.243	-0.933	-0.977*	-0.064	-0.115	-0.136
	(-0.427)	(-1.396)	(-1.414)	(-1.686)	(-0.687)	(-1.089)	(-1.385)
LnIndIPOVol	0.011	-0.031	-0.181	0.005	0.030	0.023	0.016

	(0.758)	(-0.624)	(-1.262)	(0.035)	(1.415)	(0.979)	(0.722)
IndRFOption	2.036**	7.224	-0.433	-13.874	-4.769**	-2.736	-2.674
	(2.448)	(1.644)	(-0.033)	(-0.939)	(-2.073)	(-1.195)	(-1.343)
LnInventor	0.006	0.045	0.080	0.151	0.057**	0.048*	0.038*
	(0.485)	(0.880)	(0.688)	(1.447)	(2.265)	(1.840)	(1.767)
F-statistics	12.001						
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	697	697	697	697	697	697	697

Figure 1: Entrepreneurial Diffusers and Their Original Employers' Post-IPO Buy-and-hold Abnormal Returns

This figure displays the association between the departure of entrepreneurial diffusers and their original employers' post-IPO buy-and-hold abnormal returns (*BHAR*), based on the regression coefficients reported in Table 7. The solid line (dashed line) presents the decrease in *BHAR* in the one, three, and five years after IPO associated with a one standard deviation increase in the fraction of a firm's employees who move to private firms after IPO in the LEHD sample (inventor sample).