NBER WORKING PAPER SERIES

FOUNDING TEAMS AND STARTUP PERFORMANCE

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Working Paper 28417
http://www.nber.org/papers/w28417

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 2021

Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the U.S. Census Bureau, the Federal Reserve Board of Governors, its staff, or the National Bureau of Economic Research. Disclosure review number DRB-B0043-CED-20190418, DRB-B0049-CED-20190503, CBDRB-FY19-398, and CBDRB-FY21-CES007-001. Formerly "The Post Entry Growth and Survival of Business Startups: The Role of Founding Teams" We thank Emek Basker, Jorge Guzman, Shawn Klimek, Ron Jarmin, Martha Stinson, and participants at the 2019 Comparative Analysis of Enterprise Data, the 2019 NBER Summer Institute Entrepreneurship Meeting, the LSE 2019 Entrepreneurship Workshop, LACEA 2019, 2019 Schumpeter Lecture, HEC Paris Entrepreneurship Workshop, 2020 International Research Conference on Recent Trends in Firm Organization and Firm Dynamics, NYU Stern, George Mason University, University of Notre Dame, the 2019 RCEA Entrepreneurship Conference, the 2020 Southern Economic Association Conference, and the 2020 Oxford University Conference on Firm Heterogeneity and the Macroeconomy for helpful comments. John Haltiwanger was also a part-time Schedule A employee at the U.S. Census Bureau.

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NBER Working Paper No. 28417
January 2021
JEL No. J24,L23,L26

ABSTRACT

We explore the role of founding teams in accounting for the post-entry dynamics of startups. While the entrepreneurship literature has largely focused on business founders, we broaden this view by considering founding teams as both the founders and early joiners. We investigate the idea that the success of a startup may derive from the organizational capital that is created at firm formation and is inalienable from the founding team itself. To test this hypothesis, we exploit premature deaths to identify the causal impact of losing a founding team member on startup performance. We find that the exogenous separation of a founding team member due to premature death has a persistently large, negative, and statistically significant impact on post-entry size, survival, and productivity of startups. Consistent with our organizational capital hypothesis, effects are stronger for firms with small founding teams and those operating in business-to-business (B2B) oriented sectors. Moreover, while we find that the loss of a founder has an especially large adverse effect, the loss of an early joiner nonetheless exhibits a significant negative effect, lending support to our inclusive definition of founding teams.

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1 Introduction

Startups and young firms contribute disproportionately to job creation, innovation and productivity growth (Haltiwanger, Jarmin, and Miranda, 2013; Alon, Berger, Dent, and Pugsley, 2018; Acemoglu, Akcigit, Bloom, and Kerr, 2018). A hallmark of young firm dynamics is that most of the contribution by young firms can be attributed to the relatively few that grow rapidly; in fact, the majority of startups fail in their first five years and typical surviving firms grow only modestly (Decker, Haltiwanger, Jarmin, and Miranda, 2014; Pugsley, Sedlacek, and Sterk, 2018). However, despite its importance, relatively little is known about the sources of heterogeneity across young firms that generate up-or-out dynamics.

In this paper, we empirically demonstrate that founding teams are a key driver of the variation in startup performance. Using administrative data that contains millions of startups in the U.S., we document positive relationships between the human capital of founding teams and firm outcomes. We also identify the causal contribution of founding teams to startup performance by using the premature death of a founding team member as an exogenous separation shock. We find that losing a founding team member has large, negative effects on the size, productivity, and survival of startups. These negative effects are remarkably persistent, lasting for at least 10 years after the shock, indicating that disruptions caused by the loss are not resolved by hiring replacements. These results, further enhanced by heterogeneous treatment effect analyses, suggest that organizational capital is embodied in founding teams and those teams cannot be easily replaced.

Our definition of founding teams includes both founders and early joiners – a distinction based on the individual's timing of association with the firm and earnings. While we find that the loss of a founder has an especially large adverse effect, the loss of an early joiner nonetheless exhibits a significant negative effect, lending support to our inclusive definition of founding teams. We also construct a measure of human capital of each founding team member and find that the negative effects are larger when losing a member with higher human capital. Even so, we still find large negative effects for the loss of founding team members at the average of the human capital distribution within the firm. These results indicate that ordinary founding team members – early joiners with relatively low earnings and those without especially high levels of human capital – also play a critical role in startup performance. Taken together, these findings speak to the benefits to expanding the scope of analysis beyond the founders traditionally focused in the entrepreneurship literature.

We use administrative matched employer-employee data combined with business tax information covering all startups with paid employees established between 1990 and 2015 in the non-farm business sector. Founding teams are identified as all individuals with positive earnings in the first year of operation, supplemented by business owners of sole proprietors whose identities are obtained from income tax filings. Our focus is on startups that organize themselves as sole proprietors or corporations, as we can measure founding teams of those firms in a consistent way; we exclude partnerships because their business owners are prohibited from paying themselves wages and thus do not appear in our database. Leveraging the longitudinal structure of the matched employer-employee data, we use each founding team member's most recent earnings prior to joining the startup as a proxy for their human capital.

We first document that startups launched by founding teams with high human capital are associated with superior firm performance in survival, employment, revenue, and labor productivity. These patterns provide a rich portrait of young firm heterogeneity suggesting the importance of founding teams. Nonetheless, a number of endogeneity issues complicate the causal link between founding team characteristics and firm outcomes. For example, high-ability individuals may be more likely to join ventures based on ideas or technology with greater market potential. Therefore, the positive relationship between founding team human capital and firm outcomes could be driven by unobserved characteristics (e.g., quality of underlying business idea) that are endogenously tied to the characteristics of the founding team.

This empirical challenge is central to the debate in the entrepreneurship literature regarding the relative importance of the firm (horse) versus the founders (jockey), or interpreted more broadly the founding team. For instance, Kaplan, Sensoy, and Strömberg (2009) study a sample of 50 venture capital-backed firms and document that the core business ideas tend to be much more stable than the founding team, suggesting the importance of the horse over the jockey. Consistent with this view, although the founding team may be critical to the earliest stages of launching a venture, they may not have the appropriate skills to build and grow the business (Wasserman, 2017; Kulchina and Gjerlov-Juel, 2019). More generally, founding teams may be less critical after a business idea has been sufficiently developed, at which point the founding team members could be replaced by outside individuals with suitable skills. This perspective implies that losing a founding team member would have little or no persistent effect on the post-entry dynamics of the firm.

Alternatively, the loss of a founding team member may represent a significant loss for the firm. In nascent stages of new businesses, the founding team is actively engaged in the formation of organizational capital that may be inalienable from the team itself. This includes many factors that differentiate businesses including their core vision, customer and supplier relationships, reputational capital, and norms and culture. Such organizational capital likely grows as founding teams work together and develop team-specific complementarities. Losing a founding team member, therefore, results in the loss of accumulated organizational capital. Under this alternative view, the loss of a founding team member may have profound and persistent consequences for firm outcomes.

To address these issues with causal inference, we leverage exogenous separations of founding team members as a result of premature death.[1] In a difference-in-differences framework, we examine roughly 25,000 startups that experience a premature death of a founding team member relative to a closely matched group of "twin" startups that do not. We find that relative to their matched counterparts, treated startups experience a roughly 16%, 35%, and 22% decline in employment, revenue, and labor productivity, respectively. While there is a

[1]As we discuss below, our identification approach builds on a recent literature using premature death as a treatment that reflects plausibly exogenous variation.

slight recovery following the largest decline in the year immediately after the shock, the negative effects persist for at least 10 years after the shock. We also find that losing a founding team member lowers the probability of survival of the firm.

To further illuminate the role of organizational capital, we explore a number of heterogeneous treatment effects in settings in which the importance of organizational capital is expected to be amplified or attenuated — namely, (1) the loss of a founder versus an early joiner of the founding team, (2) business-to-business (B2B) oriented firms that rely more heavily on relationships with other businesses, and (3) small founding teams in which each member likely accounts for a greater share of the firm's organizational capital. We find that the adverse effects of losing a founder are twice as large as those of losing an early joiner. Moreover, the effects are stronger for firms in B2B-oriented sectors as well as those with small founding teams. Taken together, these results are consistent with the view of organizational capital — which accumulates over time and is largely embodied in individuals — as a key mechanism that explains why startup performance diminishes following the loss of a founding team member.

The paper is organized as follows. In Section 2 we discuss the related literature and a conceptual framework that describes how organizational capital developed by a founding team relates to standard models of firm dynamics. We then discuss our data infrastructure in Section 3. Section 4 describes basic facts about the post-entry dynamics of startups and the relationship of these dynamics to the characteristics of founding teams. Section 5 presents our identification methodology using premature deaths, our main results and then analysis of heterogeneous treatment effects. Section 6 concludes.

2 Background

Related Literature

Our work contributes to the entrepreneurship literature studying the determinants of startup growth heterogeneity. That literature has identified a number of initial characteristics that correlate with firm outcomes including age of the workers (Ouimet and Zarutskie, 2014), the outside options for and age of the founders (Choi, 2017; Azoulay, Jones, Kim, and Miranda, 2020), and the name or the incorporation location of the business (Guzman and Stern, 2015). Some studies also stress the importance of the founders' skill set (Lazear, 2004) and risk tolerance (Iyigun and Owen, 1998) and stable shared leadership of the top management team (Agarwal, Braguinsky, and Ohyama, 2019).[2] We contribute to this literature by providing new causal evidence for founding teams as an important source of variation in startup performance.

Studies of venture capital and private equity have explored the importance of founders relative to business models and ideas in determining firm success (Kaplan, Sensoy, and Strömberg, 2009; Ewens and Marx, 2017). We build upon these studies by establishing new facts about the importance of founding teams using data that covers startups outside of the typically studied venture capital-backed firms. We also leverage a unique source of exogenous variation – premature deaths – used in a few other contexts (e.g. Jones and Olken, 2005; Nguyen and Nielsen, 2010; Azoulay, Graff Zivin, and Wang, 2010; Oettl, 2012). In addition, we document new evidence for the importance of early joiners, broadening the scope of analysis beyond founders.

Our work also builds upon the firm dynamics literature. Several empirical studies have stressed that high growth young firms play a disproportionate role in aggregate job creation and productivity growth.(Decker, Haltiwanger, Jarmin, and Miranda, 2016; Alon, Berger, Dent, and Pugsley, 2018). Canonical models of firm dynamics attribute growth hetero-

[2]See Klotz, Hmieleski, Bradley, and Busenitz (2014) for a review.

geneity to initially-drawn productivity or demand (Jovanovic, 1982) and post-entry shocks (Hopenhayn and Rogerson, 1993). There is growing evidence that the initial difference – or ex-ante heterogeneity – plays an important role (Pugsley, Sedlacek, and Sterk, 2018), and we contribute to this literature by identifying founding teams as a salient initial firm characteristic.

Perhaps the closest and complementary to our work is a recent study by Smith, Yagan, Zidar, and Zwick (2019) (henceforth SYZZ), which examines the importance of human capital vis-à-vis financial capital among the highest earning pass-through businesses in the US. Using a similar identification strategy leveraging the pre-mature deaths of business owners, SYZZ find large and persistent negative effects on pass-through profits. A key distinction between their work and ours is that SYZZ focus on pass-through businesses held by top earners — many of which are legacy businesses passed down from parents to their children — through the lens of growing income inequality where we focus exclusively on young firms due to their outsized role in job creation and economic growth. Moreover, we consider the importance of founding teams and not just founders. Relatedly, our analysis of young firms allows us to focus on the earliest stages in the life cycle of the firm when organizational capital initially forms and develops.[3] Despite the compositional differences in the types of firms studied, the two studies provide consistent and complementary evidence on the role of human capital in explaining firm performance of both young firms and pass-through businesses.

Conceptual Framework

In a standard model of entry, selection, and growth (Lucas, 1978; Hopenhayn, 1992), entrants pay a fixed cost of entry, learn their productivity draw, and then face a profit function with

[3] A related study by Becker and Hvide (2019) investigates the impact of losing founders on startups using administrative data for Norway. They find large, adverse and persistent impacts of losing founders on a number of outcomes including survival, employment, revenue and profits. As with SYZZ, a critical distinction between our work and theirs (in addition to the distinction between results for the U.S. versus Norway) is our broader interest in all founding team members. Relatedly, we examine heterogeneous treatment effects by founding team member characteristics as well as by firm type to draw out the broader implications of all founding team members in the context of our hypotheses regarding organizational capital being embedded in the founding team members.

curvature (from either decreasing returns or product differentiation) and a fixed cost of operation. Firms with high productivity draws become large, those with low draws stay small, and those with sufficiently low draws exit due to their inability to cover fixed costs. Permitting dynamic learning or other adjustment frictions enable interesting post-entry dynamics (Jovanovic, 1982; Hopenhayn and Rogerson, 1993; Ericson and Pakes, 1995).

We think a useful way to interpret the fixed cost of entry is that it reflects the time and resources required to invest in the organizational capital that makes firms distinct. An illustrative model that formalizes this organizational capital interpretation of the startup process is presented in Appendix A.1. We show how the founding team of a business can play a critical role in the development and success of the investment in organizational capital. Relatedly, we show how the standard assumption of an ex post productivity draw can be interpreted as a draw from a distribution of founding team match quality. Next we provide an overview of the issues and implications of such a model, which helps motivate the empirical analysis that follows.

Several issues emerge in this interpretation of the business formation period of startup firms. First, the set of individuals that constitute the founding team needs to be identified. A narrow view is that the founding team consists solely of the founders. A broader view is that the founding team reflects the founders along with early joiners. A second question is the extent to which organizational capital is embodied in the founding team. If the organizational capital is inalienable, then the loss of a founding team member will have an adverse impact on firm performance. As shown in the appendix, this negative impact is likely to manifest in multiple measures of performance including the scale of operations in terms of revenue and employment, revenue productivity measured as revenue per worker, and survival. In our empirical analysis, we examine the impact of the loss of a founding team member on all of these outcomes.

3 Data Infrastructure

We construct a longitudinal dataset covering the majority of startups and their founding teams established between 1990 and 2015 by combining data from the Longitudinal Business Database (LBD) and the Longitudinal Employer-Household Dynamics data (LEHD). Information on startups is derived from the LBD. The LBD tracks annually all U.S. non-farm establishments and firms with at least one paid employee. An establishment is identified as a specific physical location where business activities occur and all establishments under common operational control are grouped under the same firm identifier. The primary source of information on operational control is the Company Organization Survey (conducted annually) and the Economic Censuses (conducted every five years). Information in the LBD includes the number of employees, annual payroll, industry, establishment and firm age, and entry and exit of establishments and firms. We enhance this data by incorporating revenue information imported from the Business Register (BR) as in Haltiwanger, Jarmin, Kulick, and Miranda (2017). Following LBD conventions, we define firm age as the age of the oldest establishment in the firm's first year with positive employment. Startups are defined as firms with age zero and firm death occurs when the firm and all associated establishments exit and are not again observed with employment. This approach avoids classifying exit through acquisition as a firm death.[4] Our outcome variables of interest are employment, revenue, labor productivity, and survival. Labor productivity is measured as revenue per worker.[5] As our focus is on investigating the heterogeneity in outcomes within narrowly defined sectors, we control for detailed industry by year effects in all of our analysis.

Our data contains sole proprietors and corporations where we can consistently measure

[4] In certain cases, firm identifiers in the LBD are not longitudinally consistent. Firm identifiers may change for a number of reasons unrelated to a change in common ownership. For example, identifiers may change over time due to a transition from a single- to a multi-unit firm, reorganization of the legal form, and acquisitions. In our startup panel, we construct a longitudinally consistent firm identifier by leveraging information on establishment flows, EINs, and business names. Importantly, our longitudinal firm identifier will not longitudinally link a firm before and after an acquisition event.

[5] Employment consists of full and part-time employees, including salaried officers and executives of corporations, who were on the payroll in the pay period including March 12. Revenue is measured total revenue measured annually.

active business owners. We define the founding team as all individuals with positive unemployment insurance (UI) covered earnings at the startup within the firms' first year of operation as well as business owners of sole proprietors. Owners of sole proprietors and partnerships are prohibited from paying themselves wages and therefore do not appear in the LEHD. Sole proprietors file self-employment income tax filings, which are captured in the Business Register. We are therefore able to combine sole proprietor owners with the founding teams recovered from the LEHD. Active or managing owners of partnerships, on the other hand, file Schedule K-1 pass-through income that will not be observed in either the Business Register or the LEHD. We therefore exclude partnerships from our startup sample. For C or S corporations, the vast majority of active founders/owners are likely to be included among the individuals with positive UI earnings in the LEHD. The Internal Revenue Service (IRS) requires that owners of C or S corporations who provide more than minor services to their corporations receive employment compensation.[6] Indeed, using K-1 and W-2 filings data, Nelson (2016) finds that almost 90% of all S corporations with paid employees have at least one shareholder-employee.[7] Furthermore, Nelson (2016) documents that privately-held C corporations "appear to pay out a majority of the owners' income in the form of executive compensation" and virtually all C corporation startups are privately held.[8] Therefore, for the vast majority of the startups in our data, our measurement methodology of founding teams is likely to capture both active business owners and the earlier joining employees.

While the existing entrepreneurship literature almost exclusively focuses on founders,

[6]For example, the IRS states "The definition of an employee under the Internal Revenue Code include corporate officers. Courts have consistently held S corporation officers/shareholders who provide more than minor services to their corporation and receive, or are entitled to receive, compensation are subject to federal employment taxes." See https://www.irs.gov/businesses/small-businesses-self-employed/s-corporation-employees-shareholders-and-corporate-officers.

[7]The restriction to businesses with paid employees (our focus) is crucial. There are a large number of non-employer S-corporations. Nelson (2016) reports about 30% of all S-corporations have no employees. We exclude non-employers from our analysis.

[8]Also, see https://www.irs.gov/businesses/small-businesses-self-employed/paying-yourself which states that the "An officer of a corporation is generally an employee, but an officer who performs no services or only minor services, and who neither receives nor is entitled to receive any pay, is not considered an employee." This helps explain why some K-1 owners of S corporations do not show up in W-2 as employees. We regard such owners as passive owners of less interest to our analysis.

partly due to data limitations, we decompose the founding team into two groups: founders and early joiners.[9] To identify founders, we largely follow the approach used in prior studies based on workers' earnings and the legal form of the startup (e.g, Kerr and Kerr (2017); Choi (2017); Azoulay, Jones, Kim, and Miranda (2020)). For corporations, we define founders to those who earn wages in the first quarter of the firm's operations (i.e., present on "day one") and are among the three highest-paid workers in the firm during the first year. For sole proprietorships, because owners are not observed in the LEHD, we define founders as the business owner and the top two workers with the highest earnings in the first year. In addition, we define early joiners as the remaining individuals who also appear at the startup in its first year of operations. A important distinction is that, unlike founders who are present in the first quarter, early joiners may join in subsequent quarters during the initial year of the firm.

Our measurement approach overcomes some of the pitfalls in identifying founders in the administrative data (Hyatt, Murray, and Sandusky, 2020). First, we abstract from partnerships that do not earn wage and salary income from their business. Second, we use auxiliary source information from the Business Register to identify owners of sole proprietors. For corporations, prior work finds that about 90% of S corporation owners identified by K-1 filings data also appear as the top three earners during the firms' first year in the W-2 and LEHD data (Azoulay, Jones, Kim, and Miranda, 2020).[10] Our definition of founders, therefore, captures the set of workers that are likely to hold a leadership position within the firm regardless of whether they have a financial stake in the firm. Concerns around properly identifying founders are further allayed by our empirical findings. In particular, the negative impact of losing a founding team member is more pronounced when losing a founder than when losing an early joiner, though both cases yield negative and significant effects. Our measure appears to capture the outsized role that founders typically have on their firms

[9]For a few exceptions studying non-founding employees of startups, see Ouimet and Zarutskie (2014); Dahl and Klepper (2015); Roach and Sauermann (2015); Kim (2018)

[10]Note that, unlike (Nelson, 2016), Azoulay, Jones, Kim, and Miranda (2020) is based on employer startups in the LBD.

relative to early joiners.

We use the prior earnings of each founding team member as a proxy for human capital, which captures heterogeneity in skills and experience. Prior earnings are computed as the individual's most recent full-quarter earnings prior to joining the startup.[11] An important feature of this approach is that prior earnings are an ex-ante characterization of each individual. Therefore, prior earnings are a useful proxy for human capital and also serve as a robustness check to our founder definition. In the following section, we establish some basic facts in the relationship between human capital of the founding team — separately for founders and early joiners — and firm outcomes.

Our analytical database for basic facts, and the frame from which our causal analysis is drawn, tracks more than 6 million startups and over 72 million founding team members from 1990 to 2015. The database includes each LEHD state as the data becomes available in the LEHD infrastructure. State-level coverage in the LEHD varies over time but by 2000 coverage is nationally representative.

4 Basic Facts about Firm Outcomes and Founding Teams

Before exploring the relationship between human capital and firm performance, we first verify that our data infrastructure has properties consistent with the findings in the literature. Consistent with previous studies, we find that the exit rate of young firms is higher than older firms but that conditional on survival, young firms have higher average growth rates than older firms. In addition, we find that this heterogeneity in outcomes is tightly linked to productivity: firms with higher realized productivity are more likely to survive and grow. These results can be found in Figures A1, A2, A3 and Table A1 in the appendix.

We also find systematic and statistically significant relationships between the human capital of founding teams and firm performance. We calculate the average prior earnings of the

[11] Full-quarter earnings is measured as earnings for a quarter in which the individual also was observed with earnings in the prior and subsequent quarter. These restrictions ensure the earnings measure captures an entire quarter of work rather than a partial quarter.

founders and early joiners of each startup and organize the firms into twenty equal-sized bins by average human capital. Then we regress five-year employment and productivity growth rates and a binary indicator of firm exit on the bin indicators, controlling for industry by year fixed effects and initial conditions (initial employment for survival and employment growth and initial productivity for productivity growth). We find that startups with high-human-capital founding teams experience faster employment and productivity growth conditional on survival (panel (a) and (b) of Figure 1) and are less likely to exit (panel (c) of Figure 1). These patterns hold monotonically in all parts of the human capital distribution except for the very top for employment growth and exit outcomes.

Leveraging the longitudinal structure of our data, we examine post-entry attrition patterns among founders and early joiners. Figure 2 shows the average number of founders and early joiners remaining at the firms in years since startup (left) and their human capital (right). We find that attrition is significant for both founders and early joiners, while it is notably higher for the latter. Interestingly, attrition among the founding team generally stems from the bottom of the human capital distribution. That is, conditional on survival, the average human capital of founding team members remaining at the startup increases over time. Finally, we also find evidence of substantial positive assortative matching between founders and early joiners. As shown in Figure 3, founders with high human capital tend to associate with early joiners with high human capital.

In short, we find that the human capital of founding teams is closely linked to the up-or-out dynamics of young firms. However, we are unable to interpret these correlations as causal because both the composition and attrition of the founding team are not random. To identify causal relationships, we use exogenous variation in the founding team due to premature death, which we turn to next.

5 Causal Impact of Founding Teams

We use the premature death of founding team members to approximate an experiment in which a founding team member is randomly separated from a startup. Our research design combines a matching strategy with a difference-in-difference analysis. This approach allows us to estimate changes in startup outcomes for firms that experience the premature death of a founding team member relative to "twin" startups that do not. For each startup firm that experiences the death of a founding team member in quarter t, we find a similar control firm by matching on characteristics measured in the same quarter. One strength of this approach is that we can empirically test the core assumption that the treated and control firms exhibit similar trends prior to the death shock. If the pre-treatment trends are not similar, premature death is not likely to be as good as randomly assigned between the treated and control firms. To focus on early-stage startup dynamics, we first consider firms that experience the death of a founding team member within the first five years of operation. We then track firm outcomes for five years after the event allowing for the possibility that the firm exits.

Information gathered from the Census NUMIDENT file is used to identify premature deaths. Following Jaravel, Petkova, and Bell (2018) and a number of other studies that use premature death as a source of identification (e.g. Jones and Olken, 2005; Nguyen and Nielsen, 2010; Azoulay, Graff Zivin, and Wang, 2010; Oettl, 2012), we classify premature death as death at or before 60 years of age. For a founding team member's death to be considered a shock to the firm, we require that the individual have positive earnings during the quarter in which the death is observed. For sole proprietor owners, for whom we do not observe quarterly earnings, we measure their death as a shock to the firm if the firm has non-zero employees in the death shock quarter and did not change its EIN since its inception.[12] Treated firms are those with only one premature death in the first five years.

We use coarsened exact matching to identify a single control firm for each treated firm

[12]If a business experiences a change in ownership it must request a new EIN or file under some other existing EIN.

(Blackwell, Iacus, King, and Porro, 2009). We require that our treated and control firms have the same birth year, operate in the same detailed industry (four-digit NAICS), have the same legal form of organization, and reside in the same state. We also match on the number of active founding team members prior to the death shock. Whether a firm experiences a death shock will be related to the number of founding team members at risk of premature death. A firm with more active founding team members will have a higher probability of treatment. The probability a firm experiences the death of a founding team member is also related to the age of its founding team. Therefore, we match on the average age of the active founding team members in the death shock quarter. Typically, more than one control firm will matched to each treated firm after the coarsened exact matching procedure. Instead of using matching weights, we select a single control for each treated firm, choosing the closest matched control firm based on the absolute differences in the continuous matching variables. Ties are broken randomly. Control firms are not selected with replacement; we do not use a matched control firm as a single control for multiple treated firms.

Selected summary statistics for the treated and control firms, evaluated in the treatment (death shock) year, are presented in Table 1. The sample contains roughly 52,000 firms with an equal split between the treated and control groups.[13] The sample is reduced for revenue based measures since only about 80% of firms in the LBD are assigned revenue values.[14] In terms of balance, treated and controls have similar firm age, founding team age, and (log) levels of employment, revenue, and productivity.

5.1 Main Results

The primary outcome variables of interest include scale in employment and revenue and labor productivity. Specifically, we consider the inverse hyperbolic sine (*ihs*) of employment, revenue, and labor productivity approximated as the difference between the *ihs* revenue

[13] In unreported results, we find that the treated-control sample has similar characteristics as the full founding team database.

[14] Haltiwanger, Jarmin, Kulick, and Miranda (2017) show that the pattern of missingness for revenue is approximately random.

and ihs employment.[15] By using the ihs measures, we are able to include the impact of treatment inclusive of the intensive and extensive margins. We also consider log employment, log revenue, and log labor productivity (revenue per employee), which condition on survival. We estimate the dynamic impact of a premature death shock among the founding team using a difference-in-differences specification with leads and lags, as shown in Equation (1).

$$Y_{i,j,t} = \sum_{k=-5}^{5} \lambda_k d[k]_{i,t} + \sum_{k=-5}^{5} \delta_k d[k]_{i,t} \times TREAT_i + \alpha_i + \tau_{j,t} + \epsilon_{i,j,t} \tag{1}$$

$Y_{i,j,t}$ is the outcome for startup i in industry j in year t. $d[k]_{i,t}$ are a series of relative year dummies before and after the death shock. $TREAT_i$ is the treatment dummy that equals 1 if it experiences a death of a founding team member, zero otherwise. α_i and $\tau_{j,t}$ are firm and industry by year fixed effects. Estimates of δ_k are the parameters of interest, representing the change in outcomes in each year for treated firms relative to the control group. We also control for firm age fixed effect in our main specifications.

Figures 4 and 5 show the main results for ihs employment, ihs revenue, and ihs productivity. We do not find evidence of differential pre-trends for any of the outcome variables, lending credibility to our research design utilizing premature death shocks. This allows us to causally interpret the estimated effects following the death shock. The impact of losing a founding member due to premature death is immediately negative, persistent, and statistically significant. Startup employment, revenue, and labor productivity sharply diminish in the year of the founding member death. Though these negative effects are reduced slightly in the following year, they persist to five years after the death shock.

In interpreting these results, we note that there might be a mechanical transitory effect on employment that is a direct result of the death. That is, it might be thought that a premature death causes at least a transitory decline of one employee until a vacancy is posted and filled.

[15] The inverse hyperbolic sine approximates the log transformation but permits inclusion of zeroes. $ihs(x) = ln(x + (1 + x^2)^{0.5})$. Burbidge, Magee, and Robb (1988) and Pence (2006) described the advantages of the ihs transformation for analysis of distribution of outcomes with extensive zero values (e.g., earnings, wealth, employment,etc.) Variation in ihs measures are approximately equivalently to log variation for x not close to zero.

The results in Figure 4 reject this interpretation on a number of dimensions. First, Davis, Faberman, and Haltiwanger (2013) show that the average vacancy duration is about 20 days, and we find effects persistent up to five years after the death shock. Second, we can quantify how large the initial transitory impact driven by the mechanical effect might be. The average number of employees of the firms at the time of the death shock is 15.5 and the reduction in *ihs* employment implied by the mechanical reduction of one person is -0.07, which is denoted in the figure. This is less than half of the actual impact in period 1 after the death shock which is -0.25. Moreover, as emphasized, this mechanical effect should be transitory.

The persistent reduction in revenue is even greater than the reduction in employment. For revenue, *ihs* revenue declines by 0.6 in the first year while *ihs* employment falls by 0.25. After period 1, *ihs* revenue declines by about 0.4 persistently for years 2 through 5 after the death shock while *ihs* employment declines by about 0.2. These results imply that *ihs* productivity falls by about 0.4 in period 1 and 0.2 in years 2 to 5 after the death shock.

We also estimate the specifications using $\log(Emp)$, $\log(Rev)$, and $\log(Prod)$ (revenue per worker) as dependent variables. These measures, by construction, condition on survival.[16] Results are presented in Figure 6. The patterns for the log based outcomes are very similar qualitatively to those for the *ihs* based outcomes. We find evidence of large, negative, persistent, and statistically significant effects of losing a founding team member. The magnitude of the effects are less severe relative to Figures 4 and 5 but still quantitatively large. $\log(Rev)$ declines by about 10 log points, $\log(Emp)$ by 5 log points with an accompanying decline in $\log(Prod)$ by about 5 log points. As with the *ihs* outcomes the effects are highly persistent. The evidence is not consistent with a transitory effect deriving either from a mechanical vacancy creation or from a temporary disruption effect.

For the log outcome results, there is a concern for potential selection bias since log transformation requires positive activity in the post-treatment years. Treated firms that survived after being hit by the founding team death shock may be more resilient than

[16] Note that treated and control firms exist at the time of the shock. No exit occurs prior to death shock among either treated or control firms.

surviving control firms that did not experience a such shock. In that case, treated firms might have grown faster, on average, than their control counterparts in the absence of the shock, and thus negative effects on log outcomes could be attenuated. If this difference between treated and controls is quantitatively negligible, then selection bias is not a concern. While it is impossible to isolate how much faster or slower surviving treated firms would have grown compared to a counterparts had they not been treated, we can characterize their pre-treatment differences. The absence of pre-treatment differences in Figure 6 provides evidence that selection bias is not a substantial concern. In the appendix, we also compare the growth rate of employment, revenue, and productivity from birth to the year prior to the death shock year between the treated and controls that survived after the treatment year. The results of this analysis are shown in Table A2. Conditioning on survival in post-treatment years, the difference in growth between treated and control firms in the pre-treatment period is statistically indistinguishable from zero. Taken together, these results suggest that the selection bias in the estimated effects of log outcomes is small.

To summarize the main results, we collapse the leads and lags into a binary pre/post indicator and estimate the average treatment effects as in Equation (2).

$$Y_{i,j,t} = \lambda \cdot POST_{i,t} + \delta \cdot POST_{i,t} \times TREAT_i + \alpha_i + \tau_{j,t} + \epsilon_{i,j,t} \tag{2}$$

$Y_{i,j,t}$ is the outcome for startup i in industry j in year t. $POST_{i,t}$ is the time dummy that equals 1 if $0 \leq t \leq 5$ and 0 otherwise with $t = 0$ being the death shock year. $TREAT_i$, α_i and $\tau_{j,t}$ are identically defined as in Equation (1). We also control for firm age fixed effects. δ is the coefficient of interest. This simplified specification facilitates the analysis of heterogeneous treatment effects below.

Table 2 shows the average treatment effect estimates. Overall, the findings are consistent with those seen in Figures 4, 5 and 6. Note that while columns 1-3 use *ihs* measures, columns 4-6 use *log* measures which exclude zeroes and therefore condition on survival. Therefore, the *log* results in columns 4-6 capture effects at the intensive margin. Though they are negative and statistically significant, these point estimates are lower than those in columns 1-3, suggesting that the treatment effect is operating at both the intensive and extensive margins.

We now explore the extensive margin directly by quantifying how the loss of a founding team member influences the likelihood of exit. We accomplish this by first using a Cox proportional hazards model to assess the differences in the likelihood of survival in the years following the death event between treated and control firms. In Figure 7, we find that treated firms are more likely to exit after experiencing the death shock. To further quantify the extensive margin, we use a linear probability model to assess the impact of losing a founding team member on firm death some number of years after the death shock. As Table 3 shows, treated firms are roughly 12 percentage points more likely to exit within one year of losing a founding team member. The estimates using longer time windows are similarly large and statistically significant. However, the economic magnitudes considerably vary. Relative to the baseline death rates of closely matched control firms, treated firms are 160% and 40% more likely to exit in a one- and five-year window, respectively. These results suggest that the loss of a founding team member yields a significant negative impact at the extensive margin — particularly during the years just after the premature death shock.

5.2 Mechanism

Next, we explore organizational capital as a primary mechanism explaining the decline in startup performance following the loss of a founding team member. To do so, we revisit our theory around organizational capital, which we define to be tacit knowledge and resources developed in the nascent stages of a venture. If at least some organizational capital is embodied in individuals then we would expect some organization capital to be lost when a founding team member separates from the firm. However, the degree to which this reduction in organizational capital lowers firm performance will depend on the context-specific salience of organizational capital. For instance, a sudden loss of organizational capital can be less detrimental for startups that operate on knowledge more easily codified and communicated and thus more easily transferred from the founding team members.

We test this idea empirically by examining settings in which the role of organizational capital is expected to be amplified or attenuated — namely, (1) the loss of a founder versus an early joiner, (2) firms in B2B-intensive sectors which rely more heavily on relationships with key customers, and (3) firms with small founding teams in which each member likely accounts for a greater share of the firm's organizational capital. For the analysis of heterogeneous effects, we extend our pre-post difference-in-differences approach by including a third difference as shown in Equation (3).

$$
\begin{aligned}
Y_{i,j,t} = & \lambda \cdot POST_{i,t} + \delta \cdot POST_{i,t} \times TREAT_i \\
& + \beta \cdot POST_{i,t} \times TREAT_i \times Z_i \\
& + \eta \cdot POST_{i,t} \times Z_i + \alpha_i + \tau_{j,t} + \epsilon_{i,j,t}
\end{aligned} \tag{3}
$$

Z_i is the additional variable, β is the parameter of interest representing the additional effect when $Z_i = 1$, and δ is the baseline treatment effect when $Z_i = 0$.[17] For brevity, we only report the estimates for the coefficients δ and β.

5.2.1 Losing a Founder versus an Early Joiner

Given our broad definition of the founding team, which includes both the founders and early joiners, we first investigate whether the impact is greater when losing a founder. The primary difference between founders and early joiners, as we have defined them, is that founders are present at the firm during its first quarter of operations and are among the highest earning workers in the first year. As a result, founders may account for a greater share of the underlying organizational capital.

[17] For these analyses we do not include Z_i as a separate control since it is not identified with the inclusion of firm fixed effects.

Consistent with this view, Table 4 shows that the impact of losing a founder is significantly larger than that of losing an early joiner. While the negative effects are roughly twice as large for *ihs* employment, they are more than four times as large for *ihs* revenue, leading to a significant decline in labor productivity. Furthermore, though the effect sizes are smaller, we find that losing an early joiner results in a significant and negative impact on all three measures of firm performance. This implies that our main results are not solely driven by deaths of founders and that early joiners also play an important role in startup growth and survival. The impact of early joiners and founders operate through both the extensive and intensive margins. However, the gap between the *ihs* and *log* impact is larger for founders than early joiners suggesting the adverse impact of losing a founder is relatively more important on the extensive margin. Together, these results suggest that while organizational capital is embodied in the broader founding team, it disproportionately resides in the founders.

5.2.2 B2B versus B2C-intensive Sectors

Second, we explore whether the impact of losing a founder is greater for business-facing (B2B) rather than consumer-facing (B2C) startups. A key distinction is that B2B firms depend more heavily on relationships with other businesses. Consequently, a greater share of the organizational capital is likely embedded in founding teams of B2B businesses due to the importance of managing relationships.

We test this view by comparing startups in B2B amd B2C-intensive industries. While we cannot make this categorization at the firm-level, we rely on input-output accounts data from the U.S. Bureau of Economic Analysis to characterize each industry at the six-digit NAICS level. Following Delgado and Mills (2020), we categorize an industry as B2B-oriented if more than 66% of the total sales in the industry are toward businesses or the government rather than toward personal consumption, and B2C otherwise.[18]

[18]The distribution of sales to businesses versus consumers across industries is highly bimodal. A binary categorization therefore appears appropriate. Nonetheless, results are robust to using a continuous measure

Consistent with our theory of organizational capital, Table 5 shows that losing a founding team member in a B2B-intensive sector leads to a greater decline in startup performance than in a B2C sector. The economic magnitudes of the interaction term are large and significant. For instance, the additional impact associated with B2B sectors is -.05 for *ihs* employment and -.20 for *ihs* revenue. Relative to the baseline effect among B2C-intensive sectors, this represents an increase of 38% and 72% in negative effects on employment and revenue, respectively. Comparing the *ihs* and *log* results shows that the additional impact associated with B2B sectors operates on both the extensive and intensive margins. These findings are consistent with the view that the importance of relationships in B2B businesses amplifies the role of the founding team, reflecting the link between organizational capital and startup performance.

5.2.3 Small versus Large Founding Teams

Third, we examine whether the negative impact of losing a founding team member is larger for startups with small founding teams. Intuitively, each founding team member would possess a greater share of organizational capital in relatively small teams. Therefore, we expect the impact of a found team member death shock to be larger for smaller teams. For this purpose, we define small founding teams as those with five or fewer active founding team members in the year prior to the death shock.

Table 6 presents the results based on team size. Consistent with our organizational capital hypothesis, we find that losing a founding team member leads to a larger negative impact for small teams across all outcomes. The additional treatment effect associated with small teams for *ihs* employment is roughly twice as large as the baseline effect among larger teams. The impact for *ihs* revenue exhibits an even larger difference. Given the outsized effects on revenues, small teams also experience a more severe impact on labor productivity. Again, the greater impact on small teams operates through both the extensive and intensive

of B2B orientation.

margins. The gap between the *ihs* and *log* results suggests that the adverse impact of losing a founding team member from a small team is relatively more important on the extensive margin. These estimates again support the view that the main effects are driven by the loss of organizational capital associated with the lost founding team member, which will be greater among smaller founding teams.

5.3 Alternative Explanations and Robustness Analyses

In this section, we posit and test several alternative explanations that could be consistent with the main results. In doing so, we establish robustness of the organizational capital hypothesis and verify the validity of our sample construction and measurement.

5.3.1 Founder Definition and Human Capital

As discussed previously, our ability to identify founders among founding team members is imperfect. As an alternative to a dichotomous distinction between founders and early joiners, we leverage the granular human capital profile of each member. An individual's level of human capital is likely positively related to holding key leadership positions in the firm. As described in Section 3, we measure human capital as the individual's most recent earnings prior to joining the startup. We examine whether losing a high human capital founding team member is especially detrimental to startup performance. To focus on within-firm variation in human capital, we measure the extent to which a founding team's average human capital changes following the loss of a member as shown in Equation (4).

$$HC_i = \frac{1}{N_i}(hc_i - HC_i^{FT}) \tag{4}$$

Where N_i is the number of active founding team members at the firm in the quarter prior to the death shock, HC_i^{FT} is the average human capital of those members, and hc_i is the human capital of the deceased member. Since hc_i and HC_i^{FT} are measured in logs, HC_i measures the percentage change in the average human capital of the remaining founding team caused by the death shock.[19] If $hc_i < HC_i^{FT}$, loss of the member will increase the average human capital of the remaining founding team, and if $hc_i > HC_i^{FT}$ the opposite will occur.

Table 7 presents interaction effects with the relative human capital variable. For relative human capital, the loss of a founding team member with the average human capital among the founding team ($Post \times Treated$) yields large and statistically significant reductions in employment, revenue and productivity. For example, the impact on *ihs* revenue is about -0.3 and the impact on *ihs* productivity is about -0.2. These effects are similar in magnitude to the average treatment effects reported in Table 2. These results again support our broader focus on founding teams, providing further evidence that our main results are not simply driven by founders. It is still true, however, that the loss of a founding team member with higher relative human capital yields a larger adverse effect of outcomes. For example, the loss of a founding team member with 25 log point higher human capital yields a reduction in *ihs* revenue that is about 0.18 larger (total effect of -0.48) and a reduction in *ihs* productivity that is 0.12 larger (for a total effect of about -0.31). The gap between *ihs* and *log* results is greater for the interaction effect suggesting that losing an especially high human capital member is relatively more important on the extensive margin.

Comparing the impact of the loss of an early joiner and a mean relative human capital founding team member yields further insights. The quantitative impact of the latter is about twice as the former. This suggests that not all early joiners have the same impact. At the low end of human capital the impact is substantially smaller.[20] Putting the pieces together, our

[19] This relative change measure has similar properties to to a term in the decomposition method developed by Foster, Haltiwanger, and Krizan (2001), who break down the change in aggregate productivity into the components driven by entrants, stayers, and exiters. A founding team member death is analogous to exit that causes the change in average human capital of the remaining founding team members.

[20] The results in Table 7 also imply that losing a founding team member with sufficiently low relative human capital would actually boost scale and productivity. Given the magnitudes of the coefficients, this would typically require a founding team member with very low relative human capital; for example, for $ihs(Rev)$ it would require the deceased member to have relative human capital that is more than 40 log points below the mean.

results suggest not only that founders are important, but also that the impact of a founding team member is closely follows the individual's level of human capital.

5.3.2 Persistence of the Effect

While we find that the negative impacts of a founding team member death shock are persistent through five years after the shock, it is instructive to consider how long these effects last. Long lasting negative effects may indicate that disruptions caused by the founding team member loss are not easily resolved by replacement hiring. It is possible that catch-up dynamics occurring outside of the five year window in our baseline analyses result in treated firms converging with their matched counterparts in size and productivity over a longer time horizon. To investigate this possibility, we re-estimate the regression Equation (1) and compare the differences in firms' performance through 10 years after the shock.

We find, as shown in Figure 8, that the negative effects for all of our *ihs* measures are remarkably persistent and do not dissipate even 10 years after the shock. As in our main results, treated firms appear to partially recover between 1 and 2 years after the shock, but never fully return to their pre-shock performance. These results reinforce our view that founding team members are not easily replaceable because organizational capital is largely inalienable from the founding team members.

5.3.3 Anticipation Effect

To ensure that a founding team member death is unanticipated, we follow the literature and define premature death as those occurring at age less than 60. Even so, one might question whether these deaths are truly unanticipated. For example, a critical health condition of a founder might be known years before their death, allowing the firm to adjust to such news in advance. We address this concern in our baseline sample by restricting to cases in which the deceased individuals are active wage earners at the firm in the same quarter the death is observed. Moreover, parallel pre-trends shown in Figures 4 and 5 demonstrate that there is no statistically identifiable anticipation effect.

Nonetheless, we test whether our results differ when the death occurs among relatively younger individuals, for whom death is likely to be more difficult to anticipate. We classify treated firms based upon whether the founding team member that died was above or below the median age of all founding team deaths in our sample.[21] Table 8 shows the results based on whether the deceased founding member is relatively older. Generally, we do not find significant differences in the effects of deaths of young versus old founding team members. The only exception to this is the estimate for *ihs* productivity, which is negative and significant at the 10% level, but the magnitude is relatively small compared to the main effect size. Similar results in both the direction and magnitudes for young versus old individuals allay the concerns about anticipation effects and the exogeneity of our death shock.

5.3.4 Small Business-Intensive Industries

Rather than organizational capital, our main results may be driven by particular industries where small business owner-operators are particularly important. Hurst and Pugsley (2011) show that the majority of small businesses are concentrated in a subset of industries such as skilled craftsmen, lawyers, real estate agents, doctors, small shopkeepers and restaurateurs. Firms in these industries tend to operate with small natural scale of production and their operation depends heavily on the human capital and labor supply of business owners. One might argue that a plumbing business with one owner will necessarily have to exit if the owner-plumber dies unexpectedly. Since founding teams in these industries are generally small, the probability of the deceased founding team member being one of the business owners is relatively high.[22]

While closely related, a tight link between owner death and firm exit under small natural

[21] The median age of founding team members who died in our sample is 45 years old.

[22] Note that death of a business owner does not necessarily lead to business closure if there are multiple owners. Kerr and Kerr (2017) document that the average number of owners for new businesses in the U.S. is around two. In addition, even if the owner of a single-owner business dies, it does not close if another entity acquires the business and continues its operation.

scale of production is distinct from our organizational capital hypothesis. If the negative impact of losing a founding team member is predominantly driven by startup firms in these small business-intensive industries, one may argue that our main results are driven by the nature of production technology of young firms in these industries rather than the organizational capital embodied in the deceased founding team member.

To test this alternative hypothesis we estimate heterogeneous treatment effects using a small-business intensive industry indicator. Following Hurst and Pugsley (2011), we define small business-intensive industries as the top 40 four-digit NAICS industries in terms of the share of small firms (those with less than 20 employees) out of all firms in the same industry. Results are shown in Table 9. We find that the negative *ihs* effects are 0.03, 0.11, and 0.07 log points larger for the HP sector. Relative to the effect of 0.16 in *ihs* employment for non-HP sectors, the estimated coefficient implies that the negative impact in the HP sector is about 21 percent larger. Nonetheless, the estimated effects for non-HP sectors are similar in magnitude to the main effects shown in Table 2, indicating that the main results are not primarily driven by small-business intensive industries. Consistent with the intuition above, losing a founding team member in a small-business intensive industries has no statistically significant impact on *log* outcomes suggesting that in these industries the primary impact of losing a founding team member is on the extensive margin.

When we further explore the heterogeneous effect by the founder status of the deceased member, as shown in Table 10, we find that death of early joiners in HP sectors – who are not likely business owners – causes *ihs* employment to decline by 0.08. This again is inconsistent with our main results being driven by deaths occurring in small family-owned businesses or those of plumbers, or skilled-craftsmen, whose business operations are mostly tied to the owners' human capital and labor. Even in small-business intensive industries early joiners play a critical role in startup performance.

5.3.5 High Tech Sector

Next we examine whether the negative impact of losing a founding team member is particularly pronounced in High Tech industries. One may argue that the organizational capital hypothesis applies to founding teams of innovative, growth-oriented ventures such as those in High Tech industries. Conversely, organizational capital may be less relevant for the vast majority of new businesses outside of those High Tech industries. To investigate this possibility, we compare the impact of the death shock between High Tech and non-High Tech industries. To identify High Tech industries we use the updated STEM classification in Goldschlag and Miranda (2016), which uses STEM employment shares following Hecker (2005).[23]

As shown in Table 11, we find no evidence that effects differ between High Tech and non-High Tech industries. Given that High Tech is a relatively small share of our sample, we might be worried about statistical power. Table 12 suggests this is not the case. When we compare treated and control firms within High Tech industries there remains a substantial adverse impact on scale and productivity of magnitudes comparable to the main effects reported in Table 2 and the non-High Tech estimates ($Post \times Treated$ in Table 11). The loss of a founding team member for a firm within the High Tech industries yields an impact on ihs revenue of -0.47 (compared to the -0.36 impact in Table 2) and an impact on ihs productivity of -0.31 (compared to the -0.16 impact in Table 2).

5.3.6 Young versus Mature Firms

In early phase of their life cycle, young firms learn about the viability of their business ideas (Jovanovic, 1982; Kerr, Nanda, and Rhodes-Kropf, 2014) and build a customer base from the ground up (Foster, Haltiwanger, and Syverson, 2016), often in the face of financial constraints (Schmalz, Sraer, and Thesmar, 2017). Since young firms are underdeveloped

[23]This classification has recently been used to study the dynamics of High Tech industries in Decker, Haltiwanger, Jarmin, and Miranda (2018).

along many dimensions, they may be especially sensitive to unanticipated shocks relative to more mature firms.[24] Our results might be driven by the inherent sensitivity of nascent firms. To test this idea we extend our data to incorporate founding team member deaths that occur when the firms are older (up to age 11). Then we compare heterogeneous treatment effects of the shock by maturity of the firms: between age 0 and 5 versus between age 6 and 11.

The results are presented in Table 13. Surprisingly, we find that the negative impact is smaller for young startups, which experience an attenunation of 15% and 13% in the decrease in employment and revenue, respectively, relative to their mature counterparts. This result could be explained by at least two factors. First, as we show in Figure 2, founding team members that remain at the firm longer tend to have higher human capital. Second, founding team members accumulate work experience and firm-specific human capital as the firm ages, leading to a larger negative impact of their death. Nonetheless, our findings do not appear to be driven solely by the vulnerability of young firms.

5.3.7 Emotional Distress

Finally, an important alternative explanation of our findings is the emotional distress that results from the loss of a coworker, which negatively impacts the motivation and productivity of the surviving members of the startup. Rather than the loss of organizational capital, it may be the interpersonal shock associated with the death of a colleague that explains the post-shock decline in firm performance. While we cannot directly observe and control for the emotional well-being of individuals, our results thus far do not appear to support emotional distress as the primary mechanism. For instance, we find that the negative impact on firm performance increases with the human capital of the deceased founding team member (see Table 7). Insofar as losing a coworker is a traumatizing event in and of itself, it is unlikely that the severity of the emotional toll is proportional to the prior earnings of the deceased

[24] Consistent with this argument, Fort, Haltiwanger, Jarmin, and Miranda (2013) show that young firms are disproportionately negatively affected by economic crises, even more so than old and small firms.

individual. The same logic applies to the differential impact by the loss of founders versus early joiners, and the industry of the startup (e.g., B2B versus B2C-oriented). Furthermore, one might expect the emotional shock to gradually subside, especially given the substantial turnover among young firms. Our findings, however, show that that the negative impacts persist even ten years after the death shock. While we cannot rule out the importance of psychological stress induced from losing a coworker, our results do not support this as a primary mechanism underlying the link between the loss of a founding team member and startup performance.

6 Concluding Remarks

In this paper we investigate the relationship between the founding teams and post-entry outcomes across scale, growth, productivity, and survival. We combine employee-employer data with administrative tax information on all new employer startups between 1990 and 2015. We begin by demonstrating the salience of founding team characteristics for understanding young firm dynamics. We document that the founding team's human capital, proxied by prior earnings of each team member, is systematically related to startup performance. Furthermore, we document rich attrition dynamics and assortative matching between founders and early joiners in the founding team.

To explain these patterns, we develop a hypothesis that startup performance largely depends on the organizational capital developed by the founding team in the early stages of firm formation. Organizational capital consists of tacit knowledge and resources such as customer relationships and founding vision. In this conceptual framework, we posit that organizational capital is largely embedded in individuals. Therefore, organizational capital is (at least partly) lost when a founding team member suddenly separates from the firm.

To test this hypothesis, we leverage the premature death of founding team members in a difference-in-difference framework to identify the causal impact of losing a founding team member. We use a matching strategy to create a group of control firms that are observably similar to our "treated" firms that experience death of its founding team member. Our estimates imply that exogenously separating a founding team member from a startup has a negative, significant, and persistent impact on employment, revenue, and labor productivity.

To further whether organizational capital is a primary mechanism underlying our main results, we explore a series of heterogeneous treatment effects in settings where the role of organizational capital is expected to be more or less salient. First, we show that the impact of losing a founding team member is especially large for founders, though the effect is significant and economically important for early joiners as well. We also show that the negative effects are larger in B2B intensive industries, where firms are more dependent on relationships with other businesses. In addition, the adverse impact of losing a founding team member is significantly greater for firms with small founding teams. All of these results are consistent with our hypothesis that organizational capital is an important mechanism by which founding teams contribute to firm performance.

We show the robustness of our results and measurement with additional heterogeneous treatments. Founders are difficult to precisely identify in our data, but our founder estimates are confirmed by our finding that that the loss of higher human capital founding team members is particularly damaging to the firm. Analogous to the early joiner estimates, we find that the typical founding team member with the average level of human capital still has an important impact on firm outcomes. To ensure that our premature death shocks are unanticipated we show that the effects of losing a younger founding team member, for whom death is more difficult to anticipate, are not significantly different than those for the loss of an older founding team member. Moreover, our results are remarkably persistent, unabated up to ten years after the shock. We also find that our results are similar for High Tech and non-High Tech industries, suggesting the importance of founding teams even outside of innovation-intensive industries.

Finally, though consistent with our organizational capital hypothesis, our estimates could be explained by several other factors. These alternative mechanisms include the main effects being driven by: small business intensive industries where firms are more reliant on owner-operator provided labor, the inherent fragility of young businesses, and the emotional trauma associated the the loss of colleague. Testing each in turn, the findings continue to support our organizational capital hypothesis. Though effects are larger in small-business intensive industries, our main effects do not appear to be driven by those larger effects – early joiners in these industries appear to matter for firm performance as well. We also find that the negative effects are larger for more mature startups, cutting against the argument that our findings reflect the inherent fragility of young businesses. Finally, taken together, our findings that losing founders and higher human capital founding team member has a larger effect suggest that, though emotional distress may play a role, it is unlikely to be the primary mechanism at work.[25]

We explore both the extensive and intensive margins of losing a founding team member. Losing a founding team member reduces the probability of survival but also has a significant and persistent adverse impact on intensive margin outcomes. Our results suggest that the extensive margin is relatively more important for founders, high human capital founding team members, and for founding team members from small teams and in small business intensive industries.

Our findings demonstrate that the founding team, inclusive of but also beyond the founders themselves, is important in accounting for post-entry dynamics of firms. One concern about this interpretation is whether our results are being driven by the impact of losing a worker whether or not they are members of the founding team. The evidence in Jager and Heining (2019) argues against this view. They find that small (but not necessarily

[25]Relatedly, Jaravel, Petkova, and Bell (2018) provide evidence against this mechanism of emotional distress among surviving co-inventors by turning to the fact that the treatment effect is long-lasting and also larger when losing a high-achieving collaborator. It is also worth noting that SYZZ find that the retirement of founders yields about the same adverse impact as a premature death of a founder. Retirements are a less plausibly exogenous separation but it is instructive that the effects of retirements are similar to those for premature deaths in their setting. It would be interesting to explore alternative forms of exogenous separations in future work.

young) businesses that lose a worker due to premature death suffer only a relatively small, temporary reduction in employment while we find a large, persistent impact.

Taken together, our results demonstrate the critical role of founding teams in shaping the growth dynamics and survival of young firms. Consistent with the large and persistent adverse impact of losing a founding team member, organizational capital formed during the early stages of a firms life-cycle appears to be embodied in the founding teams. Though it raises many questions for future research, this study sheds light on founding teams as a central piece to understanding the sources of the enormous variation in startup performance.

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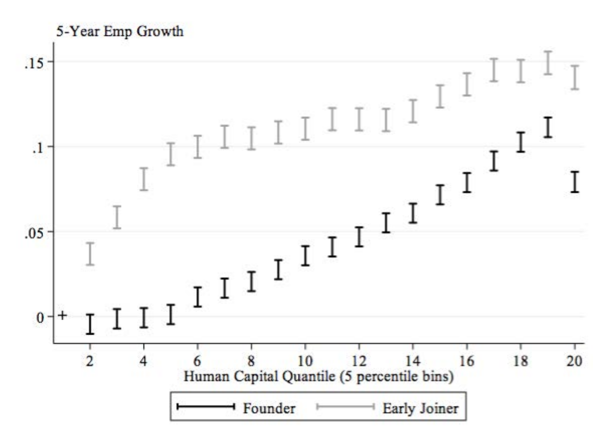
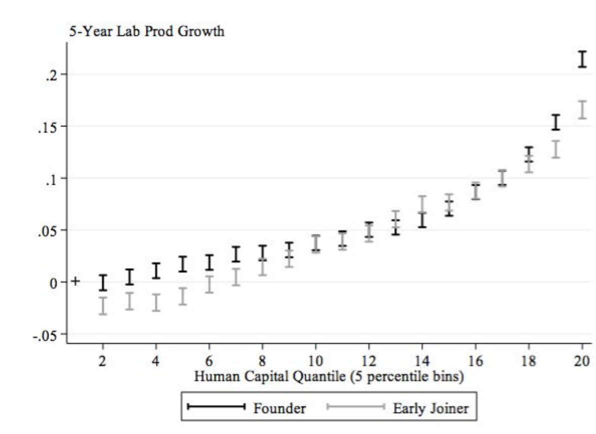
Figures

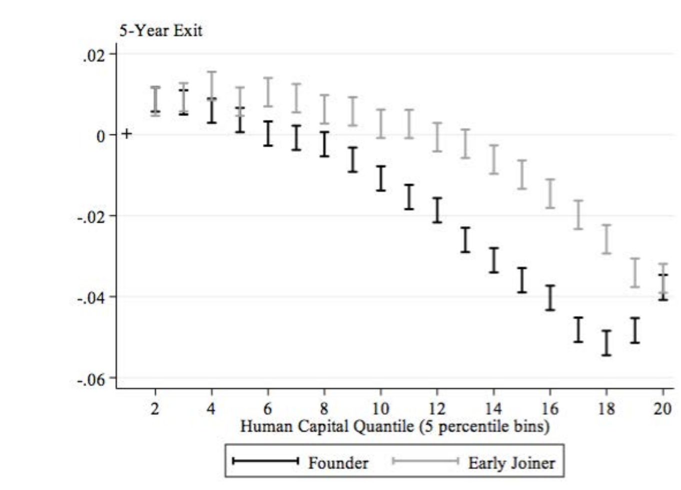
Figure 1: Founder and Early Joiner Human Capital and Startup Outcomes



(a) Emp Growth and Human Capital



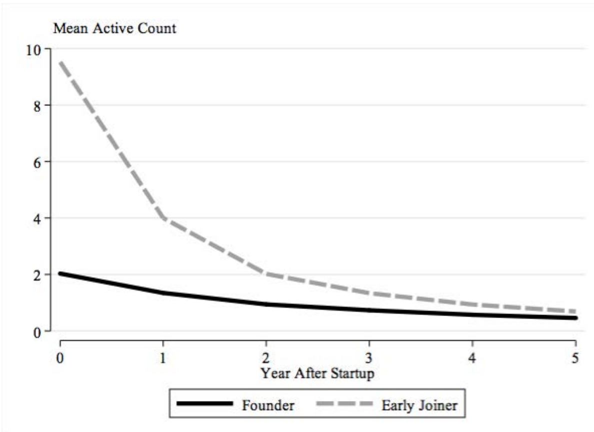
(b) Productivity Growth and Human Capital



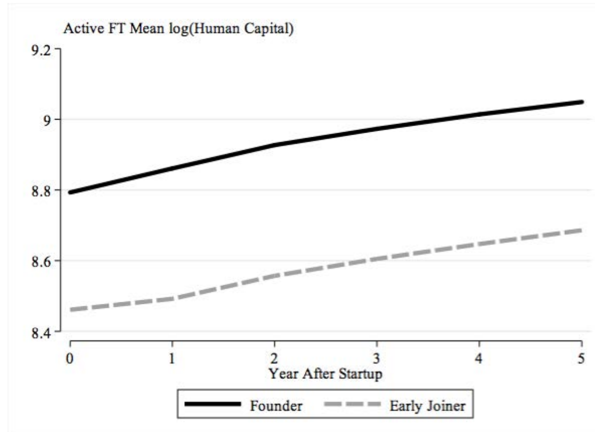
(c) Exit and Human Capital

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year effects and initial employment in employment growth and exit regressions and initial labor productivity for labor productivity growth regressions. Shown are 95% confidence interval estimates for each HC bin. Estimates are relative to reference group HC bin 1.

Figure 2: Founder and Early Joiner Attrition and Human Capital



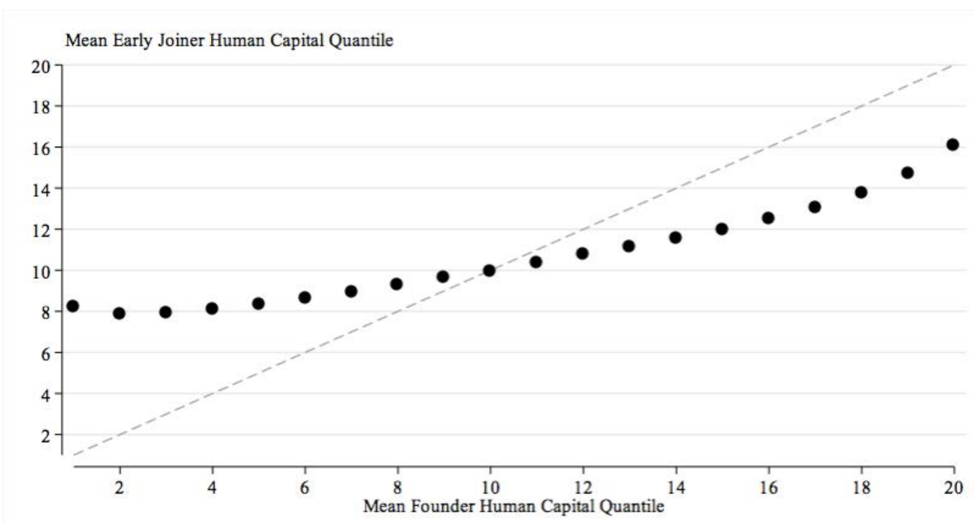
(a) Attrition of Founders, Early Joiners



(b) Human Capital of Active Founders, Early Joiners

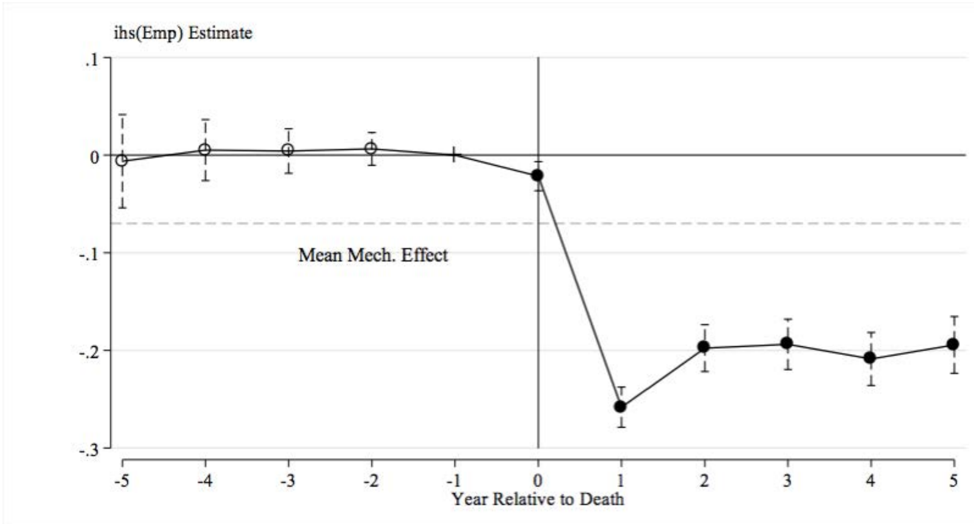
Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Mean count of active (earnings positive) founders and early joiners each year after startup (a) and mean active founder and early joiner log human capital (prior earnings) (b).

Figure 3: Human Capital Composition of Founders and Early Joiners



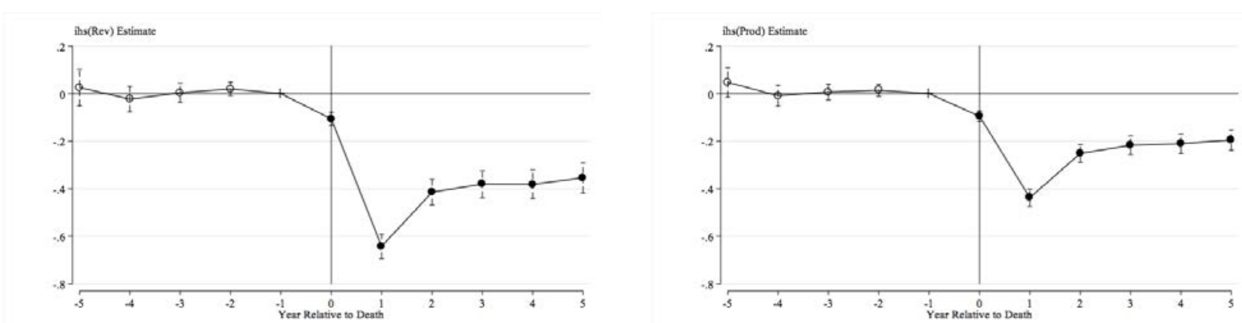
Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Mean early joiner human capital quantile bin for each founder human capital quantile bin. 45° shown to emphasis when founder human capital position is equal to early joiner human capital position.

Figure 4: Founding Teams Death Shocks and $ihs(Emp)$



Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for firm effects, firm age and industry-year effects. Hollow points $\rightarrow p > 0.05$. Reference group $t-1$. Mean mechanical effect shown is the implied reduction in $ihs(Emp)$ given a one-person reduction in firm size induced by the founding team member death given the average number of employees of the firms at the time of the death shock is 15.5, the mean size at death shock in our sample.

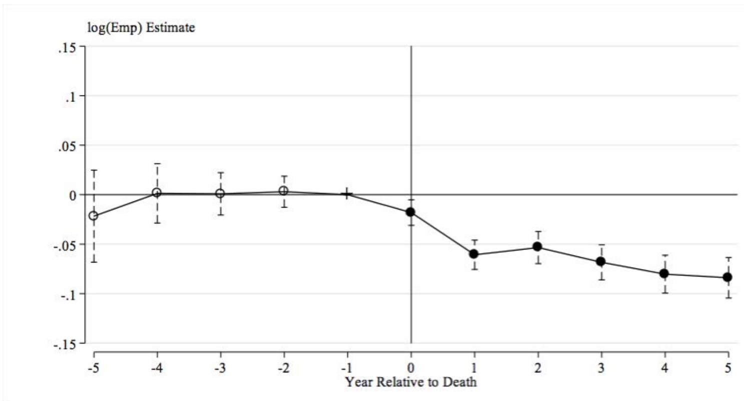
Figure 5: Founding Teams Death Shocks, $ihs(Rev)$ and $ihs(Prod)$



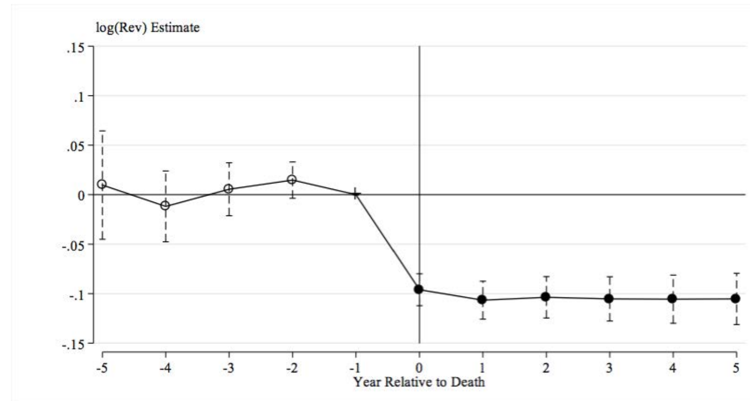
(a) Death Shocks and $ihs(Rev)$ (b) Death Shocks and $ihs(Prod)$

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for firm effects, firm age and industry-year effects. Hollow points $\rightarrow p > 0.05$. Reference group $t-1$.

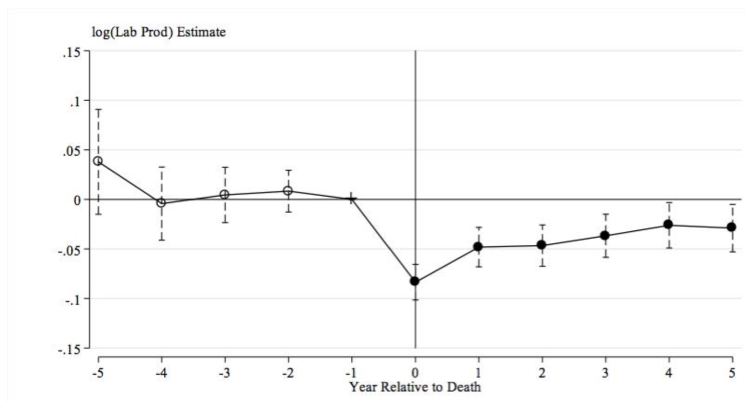
Figure 6: Founding Teams Death Shocks, $log(Emp)$, $log(Rev)$, and $log(Prod)$



(a) Death Shocks and $log(Emp)$



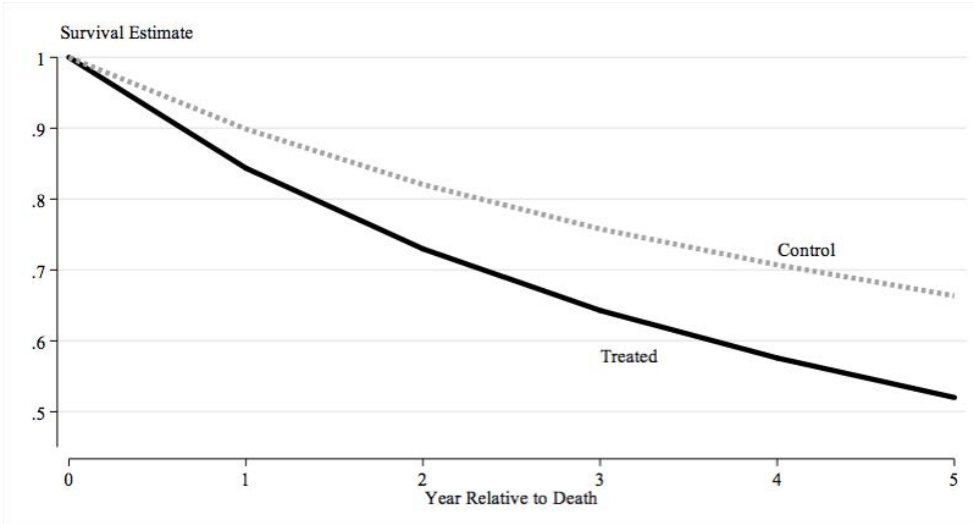
(b) Death Shocks and $log(Rev)$



(c) Death Shocks and $log(Prod)$

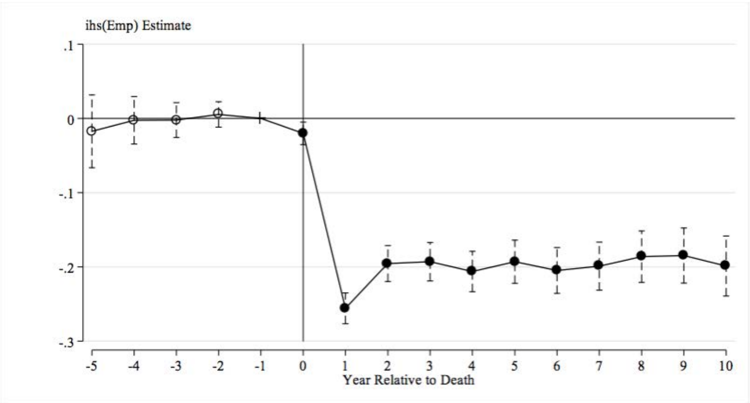
Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for firm effects, firm age and industry-year effects. Hollow points $\rightarrow p > 0.05$. Reference group $t-1$.

Figure 7: Founding Teams Death Shocks and Survival

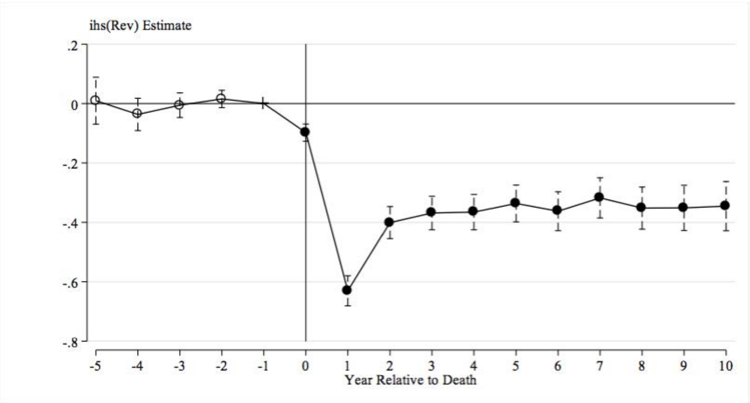


Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Cox estimate 0.35 (0.013). Controlling for firm age, industry, state, and year.

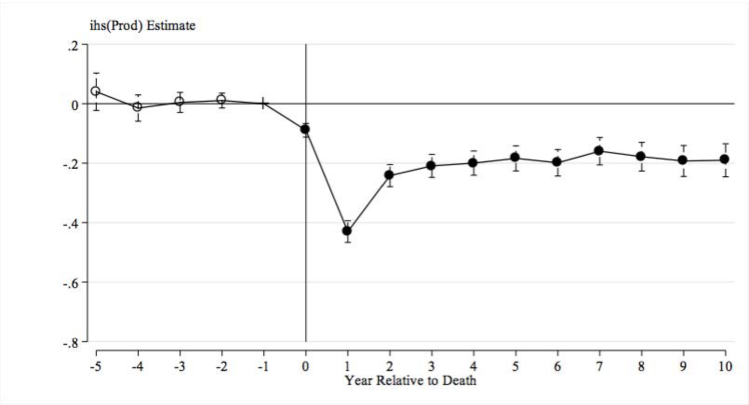
Figure 8: Persistence of Effects, $ihs(Emp)$, $ihs(Rev)$, and $ihs(Prod)$



(a) Death Shocks and $ihs(Emp)$



(b) Death Shocks and $ihs(Rev)$



(c) Death Shocks and $ihs(Prod)$

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for firm effects, firm age and industry-year effects. Hollow points $\rightarrow p > 0.05$. Reference group $t-1$.

Tables

Table 1: Summary Statistics on Treated and Controls in Death Shock Year

	Treated	Control
Firm Age	2.463	2.464
Log(Employment)	1.968	1.891
Log(Revenue)	7.166	7.161
Log(Productivity)	4.409	4.539
Avg Age of FT	42.05	41.98

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Means of key variables for the treated (death shock cases) and controls in the death shock year. Observation counts rounded to avoid the disclosure of sensitive information.

Table 2: Premature Death Shock, Main Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post	.2477***	.3578***	.1627***	.07332***	.04057***	-.02588***
	(.006371)	(.01294)	(.009183)	(.005002)	(.006311)	(.006088)
Post × Treated	-.1682***	-.375***	-.2428***	-.05137***	-.1059***	-.05579***
	(.008284)	(.01836)	(.01318)	(.006822)	(.009083)	(.008237)
R^2	.7159	.6012	.6022	.8766	.8917	.8153
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information.

Table 3: Firm Death Linear Probability Model

	Firm Dth $t+1$	Firm Dth $t+2$	Firm Dth $t+3$	Firm Dth $t+4$	Firm Dth $t+5$
Treated	.123***	.1337***	.1321***	.1294***	.124***
	(.01154)	(.01135)	(.01099)	(.01092)	(.01086)
R^2	.1511	.1389	.1392	.1466	.1529
N	52500	52500	52500	52500	52500
Control Mean	.07667	.1644	.2329	.2841	.3258

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, state, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Each column shows estimates where the LHS variable is a binary indicator equal to 1 if the firm exits some number of years after the premature death shock. Observation counts rounded to avoid the disclosure of sensitive information. The mean of the LHS variable among control firms, which captures the firm death rate some number of years after the premature death shock is shown at the bottom of the table.

Table 4: Founder vs. Early Joiner Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.08331***	-.1265***	-.05837***	-.03583***	-.05057***	-.01611
	(.01218)	(.02323)	(.01585)	(.009717)	(.01207)	(.01072)
Post × Treated × Founder	-.1742***	-.5479***	-.4069***	-.03397**	-.126***	-.08915***
	(.01649)	(.03686)	(.02657)	(.01362)	(.01829)	(.01661)
R^2	.7161	.6024	.6036	.8767	.8918	.8154
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information. Regression specifications also include $Post$ and $Post \times Founder$, the estimates for which are excluded for simplicity.

Table 5: B2B Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.1429***	-.2798***	-.1809***	-.03528***	-.07002***	-.03661***
	(.01078)	(.02378)	(.01687)	(.008396)	(.01085)	(.01033)
Post × Treated × B2B	-.05432**	-.2007***	-.1304***	-.03441**	-.07597***	-.0408**
	(.01671)	(.03698)	(.02658)	(.01387)	(.01845)	(.01666)
R^2	.7159	.6013	.6023	.8767	.8917	.8153
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information. Regression specifications also include $Post$ and $Post \times B2B$, the estimates for which are excluded for simplicity.

Table 6: Small vs. Large Founding Teams

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.07172***	-.1001***	-.04023**	-.02642**	-.04537***	-.01632
	(.01513)	(.02667)	(.01726)	(.0114)	(.01339)	(.01176)
Post × Treated × Small	-.1499***	-.4512***	-.3346***	-.03971**	-.1003***	-.06637***
	(.01802)	(.03623)	(.02512)	(.01426)	(.01809)	(.01623)
R^2	.716	.6021	.6034	.8767	.8918	.8154
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include $Post$ and $Post \times Small$, the estimates for which are excluded for simplicity. A firm is classified as small ($Small = 1$) if it has five or fewer active founding team members in the year of the death shock (treatment).

Table 7: Human Capital Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.1499***	-.3133***	-.2006***	-.04482***	-.08924***	-.048***
	(.009483)	(.0201)	(.01434)	(.007754)	(.01011)	(.00913)
Post × Treated × HC	-.2166***	-.6607***	-.4711***	-.0357	-.1757**	-.1479**
	(.04875)	(.1194)	(.08587)	(.04191)	(.0597)	(.0534)
R^2	.715	.6037	.6086	.8775	.89	.8168
N	242000	176000	176000	223000	166000	166000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include $Post$ and $Post \times HC$, the estimates for which are excluded for simplicity.

Table 8: Older Founding Team Member Deaths

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.1629***	-.3502***	-.2179***	-.05402***	-.1126***	-.05382***
	(.01255)	(.02713)	(.01938)	(.0103)	(.01329)	(.01219)
Post × Treated × Old FT	-.009963	-.04557	-.04514*	.004404	.01129	-.003685
	(.01669)	(.0368)	(.02641)	(.01374)	(.01823)	(.0166)
R^2	.7159	.6013	.6023	.8767	.8917	.8153
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include $Post$ and $Post \times OldFT$, the estimates for which are excluded for simplicity. $OldFT$ is equal to 1 if the founding team member that died was above the median age (45 years old) of all founding team member deaths.

Table 9: HP Sector Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.1576***	-.3416***	-.2221***	-.04757***	-.09898***	-.05705***
	(.0104)	(.02227)	(.01565)	(.008383)	(.01101)	(.009752)
Post × Treated × HP	-.03372**	-.1087**	-.06724**	-.01217	-.02257	.003983
	(.017)	(.03932)	(.02898)	(.01438)	(.01947)	(.01817)
R^2	.7159	.6013	.6023	.8766	.8917	.8153
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include $Post$ and $Post \times HP$, the estimates for which are excluded for simplicity. HP is equal to 1 if the firm is in a HP sector and zero otherwise.

Table 10: HP Sector by Founder Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$
Post × Treated	-.08338***	-.1258***	-.05914**
	(.01461)	(.02744)	(.01839)
Post × Treated × Founder	-.1659***	-.5173***	-.3906***
	(.02063)	(.04556)	(.03233)
Post × Treated × HP	-.0003677	-.002745	.00297
	(.02613)	(.0514)	(.03631)
Post × Treated × HP × Founder	-.02113	-.08341	-.04607
	(.03439)	(.07814)	(.05742)
R^2	.7162	.6024	.6036
N	316000	224000	224000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include $Post$ and $Post \times HP$, the estimates for which are excluded for simplicity. HP is equal to 1 if the firm is in a HP sector and zero otherwise.

Table 11: High Tech Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.1674***	-.3715***	-.2402***	-.05163***	-.1053***	-.05488***
	(.008391)	(.01858)	(.01335)	(.006889)	(.009112)	(.008345)
Post × Treated × HT	-.02319	-.093	-.06966	.00735	-.01521	-.02497
	(.05039)	(.1114)	(.07982)	(.04413)	(.06385)	(.04951)
R^2	.7159	.6012	.6022	.8766	.8917	.8153
N	316000	224000	224000	290000	210000	210000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include *Post* and $Post \times HT$, the estimates for which are excluded for simplicity. HT is equal to 1 if the firm is in a High Tech industry and zero otherwise.

Table 12: High Tech Main Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post	.2454***	.3059***	.1307**	.08483**	.02456	-.03747
	(.03853)	(.07574)	(.05472)	(.03153)	(.04672)	(.03975)
Post × Treated	-.1976***	-.468***	-.3103***	-.04937	-.123*	-.08034
	(.05049)	(.1111)	(.0792)	(.04386)	(.06362)	(.04916)
R^2	.6909	.5805	.4925	.8435	.8469	.6865
N	10000	7700	7700	9400	7300	7300

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation counts rounded to avoid the disclosure of sensitive information. Includes only firms in High Tech industries.

Table 13: Young vs. Mature Heterogeneous Effects

	$ihs(Emp)$	$ihs(Rev)$	$ihs(Prod)$	$log(Emp)$	$log(Rev)$	$log(Prod)$
Post × Treated	-.2007***	-.4267***	-.283***	-.05279***	-.1304***	-.07603***
	(.01152)	(.02546)	(.01825)	(.009227)	(.01224)	(.01057)
Post × Treated × Yg Firm	.03328**	.05351*	.04148*	.0019	.02505*	.02011
	(.01414)	(.03123)	(.02243)	(.01147)	(.01522)	(.0134)
R^2	.7349	.6133	.6043	.883	.8962	.8152
N	411000	300000	300000	382000	285000	285000

Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry-year, firm, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation counts rounded to avoid the disclosure of sensitive information. Regressions specifications also include $Post$ and $Post \times YgFirm$, the estimates for which are excluded for simplicity. $YgFirm$ is equal to 1 if the firm is five years old or younger in the year of treatment.

Appendix

A.1 Model

In this appendix, we develop an illustrative two period model of selection and size based on the formation of organizational capital by founding teams. To start a business, an entrant pays a fixed entry fee in a formation period with a founding team devoting time and resources to develop organizational capital. Let the number of founding team members be given by N. Founding team members are ex ante homogeneous but are heterogeneous in terms of their ex post match quality for developing organizational capital. We intentionally focus initially on a specification without ex ante differences among founding team matters to highlight the potential role of the founding team even without such effects. We discuss extensions with ex ante heterogeneity below.

This setting provides a novel way to interpret the ex ante fixed cost of entry in standard models. Here it is given by $w_0 N$ where w_0 is the market wage paid to the founding team in the formation phase. That is, decisions about the founding team play a role of the fixed entry fee. In period 0, the formation phase, the founding team invests in organizational capital that a firm in turn obtains a draw M_{i1} from a distribution of founding team match quality. The founding team is also subject to exogenous idiosyncratic attrition before the production period at a rate $(1-\chi_{i1})$. This attrition impacts the available founding team members as well as the productivity for period 1. Productivity in period 1 is given by $M_{i1}(1-\chi_{i1})^{\kappa}$. The parameter κ captures the knowledge decay from the (exogenous) attrition of founding team members. If $\kappa = 0$ then there is no decay so the organization capital created in the formation period is not embodied in the founding team. However, as κ increases there is positive decay. Given the exogenous idiosyncratic attrition the maximum number of founding team members available as employees in the production phase period 1 is $L_{i1}^{FT} \leq (1-\chi_{i1})\, N$. Thus, the maximum share of founding team members available in period 1 is $1-\chi_{i1}$.

In period 1, the firms decide whether to produce or exit, and then if they produce how many workers to employ. The revenue function is given by:

$$R_{i1} = M_{i1}(1-\chi_{i1})^{\kappa}(L_{i1}^{FT} + \gamma L_{i1}^{NT} - f)^{\theta} \tag{5}$$

where L_{i1}^{NT} is the number of non-founding team members, $\theta < 1$ representing curvature in the revenue function (from product differentiation or DRS), $\gamma \leq 1$ is a parameter reflecting the assumption that non-founding team members may be less productive in implementing the organizational capital and f reflects fixed costs of production captured by overhead labor. With this revenue function, the marginal revenue product of founding team members always exceeds that of non-founding team members as long as $\gamma < 1$. This formulation does not have any knowledge capital decay from endogenous attrition of founding team members. Adding this feature enhances the results discussed below but yields less transparent decision rules. In this more general case, founding team members have higher marginal revenue products than non-founding team members from this extra effect on productivity.

The profit function is given by:

$$\pi_{i1} = M_{i1}(1-\chi_{i1})^{\kappa}(L_{i1}^{FT} + \gamma L_{i1}^{NT} - f)^{\theta} - w_1(L_{i1}^{FT} + L_{i1}^{NT}) \tag{6}$$

where w_1 is the market wage paid to the workers in the production period.[26]

The first order conditions for founding team and non-founding team employment if the firm produces are given by:

$$M_{i1}(1-\chi_{i1})^{\kappa}\theta(L_{i1}^{FT}+\gamma L_{i1}^{NT}-f)^{\theta-1}-w_1-\lambda=0 \tag{7}$$

$$M_{i1}(1-\chi_{i1})^{\kappa}\theta\gamma(L_{i1}^{FT}+\gamma L_{i1}^{NT}-f)^{\theta-1}-w_1=0 \tag{8}$$

where λ is the multiplier for the constraint $L_{i1}^{FT}\leq(1-\chi_{i1})N$. It is apparent that for $\gamma<1$, $L_{i1}^{NT}>0$ only if $\lambda>0$. This implies we can simplify these first order conditions for the ranges where only founding team are employed and when non-founding team members are employed. The optimal employment, revenue and revenue productivity are presented in the main text.

If only founding team members are employed and the constraint is not binding the optimal number of founding team members to employ is given by:

$$L_{i1}^{FT}=(M_{i1}(1-\chi_{i1})^{\kappa}\theta/w_1)^{1/(1-\theta)}+f \tag{9}$$

Revenues are given by:

$$R_{i1}=(M_{i1}(1-\chi_{i1})^{\kappa}(M_{i1}(1-\chi_{i1})^{\kappa}\theta/w_1)^{\theta/(1-\theta)} \tag{10}$$

Observe that as either M_{i1} declines or χ_{i1} increase then employment and revenue declines. Also, revenue productivity R_{i1}/L_{i1}^{FT} in this range is given by:

$$R_{i1}/L_{i1}^{FT}=(w_1/\theta)(1-f/L_{i1}^{FT}) \tag{11}$$

This implies that as M_{i1} declines or χ_{i1} increases that productivity declines. In addition, profits are given by:

$$\pi_{i1}=L_{i1}^{FT}(w_1(1/\theta-1))-fw_1/\theta \tag{12}$$

Thus for sufficiently low M_{i1} or sufficiently high χ_{i1} profits will become negative and the firm will exit. That is, either shock will lower employment and at sufficiently low employment the firm cannot cover its fixed costs.

For the range where the constraint is binding (i.e., $L_{i1}^{FT}=(1-\chi_{i1})\,N$) then the decision rules depend on whether it is profitable to produce using non-founding team members. The optimal number of non-founding team members, conditional on producing, is given by:

$$L_{i1}^{NT}=\frac{1}{\gamma}[(M_{i1}(1-\chi_{i1})^{\kappa}\theta\gamma/w_1)^{1/(1-\theta)}+f-(1-\chi_{i1})N] \tag{13}$$

Revenue is given by:

$$R_{i1}=(M_{i1}(1-\chi_{i1})^{\kappa}(M_{i1}(1-\chi_{i1})^{\kappa}\theta\gamma/w_1)^{\theta/(1-\theta)} \tag{14}$$

[26]Since FT members are more productive, it might be that the surplus is shared between the firm and founding team members. We assume for simplicity that the firm gets all the surplus.

Revenue labor productivity is given by:

$$R_{it}/L_{i1}^{tot} = (w_1/\theta)(1 - f/L_{i1}^{tot}) \tag{15}$$

where $L_{i1}^{tot} = L_{i1}^{FT} + L_{i1}^{NT}$. In this range, a decrease in M_{i1} or increase in χ_{i1} yields a decrease in employment, revenue and revenue labor productivity. That is, either will lower employment and the overhead costs will be spread over a smaller number of workers yielding lower productivity. Profits are given by:

$$\pi_{i1} = L_{i1}^{tot}(w_1(1/\theta - 1)) - fw_1/\theta \tag{16}$$

With sufficiently low M_{i1} or sufficiently high χ_{i1}, profits will become negative and the firm will exit. Observe as well that as χ_{i1} rises that the constraint on the number of founding team members will be more likely to bind, which provides some incentive to replace them in production with non-founding team members. However, an offsetting factor is that as χ_{i1} increases the marginal product of workers declines. It is important to observe that all of these implications for χ_{i1} depends on $\kappa > 0$. Attrition of the founding team matters for employment, revenue, productivity and exit only if the organizational capital knowledge is embodied in the founding team members.

Entry is determined as in the standard model by a free entry condition. Firms enter until the present discounted value of future profits equals the fixed cost of entry:

$$\int\int max(\pi_{i1}, 0)g(M_{i1})h(\chi_{i1})dM_{i1}d\chi_{i1} - w_0N = 0 \tag{17}$$

where for simplicity no discounting is assumed. This free entry condition helps make clear that our modified model is in many ways a re-interpretation of the standard model. The fixed entry fee is paying for the time and resources of the formation period when organizational capital is developed by the founding team. The ex post productivity realizations depend on the stochastic success of the founding team and the exogenous attrition of the founding team.

The model collapses to the standard model if $\kappa = 0$ and $\gamma = 1$. In this case the model becomes a minor re-interpretation of what is involved in paying the fixed cost of entry in order to obtain the ex post productivity draw. The novel feature of the model is the hypothesis that the organizational capital developed in the formation phase is embodied in (at least some) of the founding team members.

We now consider extensions of the model to allow heterogeneous ex ante workers and the more skilled playing a larger role in organizational capital. Suppose that the founding team is still of size N with ω the fraction of the founding team that is high skilled and $1-\omega$ the fraction low skilled. To make things simple, the knowledge capital is embedded only in the skilled so the productivity in period 1 is given by $M_{i1}(1-\chi_{i1})^{\kappa}$ but where χ_{i1} is now the fraction of the skilled workers who are subject to exogenous attrition. The fixed cost of the formation period is now $\omega w_{0,S} + (1-\omega)w_{0,NS}$ where w_{0S} is the wage of the skilled etc. Revenue is given by:

$$R_{i1} = M_{i1}(1-\chi_{i1})^{\kappa}((L_{i1,S}^{FT} + \gamma_S L_{i1,S}^{NT})^{\nu}(L_{i1,NS}^{FT} + \gamma_{NS}L_{i1,NS}^{NT})^{1-\nu} - f)^{\theta} \tag{18}$$

In this formulation, both skilled and unskilled founding team members are preferred to non-founding team members but this permits the possibility that for example $\gamma_S < \gamma_{NS} = 1$. That is, there is nothing special about the founding team unskilled. They might be necessary as an input during the formation period but they are perfect substitutes with non-founding team members thereafter. One could enrich this further by embedding some knowledge in unskilled founding team members but then assuming (or testing) $\kappa_S > \kappa_{NS}$. The formulation above implicitly assumes $\kappa_{NS} = 0$.

A.2 Additional Figures and Tables

Table A1: Labor Productivity, Survival, and Growth

	Exit	EmpGrowth
$ln(Prod)_{t-1}$	-.06402***	.2255***
	(.0000855)	(.000191)
Cons	.3993***	-1.234***
	(.0004215)	(.0009191)
Industry-Year FE	Y	Y
R^2	.05387	.1021
N	22200000	22200000

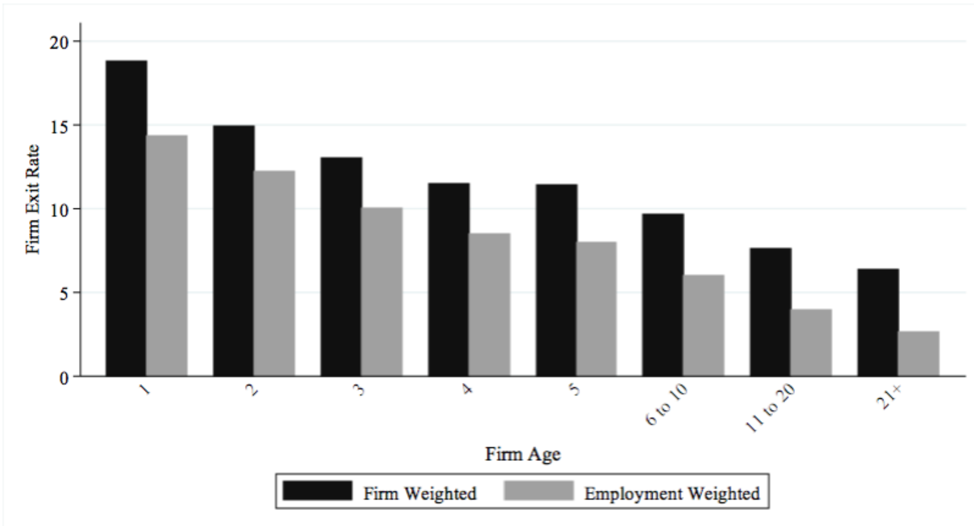
Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation counts rounded to avoid the disclosure of sensitive information.

Table A2: Pre-treatment Growth of Surviving Firms

	Employment	Revenue	Productivity
Treated	.007251	.00189	.00189
	(.006282)	(.006259)	(.006259)
NAICS4 FE	Y	Y	Y
Birth Yr FE	Y	Y	Y
Firm Age FE	Y	Y	Y
R^2	.07916	.102	.102
N	20500	14000	14000

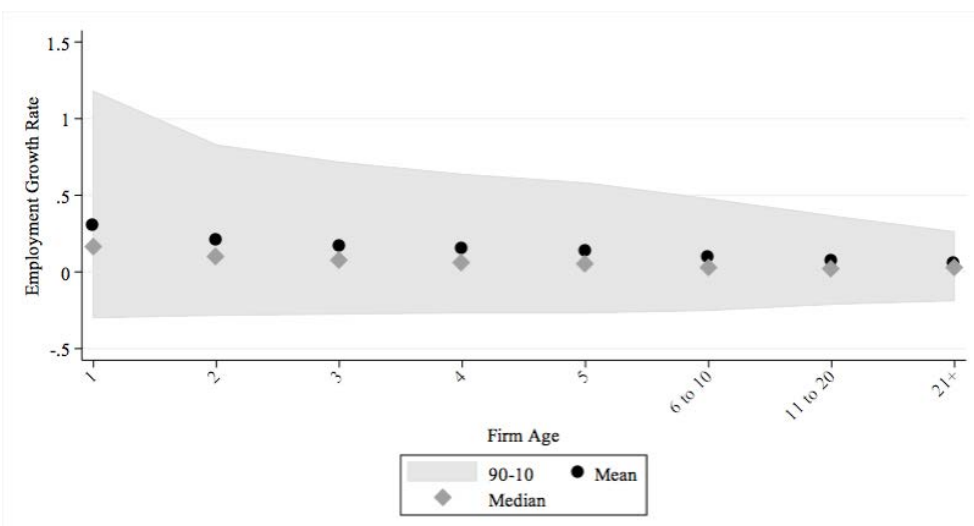
Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Controlling for industry, cohort, and firm age effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. $ihs(Prod)$ indicates $ihs(Rev) - ihs(Emp)$. Observation counts rounded to avoid the disclosure of sensitive information.

Figure A1: Firm Exit Rates and Firm Age



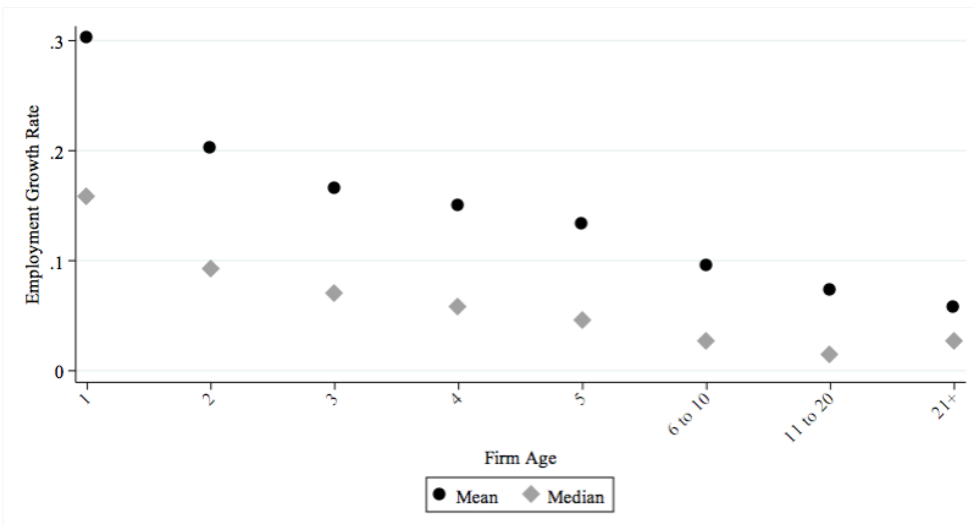
Source: Founding Team Database (LBD, LEHD), author's calculations.

Figure A2: Firm Age and Employment Growth



Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Employment-weighted distribution.

Figure A3: Firm Age and Mean and Median Employment Growth



Source: Founding Team Database (LBD, LEHD), author's calculations.
Notes: Employment-weighted distribution.