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Do Entrepreneurs Matter?

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Abstract

Entrepreneurs strongly affect firm outcomes. We use deaths of several hundred entrepreneurs as a source of exogenous variation, and find large and sustained effects of entrepreneurs at all levels of the firm performance distribution. Entrepreneurs strongly affect performance of both very young firms and more mature firms, and across the firm size distribution. The results appear stronger in 'dynamic' industries with higher education level, larger R&D expenses and higher sales growth. The effects appear to be driven by entrepreneur specialness rather than leadership transition; the effects of death of entrepreneur-managers is economically and statistically stronger than the death of managers that are not entrepreneurs. Overall, entrepreneurs play a large and unique role not previously empirically documented.

Keywords: entrepreneurship, firm performance, human capital.

JEL Classification: D21, D24, J23, L11, L25, G39.

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1 Introduction

In the large literature on firm performance, spanning corporate finance, industrial economics and parts of labor economics, economists have paid little attention to entrepreneurs. The idea of entrepreneurs as movers and shakers is old (Schumpeter, 1934), but geographical, institutional, and industry characteristics (Syverson, 2011), managers and managerial practices (e.g., Bertrand and Schoar, 2003, Bloom and Van Reenen, 2007), and financial conditions (Guiso et al., 2004) have been the focus of empirical work. One objective of the paper is to ask how much individual entrepreneurs contribute to the performance of firms.

Little is known whether entrepreneurs have much of an effect. In addition to informing our understanding of firm outcomes, this question relates to an old debate stemming from Coase (1937) over what constitutes a firm and keeps it together. We study whether the entrepreneurs constitutes the core of the firm, and for how long. We also study whether entrepreneur are special compared to managers. We contribute to the debate on the foundation of the firm, which arguably lies at the root of economics, and also to which factors contribute to the performance of nascent and young firms.

We use an extraordinarily large, representative, dataset. To study the influence of entrepreneurs, we examine firms where the entrepreneur dies. In these firms, the entrepreneur's engagement was random, determined by the timing of the entrepreneur's death rather than underlying economic conditions. These deaths therefore provide an opportunity to quantify whether entrepreneurs have a causal effect on firm performance.[1] We analyze the impact of entrepreneur death on firm survival, growth, and profitability. For example, we compare survivorship rates of firms where the entrepreneur dies

[1]Several recent papers use death as an exogenous event to study causal effects, for example Azoulay et al. (2010) on the spillover effects of research superstars, Jones and Olken (2005) on the influence of national leaders for economic growth, Nguyen and Nielsen (2010) on the value of independent directors at company boards, Bennedsen et al. (2007) on the value of CEOs, and Andersen and Nielsen (2012) on the effect of windfall gains through inheritance on entrepreneurial activity.

with survivorship rates of firms where the entrepreneur does not die. We interpret differences in survivorship rates between these two groups of firms as evidence for the personal importance of the entrepreneur.

Alternatively, a lack of difference between these two groups would provide evidence of the non-importance of the entrepreneur; once the firm has been formed the entrepreneur can vanish without harming the firm. Imagine a small restaurant. The entrepreneur decides which corner to locate on, the menu, and which individuals to hire. After these major initial decisions have been made, the entrepreneur may not play a large, irreplaceable, role anymore, and the firm may be equally well led by other individuals.

In order to estimate the effect of entrepreneur death, we make two kinds of comparisons. We compare the performance of firms where the entrepreneur dies to the performance of firms where the entrepreneur does not die. This allows us to compare entrepreneur death to the counterfactual where the entrepreneur stays alive. We also compare the effect on the firm of entrepreneur death relative to the effect of other shocks, such as a key worker dying. This allows us to compare entrepreneur death to the counterfactual where the firm experiences other shocks.

We employ a large and unique database that contains longitudinal accounting and employment information on the universe of incorporated firms established in Norway between 1999 and 2007. Covering the population of new firms means that the vast majority of firms in the database are small. Although most of these firms are not that interesting individually, they are collectively. There is an analogue to labor economics: each individual is not that interesting but we care about workers in general.

We focus on firms that employ at least one person at the end of the first year of operations. For each firm, the data identify the initial owners. We define an entrepreneur as an individual that owns more than 50 percent of the shares initially. The database contains 16,127 firms started up by such individuals, with at least one employee in the

year of foundation, and 205 firms where such majority owners die before the end of 2010. In separate analyses, we also look at 50 percent owners and at minority stake owners. We track firm performance with accounting data submitted yearly to the tax authorities. The accounting data runs until 2012, thus firms in the database are between zero and thirteen years old.

We ask whether entrepreneurs have a causal effect on firm performance. In order to accommodate that entrepreneurs that die within the sample period are older on average (and, as a consequence, wealthier) than entrepreneurs that do not, for each of the firms where the entrepreneur dies ('treated' firms) we use propensity score matching to identify a similar firm ('matched control' firm), restricted to be started up in the same calendar year. The matched control firms have similar characteristics at startup date, but do not experience subsequent entrepreneur death. We run difference-in-differences regressions, comparing the performance of treated firms and matched control firms before and after entrepreneur death. In a separate set of regressions, we utilize all firms in the database (i.e., do not use matching) and obtain very similar results. To accommodate time-invariant firm characteristics, we include firm fixed effects in both type of regressions.

The empirical analysis provides robust evidence that firm performance drops after the entrepreneur's death. Entrepreneur death leads to a reduction in firm survival compared to the control group. The effects are large; conditional on the firm being active the year before entrepreneur death, the treatment effect on survival is about 25 percent. Entrepreneur death leads to a stark reduction in sales and smaller but significant effect on employment. We expected the group of firms that experienced the death of the entrepreneur to have a dip in performance immediately after the death owing to the upheaval, but anticipated there would be a bounce back. However, even four or five years after the death, the treated group of firms shows no sign of recovering relative to the control group and the negative effect on performance appears to continue even further

beyond that.

The results on sales and employment are partly driven by firms closing down; a firm that has closed down would have zero sales and zero employees. Importantly, quantile regressions suggests large negative effects of entrepreneur death also for firms that do not go out of business; the results are strong at all quantiles from the 50th to the 90th.

The majority of firms in the database are small, and it would not be surprising that miniature firms, consisting of the founder himself and perhaps an employee or two, close down if the founder dies. We show that the effects are strong up to the fourth quintile of the firm size distribution (firms with 5-8 employees the year before founder death). For the top quintile we do not find treatment effects, which could be because of the large heterogeneity of firms in this category. This shows that our results are not driven by miniature firms closing down after the founder dies.

One would expect entrepreneurs to matter more in sectors of the economy that are more reliant on human capital relative to physical capital. The results suggest that this is indeed the case; the negative effects of entrepreneur death are larger in sectors with more highly educated entrepreneurs, and in sectors with larger R&D expenses and higher sales growth.

The results we are picking up may not be due to entrepreneur specialness, but detrimental effects of abrupt leadership transition in young firms. Indeed, it is possible for founders and successors to be of identical ability and yet to find an effect of founder death because it is costly for the firm to adapt to a new leader. In order to deal with this question, we employ data that provides the identity of the firm's chief executive officer (CEO) between 2002 and 2007. We split the CEOs into two groups: founders and non-founders, and compare the causal effect of CEOs that are founders with the casusal effect of CEOs that are not founders. We find that the effects of death of founder CEOs are economically and statistically much stronger than for CEOs that are not founders. We also investigate

whether 'lesser' shocks have a greater impact with CEO-founders, by analyzing the effect on firm performance of death in the nucleous family of the CEO. Again the negative effects are larger for CEO-founders than for CEOs that are not founders. We conclude that our results appear driven by the specialness of the entrepreneur and not leadership transition of young firms.

One would expect that firms become less reliant on the entrepreneur as they mature. Johnson et al. (1985) examine the effect on share price of senior management deaths for a sample of 53 U.S. publicly traded firms. The effect of CEO death on share price is negative for the sample overall, but positive for the death of CEOs that were also founders of the company, a finding verified with more recent data by Pérez-González (2006). We analyze whether the magnitude of the drop in firm performance depends upon firm age at entrepreneur death. We find large effects of founder death for firms that are up to seven years old when the founder dies, and weaker effects for firms that have exceeded this threshold.

We interpret our estimates as capturing the causal effect of the entrepreneur. An alternative explanation could be reverse causality: poor firm performance leads to the entrepreneur having a higher probability of dying. This could come in two forms. First, firms experiencing founder death might be weaker at birth because illness (or expectation of illness) of the founder leads the founder to start small. We do not really expect this to be the case given the undoubted strains of starting up a business, which might make firm foundation more of an 'all or nothing' choice. Indeed, we show that treated and control firms do not differ in their year zero employment and equity, suggesting that key observable indicators of firm size do not differ between the two groups. Second, firms experiencing founder death might start to perform poorly after foundation but before founder death. We do not find evidence of pre-treatment differences in firm performance. These diagnostic tests suggest that reverse causality is not a major concern.mk,k,,kk

We believe our paper is the first to identify that entrepreneurs have a large effect on startup performance. Part of the explanation for the strong effects could be that after the entrepreneur has died, the control of the firm is transfered to less competent family members (Perez-Gonzales, 2006, Bennedsen et al., 2007, and Bertrand et al., 2008 document negative effects on performance from family CEO appointments inside mature firms). To deal with this question, we examine whether entrepreneur death affects family firms (defined as a firm where another family member is a co-owner initially) differently than non-family firms. Although the sample of family firms is not large (less than 6%), it appears that family firms are more resilient to the loss of the entrepreneur than non family firms. It does not appear, therefore, that value destruction by family members can explain the results.

Firms that experience entrepreneur death have much lower survival rates in the years after the death event.[2] Perhaps heirs voluntarily close down firms that were largely motivated by providing private rather than economic benefits for the dead entrepreneur. To examine this question we analyze bankruptcies. The bankruptcy code in Norway is similar to Chapter 7 in the U.S. bankruptcy code, i.e., bankruptcy is associated with creditors taking control, and very unlikely to be 'voluntary' (as in Chapter 11 in the U.S bankruptcy code). We find that firms where the entrepreneur dies have twice the probability of going bankrupt. Thus there is little to support the notion that voluntary close-downs by heirs is driving the results.

The paper connects to several strands of literature. First, economists have shown that large and persistent differences in productivity across firms exist even after taking into account geographical, industry and firm age differences (see the surveys by Bartelsman and Doms, 2000 and Syverson, 2011). Much less is known about the importance of individuals. We point out that a factor missing in this literature – individual entrepreneurs and their

[2] A firm is not active if it (a) has gone bankrupt, (b) closed down for other reasons, (c) has less than NOK 50,000 (ca. 6,500 Euros) in sales. So, bankruptcy is just one reason for non-survival.

engagement – can explain some of the heterogeneity for young firms.

Second, a growing literature demonstrates that professional managers and management practices can lead to improved outcomes for mature firms.[3] Bennedsen et al. (2007) show that within-family succession of chief executive officers (CEOs) harm firm performance relative to employing a manager from outside the family. Bennedsen et al. (2010) finds that the average operating returns on assets decreases by about 1 percentage point in a four-year window around CEO death. Bennedsen et al. (2012) find that CEO hospitalization leads to firm under-performance. For example, long hospital stays (more than 30 days within a year) implies about 1 percentage point drop in operating returns on assets of the firm. Our findings complement this literature by showing that for young firms, entrepreneurs play a large role. In addition, we show that entrepreneur-managers play a much larger role than non-entrepreneur managers.

Third, much work on entrepreneurship focuses on the antecedents of entrepreneurship (Evans and Jovanovic, 1979, Hurst and Lusardi, 2004, Kerr and Nanda, 2009) and the risk-return trade-off of the entry decision (Hamilton, 2000, Vereshchagina and Hopenhayn, 2009, Hall and Woodward, 2010). Less is known about which factors affect outcomes. Holtz-Eakin et al. (1994), Hvide and Moen (2011) and Andersen and Nielsen (2012) analyze the role of financial constraints. Lerner and Malmendier (2014) finds that learning about other individuals' entrepreneurial experiences decreases entry rates but improves performance, and Hvide and Panos (2014) finds that entrepreneurial risk aversion has a similar effect. We complement this literature by being the first to directly measure the impact of entrepreneurs, and to demonstrate that the impact is large.[4]

[3]Bertrand and Schoar (2003) documents differences in management styles between individuals, and find evidence consistent with CEOs of publicly listed companies affecting firm performance. Bloom and Van Reenen (2007) and Bloom et al., (2011) document that higher-quality management practices are correlated with several measures of productivity and firm performance in a sample of non-listed firms. They do not focus on the role of individual managers, but their results are consistent with individual managers playing a large role through affecting management practices. Kaplan et al., (2012) show that CEO characteristics matter for firm performance.

[4]Kaplan et al. (2009) study strategy and management changes in a sample of 156 fast-growing

Fourth, governments try to boost competitiveness through a vast array of policies, many with the objective to reduce credit constraints among young firms. If entrepreneurs personally embed a major part of the value of the firm, it will be difficult to pledge the value of the firms to outside investors, which leads to lack of financing and under-investment in entrepreneurial firms, as in Hart and Moore (1994). The extent to which entrepreneurs are non-substitutable is a largely unexplored question. We show that entrepreneurs personally do embed a major part of the value of the firm, and for surprisingly long.

The remainder of this paper is organized as follows. Section II discusses why entrepreneurs should matter in light of existing theory and evidence. Section III presents the data and descriptive statistics. Section IV discusses the empirical strategy. Section V presents the main results and specification checks, while Section VI explores mechanisms. Section VII analyzes leadership transition (CEO death). Section VIII interprets the results and concludes.

2 Why should entrepreneurs matter?

Standard theoretical models tend to take a neoclassical view of the firm in which entrepreneurs are homogeneous inputs in the production process, and substitutable once a firm has been founded. For example, in Kihlstrom and Laffont (1979), the entrepreneur bears residual risk but does not contribute to firm performance. In sorting models (e.g., Lucas, 1978, Evans and Jovanovic, 1989, Lazear, 2005), individuals with high en-

companies that eventually go public. Between receiving venture funding and the initial public offering, almost none of these companies change their line of business, while the management team changes quite frequently. Thus, for this sample of companies, the idea seemed more stable than the management team. One takeaway from the present paper is that individuals are more important for newly established firms than the results from Kaplan et al. (2009) would suggest. Glaeser et al. (2015) use mines as an instrument for entrepreneurship and find a persistent link between entrepreneurship and city employment growth. We use random variation created by death and find evidence suggesting that entrepreneurs have a large and sustained impact on their firms.

trepreneurial ability become entrepreneurs, while individuals with low entrepreneurial ability become workers. Although sorting models, or variations of such, are consistent with individual entrepreneurs being important to firm performance, a degree of smoothness in the distribution of entrepreneurial ability will tend to rule out individuals playing a large role. Of course, the neoclassical view does not exclude the possibility that there are transitional costs, such as search costs or turbulence costs, from replacing the entrepreneur.[5]

One theoretical tradition that justifies non-substitutability is critical resource theory (Wernerfelt, 1984, and Rajan and Zingales, 1998, 2001), where a firm is a set of specific investments built around a critical resource or resources. In the current context, the entrepreneur's human capital, personality, and ideas can be seen as the critical resource which the firm is initially organized around (this is a sense in which the entrepreneur shapes the production function of the firm). The entrepreneur then invests in physical and human assets that are complementary to himself, and may not be fully substitutable because other individuals lack his combination of traits. Under this view, the entrepreneur can have two effects on firm performance. The first is the direct effect through own productivity, and the second, which works via providing the critical asset, is positive spillover effects on the other assets of the firm. We find very large negative effects on sales after entrepreneur death but smaller negative effects on firm employment, consistent with spillovers from the entrepreneur to the productivity of the firm's employees.

Critical resource theory says less about for how long the entrepreneur is essential. One reason to be concerned about this question is that the duration of non-substitutability influences how long firms are financially constrained and subject to underinvestment. Critical resource theory also says less about which activities make entrepreneurs impor-

[5]Other theories of entrepreneurship such as Hellmann (2007) and Hvide (2009) emphasize how contractual frictions in established firms can induce entrepreneurship. These theories can explain productivity differences between entrepreneurs, but not why entrepreneurs become non-substitutable.

tant. Leadership in mature firms is divided between managers and owners, where managers take care of daily operations and owners oversee managers and provide strategic direction. Entrepreneurs in young firms tends to be engaged in both processes and our empirical strategy allows us to study which role is more important.

3 Data and descriptive statistics

3.1 Norway

We start with a brief description of the Norwegian economy, the tax code, and the basis for the data collection.[6] Norway is an industrialized nation with a population of about 4.7 million. The GDP per capita in 2008 was about $58,717 when currencies are converted at purchasing power parity; this is higher than the EU average of $30,651. Norway is characterized by a large middle class, and a low inequality of disposable income. For labor income, the maximum marginal tax rate (for incomes above $75,000) is about 50%, which is fairly typical by European standards. The capital income tax is a flat 28% on net capital gains.

Similar to other industrialized countries, setting up an incorporated company in Norway carries tax benefits relative to being self-employed (e.g., more beneficial write-offs for expenses such as home office, company car, and computer equipment), and incorporation status will therefore be more tax-efficient than self-employment status except for the smallest projects. The formal capital requirement for registering an incorporated limited liability company was NOK 50,000 in equity until 1998 and NOK 100,000 thereafter (in 2008, $1 was equal to about 7 NOK).

In contrast to most OECD countries, Norwegian households are subject to a wealth

[6]The material is taken from the OECD Statistical Profile for Norway: 2010, available at OECD.org, and from Statistics Norway webpages.

tax every year throughout their lives.[7] The government's statistical agency, Statistics Norway (also known by its Norwegian acronym SSB) collects yearly data on wealth and income at the individual level from the Norwegian Tax Agency, and we obtain our data from Statistics Norway. Earnings and wealth figures for individuals are public information in Norway. This transparency is generally believed to make tax evasion more difficult and hence data more reliable.

The tax value of a firm, which is included in its owners' wealth statements, is calculated as sixty percent of assets subtracted debt, where debt is evaluated at face value while assets are at book value (typically lower than market value). Selling off a non-listed company therefore produces a tax liability if, which one can expect to commonly be the case, the transaction price exceeds the tax value of the company. This liability can be evaded by transferring the company to a holding company before selling off. We therefore do not expect the capital gains tax to bias the individuals that inherit a non-listed company towards keeping it or selling it off. In Norway there is also tax on inheritance. The inheritance tax on a non-listed company is based on the tax value of the firm on January 1 in the year of death. This means that the inheritance tax is effectively sunk once inheritance has taken place. We have therefore no reason to believe that the inheritance tax will bias the results.[8]

[7] In contrast, the U.S. tax system requires wealth reporting only in connection with estate tax, which is imposed only on the very rich at the time of death (Campbell, 2006). The wealth tax in Norway is 0% up to about $120,000 in net wealth, and about 1% for net wealth above $120,000.

[8] If a spouse inherits, no inheritance tax will be paid until the spouse dies or remarries. If children of the entrepreneur inherit, in the period we study there was a 20% inheritance tax on inheritances whose tax value exceeded NOK 550.000, 8% rate on inheritances between 250.000 and 550.000 and 0% below 250.000 (for unrelated beneficiaries, the rates were slightly higher). For example, if the firm has NOK 2.1 million in assets and NOK 1 million in debt, the tax value is NOK 1.1 million. If two children inherit, they receive NOK 550.000 each, and are taxed 8% on NOK 300.000, i.e., they pay NOK 24.000 in inheritance tax each. (NOK 24,000 is equivalent to about 3,200 Euro.) This is unlikely to be a challenge for most Norwegian households, so we do not expect liquidity constraints to be important, in contrast to in Tsoutsoura (2015). The approximate median tax value of the firms in our sample is NOK 71.000, the 75 percentile is NOK 154,000, and the 90 percentile is NOK 355.000. In 2008, $1 was equal to about NOK 7.

3.2 Data

We construct a database that consists of the universe of incorporated, limited liability, firms in Norway between 1999 and 2007, where one individual holds at least 50 percent of the initial shares.[9] The data include yearly detailed accounting and employment measures for each firm until the end of 2012, so that the firms in the database are between zero and thirteen years old. Covering the population of new firms means that the majority of firms in the database are small. In the analysis, we therefore confine attention to firms that have at least one employee (which may be the entrepreneur himself) in the first year of operations. Further, to avoid counting wealth management vehicles as start-ups, we eliminate finance and real estate firms (NACE 65-70). The inclusion of these firms gives similar results. The median book value of assets and number of employees in the first year of operations is about $160,000 and three, respectively.

Comparing our dataset with recent datasets used in the productivity literature, Foster et al. (2008) analyze the universe of manufacturing plants in the U.S. over a 20-year period. The firms are split into four age categories [age bracket in parentheses]: entrants [0,5], young [5,10], medium [10,15] and old [15 and older]. Thus our data cover more than two of the four firm age brackets considered by Foster et al. (2008). Compared to datasets of the productivity literature, a main novelty is that the data contain ownership shares in the incorporation year, broken down by each owner with at least a ten percent ownership share. We have a detailed panel on socio-demographic information on all owners, including year of death if applicable, ranging from 1993 to 2009.

[9]For 1999, the data contain only a sample of the firms started. Diagnostic tests do not suggest any selection bias. We eliminated firms where the founder died after 2010 because we want to have at least two years of post-death information for any firm in our analysis. We also drop firms where the founder was older than 67, i.e. beyond retirement age, when founding the firm. Our results do not weaken if we include these firms.

The data are compiled from three different registers:

1. *Accounting information from Dun & Bradstreet's database of accounting figures based on the annual financial statements submitted to the tax authorities.* This data include variables such as 5-digit industry code, sales, assets, number of employees, and profits for the years 1999-2011. Note that the D&B data contain yearly information on *all* Norwegian incorporated limited liability companies, and not a sample as in the U.S. equivalent. Incorporated companies are required to have an external auditor certifying the accounting statements in the annual reports.

2. *Data on individuals from 1993 to 2010 prepared by Statistics Norway.* These records are based on government register data and tax statements, and include the anonymized personal identification number and yearly socio-demographic variables such as gender, age, education in years, taxable wealth, and income. The data identify the year of death, if applicable, and also identifies family relationships between individuals, which allows us to identify family firms. The data contain *all* Norwegian individuals, not a sample as in the Panel Study of Income Dynamics or the Survey of Consumer Finance. As with the PSID and the SCF, the data are anonymized (contains no names of individuals).

3. *Founding documents submitted by new firms to the government agency 'Brønnoysundregisteret'.* This register data include the start-up year, total capitalization, and the personal identification number and ownership share of all initial owners with at least 10 percent ownership stake.

For each new firm identified in 1), we create a list of owners identified through 3) and compile their associated socio-demographic information from 2). We define an entrepreneur as a person with more than 50 percent ownership of the total shares in a newly established limited liability firm. We interchangeably refer to this person as 'the

entrepreneur' or 'the founder'. Restricting the sample to majority owners ensures that we are likely to include 'real' entrepreneurs in our sample. (In separate analysis below, we also look at owners with less than, and equal to, 50 percent ownership share.) For a small fraction of firms, the first year of financial reporting, defined through 1), is different than the year of incorporation defined by 3). For these firms, we define the first year as the first year of reporting.[10]

3.3 Descriptives of original sample

Table 1 presents descriptive statistics of the firms and founders in the sample. Founder characteristics generally refer to the first year of operations, with the exception of log wealth and log earnings which are taken as the log of five-year averages prior to firm foundation. Firm characteristics refer to time of incorporation. Table 1 contrasts characteristics of 'treated' firms (i.e., where the founders die during our sample period) with 'control' firms (i.e., where the founders do not die during the sample period). In the initial sample of 16,127 firms, 205 experience founder death during our sampling period.[11] Founders who die are older and, likely as a consequence, wealthier and less educated. The sectoral composition is very similar. The only small differences are that firms where the founder dies are more likely to be in transportation, and less likely to be in other services. This might reflect the fact that the 'treated' founders are less educated and therefore more prone to be in more traditional industries.

INSERT TABLE 1 HERE

Table 2 shows the timing of entry and the timing of death for the treated firms. Firms

[10] A large literature focuses on the self-employed (e.g., Hurst and Lusardi, 2004). By studying incorporations, we can meaningfully distinguish between the life-span of the entrepreneur and the life-span of the firm; our empirical strategy would be impossible with data on the self-employed.

[11] About one-half of the firms in our database have an individual with at least 50% initial ownership. The remaining firms are either started up by a team of individuals or (more frequently) by a firm. The latter category is likely to be spin-offs of divisions of established firms, rather than start-ups proper. This is also reflected in the size distribution of these firms.

where the founder dies enter in all years between 1999 and 2007 inclusive. Founders of these firms die in all years between 2001 and 2010 inclusive.[12] Another useful descriptive is firm age at founder death. Founder death occurs at any firm age, from year 1 through year 11 (the maximum firm age possible given our sample). In our analysis, amongst others, we will look into the question of whether founder death has different implications for younger versus older firms.

INSERT TABLE 2 HERE

4 Empirical strategy

4.1 Estimation sample

It is natural *not* to compare the 205 firms with founder death to *all* 15,922 firms without founder death, but to limit the analysis to those firms (and their founders) in the control group who are most comparable in terms of their observable characteristics. We use propensity score matching to select the firms in the control group who are most similar to the firms in the treatment group. More specifically, we use nearest neighbor matching to select those firms in the control group whose *ex ante* probability of experiencing founder death is closest to that of the 205 firms where the founder dies.[13] Our further analysis then proceeds on this matched sample. For comparison, we also perform the analysis using OLS on all 16,127 firms in our database. Those results are presented in Table A.1.

The propensity score is the probability of treatment (i.e., founder death) conditional on pre-treatment characteristics. The idea of propensity score matching is to match treated and controls whose *ex ante* probability of receiving treatment (i.e., to experience

[12]Remember that we deliberately excluded observations where the founder dies after 2010 because we have no data for their firms after the year of death, so we cannot identify effects of founder death on firm survival and firm performance for them.

[13]In unreported analysis, we use two-nearest neighbor matching and obtain very similar results.

founder death) – as predicted by their pre-treatment characteristics – is 'identical' (see Rosenbaum and Rubin, 1983). By 'pre-treatment characteristics' we mean characteristics at firm foundation, i.e., the variables shown in Table 1. Characteristics measured at a later point, e.g., in the year before founder death, might already be subject to endogeneity bias because of the foreshadowing of (later) founder death.

To estimate the propensity score, we run a probit model of founder death on the characteristics from Table 1. The results are reported in Table A.2. We obtain estimated propensity scores for all 205 'treated' founders and for 15,922 controls.[14] *Ex ante*, the treated make up just above 1 percent of our sample. Based on the estimated propensity score, we use nearest-neighbor matching (without replacement) to combine treated and control observations.[15] We impose a caliper (i.e., radius) of 0.05, i.e., treated firms that have no comparison unit whose estimated propensity score is within 0.05 of their own estimated propensity score are discarded to avoid bad matches. Imposing this caliper, it turns out, we lose no treated founders whatsoever.[16] Importantly, we impose exact matching on the year the firm starts activities. This is to make sure that we are comparing pairs of treated and control firms that are of the same age in the same calendar year.

In line with the differences detected in Table 1 between treatment and control group, the pre-treatment characteristics have substantial explanatory power in predicting founder death. Table A.2 shows that the pseudo-R^2 is 0.11. The variables entering the propensity score estimation are jointly significant at the 1%-level. Another indicator of differences between treatment and control group before matching is the so-called median absolute standardized bias, defined by Rosenbaum and Rubin (1985) as the comparison between

[14] Some control units are automatically dropped in the propensity score estimation because they have predicted probabilities of zero, i.e. their characteristics perfectly predict non-treatment.

[15] We use a version of Edwin Leuven and Barbara Sianesi's Stata module *psmatch2* (2010, version 4.0.4, *http://ideas.repec.org/c/boc/bocode/s432001.html*) to perform propensity-score matching and covariate balance testing.

[16] While imposing a caliper is inessential in our case, we follow common practice to impose it in the first place.

(standardized) means of treated and control units, where the standardized differences (standardized biases) between the means for a covariate $\boldsymbol{x}_i$ are defined as:

$$B_{before}(\boldsymbol{x}_i) = 100 \cdot \frac{\bar{\boldsymbol{x}}_{i1} - \bar{\boldsymbol{x}}_{i0}}{\sqrt{\frac{1}{2}(V_1(\boldsymbol{x}_i) + V_0(\boldsymbol{x}_i))}}$$

where $\bar{\boldsymbol{x}}_{i1}$ denotes the treated unit mean and $\bar{\boldsymbol{x}}_{i0}$ the control unit mean for covariate $\boldsymbol{x}_i$ and where $V_1(\boldsymbol{x}_i)$ and $V_0(\boldsymbol{x}_i)$ are the sample variances in the treated group and control group, respectively. The median absolute standardized bias before matching is 16.95. Rosenbaum and Rubin (1985) suggest that a value of 20 is 'large', i.e., in line with the other two indicators above, treated and control groups do differ considerably *ex ante*.

On the basis of the estimated propensity score, for each treated firm we search for the control whose propensity score is closest to that of the treated firm ('nearest neighbor matching'). All control firms that do not qualify as a nearest neighbor are discarded from the further analysis.

Matching gives us a better control group and reduces the bias in comparing treated and control groups to the extent that it manages to largely remove the pre-treatment differences between the treatment and control group. We can formally test this, using the same three indicators of imbalance between the treatment and control group, but now using the matched sample. To do so, we re-run the same propensity score specification on the matched sample, i.e., on the sample of treated and *matched* controls. After matching, the pseudo-R^2 drops to 0.02 (from the 0.11 reported in Table A.2). Similarly, the variables entering the propensity score are no longer jointly significant, with a p-value of 0.995. The median absolute standardized bias drops from 16.95 before matching to 3.85 after matching.[17] Matching thus appears to be very successful at reducing (or even

[17]The median absolute standardized bias after matching is defined as

$$B_{after}(\boldsymbol{x}_i) \quad = \quad 100 \cdot \frac{\bar{\boldsymbol{x}}_{i1M} - \bar{\boldsymbol{x}}_{i0M}}{\sqrt{\frac{1}{2}(V_1(\boldsymbol{x}_i) + V_0(\boldsymbol{x}_i))}},$$

removing) differences in observable pre-treatment characteristics. In other words, our matched sample consists of firms where the founder dies and a set of 'twin firms' who are *ex ante* observationally identical, but where the founder does not die. We consider the matched control group as a useful comparison group that approximates the counterfactual outcome of the treated firms.

4.2 Difference-in-differences setup

We ask whether individual entrepreneurs have a causal effect on firm performance. To answer this question, we examine whether firms where the founder dies perform differently from firms where the founder does not die. We are mainly interested in differences after founder death. However, we also look into performance differences before founder death. Differences in performance before founder death would indicate a deterioration in the condition of the founder and his firm before his death. As we will show, there are no differences between treated and control firms before founder death, which is consistent with two possible explanations. Either founder death comes as a surprise, in which case it is natural not to detect any pre-death differences in performance; alternatively, even if the founder already has health issues before his year of death, they do not seem to affect firm performance. When comparing firm performance measures in the year before founder death, we can again use the pseudo-R^2 of a regression of the treatment dummy on firm performance measures as indicators of differences between treated and control firms.[18] The pseudo-R^2 from a regression of the treatment dummy on these performance measures is 0.007, an indication that treated firms and controls do not differ in their performance in the year before founder death. In fact, when looking at t-tests for differences in means between treated firms and matched controls for each and every performance variable, we

where $i1M$ and $i0M$ refer to the matched treated and control units.

[18] We use the same firm performance measures that we use later on in our main analysis: firm survival, (log) sales, (log) assets, (log) number of employees, and operating return on assets.

find no significant differences in the year before founder death. All t-statistics are below 1.5. We take this as clear evidence that treated and control founders/firms are not only comparable at firm foundation (see the results from propensity score estimation discussed above), but that matched pairs of treated firms and controls founded in the same year also develop similarly until the year right before founder death.

Our main focus from now on is on understanding whether founder death affects firm performance after founder death. Why do we not just perform a standard regression analysis using the whole sample? There are two reasons. First, as shown above, treated firms and controls are not necessarily comparable *ex ante*, and matching allows us select those controls that are best matches. Yet, Angrist (1998) shows that matching and regression analysis using a fully saturated (=interacted) model differ only in the (implicit) weighting attached to treatment effects within cells defined by combinations of X characteristics. So, matching is not fundamentally different from a fully saturated OLS model and this is not the main reason for using matching. In fact, in Table A.1, we also present OLS results, for comparison. Second, and most importantly, for control observations, the year of founder death is not defined. Matching is key to finding comparable controls who started business in the same year as individual observations of treated firms. We then use year of founder death at treated firms to impute the counterfactual year of founder death of the matched control.[19] Based on this, we can define 'before' and 'after' founder death for both treated firms and matched controls. Our estimation sample consists of the 205 treated firms and 205 matched controls.

We start by looking at basic differences-in-differences panel regression with firm fixed effects, where we compare treated and matched controls to assess how firm performance

[19]The analysis described above, where we looked into the comparison of treated firms and controls in the year before founder death, is based on the actual (for the treated firms) and imputed (for the controls) year of founder death.

is affected by founder death:

$$Performance_{it} = \alpha_i + \beta_1 * after_{it} * treated_i + \beta_2 * after_{it} + \gamma * X_{it} + \delta_t + \epsilon \quad (1)$$

β_1 is our main coefficient of interest, measuring the difference between treated firms and control firms after founder death.[20] We routinely control for all variables that entered the original matching procedure, i.e., founder and firm characteristics pertaining to the year in which the firm started operations, as well as year dummies. Adding control variables adjusts for any small residual bias and increases efficiency. This 'bias-corrected' matching has been found in Abadie and Imbens (2006) to work well in practice.

Later, we extend this analysis in various ways. First, we look in more detail at how performance varies in a time window around founder death. This allows us to analyze the time pattern of founder death effects. It also allows us to analyze whether there are pre-treatment differences, which could be the case, for example, if illness leads to reduced founder engagement in the years prior to death. Second, we look into heterogeneity of the treatment effect by founder and firm characteristics. The idea is that, for instance, founder death may be more detrimental for young firms than for mature firms, and for smaller firms. Or the death of a highly educated founder might be a bigger loss to the firm than the death of a less educated founder.

We approach these questions by introducing interaction terms between the treatment dummies and certain characteristics, like firm age at founder death. Likewise, we interact the before/after dummies and the difference-in-differences parameter β_1 with indicators of founder or firm characteristics. This informs us whether treatment affects some firms more than others, i.e., whether there is heterogeneity in treatment effects. Third, we look

[20]Note that, in the basic differences-in-differences regressions, we exclude the year of founder death from the regressions because it cannot be clearly assigned to either before or after founder death. Later on, we take the analysis one step further and estimate separate treatment effects for each year, including the year of founder death.

into quantile regressions to see whether the results are driven by things that happen at the lower, middle or upper end of the conditional performance distribution. We turn to these issues below.

Startup performance can be measured by survival, growth, and profitability. We analyze how entrepreneur death affects all these aspects of firm performance. Survival is assessed by whether a firm is active in given year or not.[21] To assess growth, we examine the effect of entrepreneur death on sales, on human assets as measured by employment, and on the (book) value of physical assets. For a firm that closes down, we set the relevant variables equal to zero to measure the effect on sales, employment and assets.[22] To assess profitability, we use operating return on assets (OROA). OROA is defined as the ratio of earnings before interest and taxes (EBIT) to the total asset base used to generate them, and is the standard performance measure in a large accounting and financial economics literature (see e.g., Bennedsen et al. 2007 and references therein).[23] Firms that cease to exist have zero earnings, zero employees, and zero assets (see above), while OROA is undefined. We impute OROA equal to zero for these observa tions. In an alternative specification, we impute an OROA that is 'unreasonably' high, equal to the average OROA in our data (about 6.1 percent). Under this alternative imputation, we obtain no effects on OROA at the mean but obtain very similar results in the quantile regressions.

[21] A firm is not active if it (a) has gone bankrupt, (b) closed down for other reasons, (c) has less than NOK 50,000 in sales.

[22] One might be tempted to exclude firm-year observations after firm closure, but that would introduce a bias. An example illustrates this point: if founder death has a devastating effect so that only one firm survives, the one with highest quality among these firms, our regression estimates for firm growth would be positive.

[23] Unlike returns to equity or returns to capital employed, OROA compares firm profitability relative to total assets. In contrast to net income-based measures such as return on assets, OROA is not affected by capital structure or dividend policy differences across firms. The asset base we use to compute yearly OROA is the average of assets at the beginning and the end of the calendar year. To prevent outliers from driving our results, we winsorize the yearly profits and OROA values at the 5% level.

5 Do entrepreneurs matter?

5.1 Basic results

Table 3, Panel A, presents the results from the difference-in-difference estimation described in Section IV. We consider a window from five years before to five years after founder death. Appendix Figure A.1 shows that the number of observations outside this time window rapidly declines. Including all years slightly strengthens the results. The second row reports the estimated β_1 coefficient for the outcome variables.

INSERT TABLE 3 HERE

The results presented in Panel A of Table 3 show that entrepreneurs have significant effects on firm survival and growth. The effects, especially for firm growth, are large; for example, the mean effects on sales are about 51 percent, while the mean asset effects are about 59 percent.[24]

The main reason for the negative effects on firm performance documented in Panel A could be turbulence created by entrepreneur death. If turbulence drives the results, we would expect entrepreneur death to have a large short-run effect on firm performance, and a partial or full reversal over time (for example, finding a substitute for the entrepreneur could be easier in the longer than in the shorter run). On the other hand, if the entrepreneur is a critical resource for the firm, in the sense outlined in Section II, we would expect the negative performance effects to be long-lasting. To examine this question, in Panel B of Table 3 we estimate separately the effect 1-2 years after founder death, and 3-5 years after founder death. The sample size is larger than in Panel A because we also include the year of founder death. The fourth and fifth rows of Panel B show that compared to the control group, the performance for the treatment group of firms, if any-

[24]Remember that with log dependent variables, coefficients on dummy variables need to be transformed as exp(coefficient) $-$ 1 to yield percentage effects.

thing, deteriorates over time; for firm survival, the effect is about 13 percentage points 1-2 years after founder death, and 14 percentage points 3-5 years after founder death. Also for sales and assets the negative effects are sustained. It is clear that entrepreneur death leads to large and sustained negative effects on firm performance and that there is no bounce-back.The following figure plots the estimated difference between treated firms and control firms across all years of event time, summarizing the regression results.

INSERT FIGURE 1 HERE

The graphs illustrate that over time, the difference between the control and treated group is accentuated. We interpret this as evidence supporting the notion that the entrepreneur is a critical asset that is not easily substituted even in the longer run.

For comparison, we also perform the analysis using OLS on all 16,127 firms in the database.[25] The estimated coefficients, reported in Appendix Table A.1 are of similar magnitude to that in the matching analysis. In Appendix Table A.3 we run the same analysis as in Table 3, but without firm fixed effects. The results are similar.

It is it is possible that the large effect on assets reflect voluntary sale of assets to save on operating costs and improve the firm's financial position (such asset sales may be part of the reason for the zero results on profitability). Likewise, the effect on firm survival could be because of voluntary close-down, or due to forced close-down through bankruptcy. We have data on whether a firm goes bankrupt prior to 2010. The bankruptcy code in Norway is similar to Chapter 7 in the U.S. bankruptcy code, i.e., bankruptcy is associated with creditors taking control and is not voluntary as in Chapter 11 in the U.S bankruptcy code. In unreported regressions we find that 20 percent of the treated firms and 10 percent of the matched control firms go bankrupt before 2010 (the difference is significant at the 1

[25]OLS estimates on the unmatched sample are based on the following regression: $Performance_{it} = \alpha + \beta_1 * after_{it} * treated_i + \beta_2 * treated_i + \gamma * X_{it} + \delta_t + \epsilon$, where $after_{it}$ is equal to 1 in the years after founder death in firms where the founder dies. Note that $after_{it}$ is set equal to zero in all periods for firms where the founder does not die.

percent level). The strong results on bankruptcy suggest that part of the reduction in assets is due to financial distress and "forced" sales and not due to voluntary asset sales.

5.2 Are there pre-treatment differences?

We showed in Section IV that there are no differences between control and treated firms in the year of incorporation. We want to highlight that the results reported in Table 3 also address the important issue whether indeed the post-treatment effect is causal in the sense that they are the result of an exogenously timed death. Similar to Jones and Olken (2005), we look at whether there are pre-treatment differences between treated and control firms. We have done so in the context of the regression estimates presented in Table 3, illustrated in Figure 1. There is no evidence of any pre-treatment differences between treated and control firms. The timing of founder death therefore seems to come largely as a surprise and we interpret differences after founder death as the result of (largely unexpected) founder death. We discussed above that the finding of no pre-treatment effects is consistent with the alternative interpretation that even if the founder was ill before his death, on average that illness does not seem to have affected firm performance.

The lack of pre-treatment differences suggest that matching to a large degree has dealt with unobserved heterogeneity between the treated and control groups. An alternative way to show this is to analyze the treatment effects around founder death only for the treated group. Indeed, Appendix Table A.4 shows that a simple before-after analysis on the treated group gives very similar results to the difference-in-difference results.

5.3 Quantile effects

Firms that experience entrepreneur death have about 15 percentage points lower survival rates in the first years after the death event. It is possible that entrepreneur death weeds out weak firms faster, but there is little effect on higher-quality firms. Or, if the heir or

creditors voluntarily close down unprofitable firms entrepreneur death could simply mean a lower threshold for closing down firms than in if the entrepreneur were still alive, rather than changing the underlying outcome distribution.

To address the important issue of whether entrepreneur death has effects for higher-quality firms, in Table 4 we look at quantile regressions for the same type of specification as in Table 3, but where we compare the performance of treated and control firms above median of the conditional performance distribution. Below the median, there are smaller differences between treated and control firms, which is largely explained by the fact that both treated and control firms at the lower quantiles of the distribution are going out of business.

INSERT TABLE 4 HERE

There are negative effects of founder death on log(assets) and log(sales) at all deciles between the median the 90th percentile. At all quantiles, the effects are stronger 3, 4 and 5 years after founder death (not reported). At the 95th percentile (not reported), differences between treated and control firms seem to disappear. This result has to be taken with caution because Chernozhukov and Fernandez-Val (2011) suggest that, for data sets of a sample size like ours, a normal distribution approximation at the 95th percentile might not be appropriate. We conclude that entrepreneur death appears to have a negative effect on growth and profitability across the firm performance distribution.

To deal with the issue that there are no treatment effects in the lower quartile due to attrition of both treated and control firms, an alternative estimation strategy is to condition on the firm being active the year before founder death. The results of this regression are reported in Table 5.

INSERT TABLE 5 HERE

As expected, the results are larger in absolute value compared to the main analysis.[26]

[26]As another alternative, we can match on firm and founder characteristics in the year before founder

5.4 Firm age

Does the importance of the entrepreneur diminish as the firm matures? We analyze whether the drop in firm performance depends on firm age when the entrepreneur dies. We split firms into quintiles of firm age upon founder death and interact these quintiles with the treatment dummy. In order for results to be comparable across quintiles, we analyze performance effects up to two years after founder death. Table A.6 shows that there are substantial effects of founder death up to the fourth quintile, which corresponds to firm age up to seven years upon founder death. For the top quintile, the estimated coefficients are negative but not significant.

These results suggest that founder death has a very large effect even when the firm has reached a more mature phase, and that financing constraints and underinvestment of the type described by Hart and Moore (1994) may be present for a long time in a firm's life.

5.5 Firm size

The majority of firms in the database are small, and it would not be surprising that miniature firms close down if the founder dies.[27] We therefore investigate whether the effect of entrepreneur death depends on startup size. In order to analyze the differential treatment effect across startup size, we interact the treatment effect with dummies for quintiles of employment in the year prior to founder death (firms that have not survived up to this point are excluded from the regressions). In Appendix Figure A.2 we provide a histogram of firm size in the year prior to founder death.

death, restricting attention to firms that are still active. This strategy has the added benefit of reducing measurement error since we capture firm characteristics closer to founder death. The results of this regression are reported in Appendix Table A.5, Panel A. The results are similar to in Table 5.

[27]For example, many firms in our sample could be vehicles for cutting the tax bill for essentially self-employed individuals, or firms started up as a 'consumption good' for the entrepreneur. In both these cases, it would be no surprise to see the firm to vanish with the founder.

Table A.7, Panel A, shows that the effects are declining in firm size but still very substantial in the fourth quintile, which corresponds to between five and eight employees. For the top quintile, the estimated coefficient is insignificant and positive, which could be due to the large heterogeneity in this quintile. In Table A.7, Panel B, we split the top quintile into two deciles. While the estimated coefficient is zero for the ninth decile, it is positive for the tenth decile.

5.6 Other interactions

In Table 6 we report the results from analyzing the differential effects of a number of different types of firms and founders. As we have not found evidence of pre-treatment effects we again condition on the firm being alive in the year prior to founder death.

INSERT TABLE 6 HERE

We are interested in whether the entrepreneur is more important in sectors where human capital is more important relative to physical capital. Our results give some support to this conjecture. First, we find somewhat stronger effects in sectors where founder education is above that in the sector with median education, and where sector wages are above the median across industries. We also find somewhat stronger effects in sectors with higher R&D expenses, and in sectors where sales growth is above median. These results, although mostly failing to achieve statistical significance, overall suggest that founders are relatively more important in human capital intensive firms and sectors.

Among several other dimensions we do not find differences in treatment effects. First, based on the endogenous growth literature (e.g., Glaeser et al., 1992), we ask whether the causal effect of individual entrepreneurs is lesser in urban areas, where the supply of entrepreneurs is denser. In unreported analysis, we find no difference in causal effect of entrepreneurs in rural and urban areas. This might indicate that, even if there is a larger supply of (potential) entrepreneurs in a city, there could be mitigating demand-side effects,

such as the alternative entrepreneurs' opportunity cost of time being higher. We also split firms up depending on whether the entrepreneur was the sole owner at the incorporation date or not. The differences are minor. We also looked at whether founder death matters less for old founders (60 years or more in the startup year). Such founders might be less dynamic than younger founders and therefore potentially more easily replaceable. However, we find no differences in treatment effects by age (not reported). We also looked at the gender dimension, but find no heterogeneity of the treatment effect by gender (not reported).

6 Mechanisms

The results of Section V are consistent with a simple mechanism: entrepreneurs personally embed a major part of the value of firms, and less entrepreneurial engagement harms firm performance. In this section we discuss this mechanism in further detail. We also discuss the role of two alternative mechanisms; within-family transfer of control and fragility of young firms to shocks. In the next section we discuss in more detail whether detrimental effects of abrupt leadership transition could explain our results.

6.1 Entrepreneurial engagement

To explore the role of entrepreneurial engagement further, we analyze whether the effects of death depends on whether the entrepreneur works for the firm or not prior to death. We interact the treatment effect with a dummy for whether the entrepreneur had the firm as his main employer one year prior to death. The results are reported in Table 6 and show that the negative effects of founder death are predominantly driven by entrepreneurs that are employed by their firm prior to death. This result corroborates the idea that entrepreneur engagement is a critical factor to young firms. Furthermore, it suggests

that entrepreneurs, in order to be important, need to actively engage in the day-to-day operations of the firm. In Panel B of Appendix Table A.5, we corroborate the finding that founder engagement by working in the firm is important, when matching on firm and founder characteristics in the year before founder death. In Section VII we investigate entrepreneur engagement further, by utilizing data for 2002 to 2007 on the identity of chief executive officers.

6.2 The role of the family

Part of the explanation for the strong effects of founder death could be that post-death, the control of the firm is transfered to less competent family members.[28] Perez-Gonzales (2006), Bennedsen et al. (2007), and Bertrand et al. (2008) document negative effects on performance from family CEO appointments inside mature firms.

As a first step, we investigate ownership changes in the aftermath of entrepreneur death.[29] We classify ownership into two categories, the entrepreneur and family members, and outsiders. Outsiders could be either individuals that are non-family member, or other firms. In Figure 2 we graph how ownership evolves for these two categories in event time. We see that even four years after founder death, the family still owns more than half the company on average. So there is no doubt that the family plays an important role for the surviving firms.

Our next step is to regress post-death performance on a dummy of whether family keeps a majority-ownership or not, including death year variables as control. In unreported results, we find firms where the family keeps at least 50% in the first year after

[28] Alternatively, family members might be subject to inheritance tax, which in turn might force them to sell off (parts of) the firm. As we discussed in section **??**, inheritance tax issues only play a minor role.

[29] Note that, while data on ownership is complete in the year of firm foundation (which is the basis for our definition of majority, 50% and minority ownership), ownership data has some missing values in later years. While this is unfortunate, we do not have reason to believe that it biases the findings below in a systematic way.

founder death are more likely to exit in the subsequent years. This could be due to two reasons (that our data do not allow us to differentiate); either a genuine negative causal effect of family ownership, or because better-performing firms are easier for the family to sell off. However, conditional on the firm staying active, there are no significant differences in firm performance between firms where the family does or does not sell off.

The second way to approach whether the family hurts the firm is to introduce interaction terms between the treatment dummies and a family firm dummy. Likewise, we interact the before/after dummies and the difference-in-differences parameter β_1 with a family firm dummy. This method is more indirect but gives us causal estimates. It informs us whether treatment affects family firms more than others. We define a family firm as a firm where at least one of the founding minority owners is a child, parent, sibling or spouse of the entrepreneur. In the final panel of Table 6, we find evidence that family firms are more resilient to the death of the founder. Unfortunately the sample of family firms is small (about 6% of the sample) which limits our ability to get deeper into this issue.

6.3 Fragility of young firms

Initial owners of start-ups are often family members, friends, former co-workers. Our results, therefore, may not show a special role of the entrepreneur but rather the fragility of young firms to circumstances, such as turbulence and emotional distress, created by death in a close-knit group. If so, one would expect the death of other individuals inside the circle to have a similar negative effect. We therefore analyze the impact of minority owner death (an ownership share of at least 10 percent and less than 50 percent, in all 346 death events, see Table A.8 for descriptive statistics) on firm performance using the same type of matching technology as in the main analysis. The results, analogous to those in Table 3, are reported in the first panel of Table 7, and show that there are small or zero

negative effects.[30]

INSERT TABLE 7 HERE

We then analyze the effects of the death of key workers, defined as individuals that are both employed by the firm and hold an initial minority ownership share. For such key workers the effect of death, reported in the second panel of Table 7, is statistically insignificant. This surprising result reinforces the idea that engagement in daily operations by the entrepreneur is critical; daily engagement even by presumably key workers is of much less importance.[31]

To summarize, the results of Section V and VI are consistent with the mechanism outlined in Section II: entrepreneurs are a core asset for young firms, and less entrepreneurial engagement harms firm performance. Other mechanisms, such as within-family transfer or the fragility of young firms to any shocks do not appear to explain the results. In the next section we explore whether the negative effects of leadership transition can explain our results.

7 Leadership transition

Entrepreneurs typically have two roles: they found the company and provide its blueprint, but typically also manage the firm. It is possible that the results of Section V and Section VI are not due to entrepreneur specialness, but detrimental effects of abrupt leadership transition and the costs of adapting to a new leader. In order to deal with this question, we employ data that provides the end-of-year identity of the firm's chief executive officer (CEO) between 2002 and 2007. We analyze the effects of CEO death, and split the CEOs

[30]Results (unreported) are very similar when conditioning on the firm being active in the year before founder death.

[31]For completeness, the third and the fourth panel of Table 7 reports the results of the same type of analysis for individuals that own exactly 50 percent of the firm initially (129 death events, for descriptive statistics see Table A.9).

into two groups: founders and non-founders, and compare the causal effect of CEOs that are founders with the causal effect of CEOs that are not founders. We have 142 death events for CEO-founders (112 for majority owners and 30 for 50% owners) and 114 death events for CEOs that are non-founders.

The idea behind this analysis is simple: if entrepreneur specialness drives the results, we would expect the death of CEOs that are entrepreneurs to have a stronger detrimental effect on the firm than the death of CEOs that are not entrepreneurs. Conversely, if non-entrepreneur CEO death yields equally strong results, we would conclude that our results are predominantly due to leadership transition.

In this part of the analysis, we keep the firms where we know the identity of the CEO in at least one year between 2002 and 2007. As in the main analysis, CEOs that die are older, and it is not natural to compare firms with CEO deaths to *all* firms with no CEO death in our database, but limit the analysis to those firms (and CEOs) in the control group who are most comparable in terms of observable characteristics. Again we use propensity score matching to select the firms in the control group who are most similar to the firms in the treatment group.

We use nearest neighbor matching to select those firms in the control group whose *ex ante* probability of experiencing CEO death is closest to that of the firms where the CEO dies, and our further analysis proceeds on this matched sample. As in the main analysis, we also present fixed effects results, using all the firms in the database (with the restriction that we know the CEO identity in at least one year).

As CEO identity can change over time, we perform matching at the firm-year level, where we find comparable firms in the year before CEO death. For firm characteristics, we match on year zero characteristics, in order to avoid endogeneity. We require a matched control to be started up in the same year, and have the same firm age as the treated firm (this implies that treated and matched control will be measured in the same calendar year).

We also require exact matching on CEO type, i.e. we match founder-CEOs to founder-CEOs and non-founder CEOs to non-founder CEOs. In the regressions, we include year, firm age, and year by sector fixed effects. Table A.10 presents descriptive statistics of the matched sample. We have also analyzed whether there are differences between the startups with founder-CEOs to firms with non-founder CEOs. In terms of startup size there is no difference. The firms with non-founder CEOs are slightly older upon CEO death than firms with founder-CEOs (mean age 3.2 years versus 2.9 years). Also, the two types of CEOs are very similar in terms of sociodemographic characteristics such as age and education level. Thus it seems unlikely that differences in firm characteristics can explain our results.

Table 8 presents the results for firm survival (Table A.11 shows results for other firm performance measures). The first three columns are based on the matched sample. Overall, for all three groups of CEOs, death negatively impacts on firm survival. We see that the entrepreneur-CEO category yields economically large effects, statistically significant at the 1% level. The difference to non-entrepreneur CEOs is economically large and significant at the 7% level. In column 4, we perform the same analysis without matching, using all the firms in our sample, and using firm fixed effects, as in column 3. Now the entrepreneur-CEO effect is still large, but the non-entrepreneur CEO effect is small and statistically insignificant.

INSERT TABLE 8 HERE

In Panel B we investigate the effect for "smaller" shocks, the death of a person in the nuclear family (spouse or child). We obtain a matched sample in the same way as before and descriptive statistics are shown in Panel B of Table A.10. We find overall smaller effects on firm performance, as expected. Interestingly, the effect is significant only for CEOs that are entrepreneurs. Thus the finding that CEOs that are entrepreneurs

are considerably more important than non-entrepreneur CEOs seems to be a recurring pattern.

To conclude, we find that the effects of death of CEO-founders are economically and statistically much stronger than for CEOs that are not founders. We conclude that the results appear driven by the specialness of the entrepreneur and not leadership transition of young firms.

8 Conclusion

In the large literature on firm performance, economists have given little attention to the founders of firms. While the idea of entrepreneurs being important is old, other factors have been the focus of most empirical work. This paper uses several hundred exogenously timed deaths as a natural experiment to identify the causal effect of entrepreneurs on firm performance. We find that entrepreneurs strongly affect performance of both very young firms and more mature firms, and more strongly in 'dynamic' industries with higher education level, larger R&D expenses and higher sales growth. The effects appear to be driven by entrepreneur specialness rather than leadership transition; the effects of death of entrepreneur-managers are economically and statistically much stronger than the death of managers that are not entrepreneurs.

These results point to entrepreneurs playing a large and unique role not previously documented. Much of the existing evidence in favor of the importance of entrepreneurs is based on comparing environments with high versus low entrepreneurship rates (e.g., Acs et al., 2009, Glaeser et al., 2015). However, these findings are open to several interpretations. A key contribution of our analysis is to directly measure the impact of entrepreneurs, and to show that it is large even compared to managers.

We highlight one area of possible future research. Our empirical results are much in

line with the model of entrepreneurship proposed by Hart & Moore (1994). One of the implications of this model is that founder non-substitutability leads to credit constraints and suboptimal investment levels. Our empirical results suggests a metric to predict what type of founders are less substitutable, and therefore less likely to be funded in the first place. One could use this metric to predict liquidity constraints, and possibly suggest public policies to alleviate them.

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Table 1
Descriptive statistics in year of foundation

	Firms where founder dies (205 obs)				Firms where founder does not die (15,922 obs)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Founder death	1.00	.00	1.00	1.00	.00	.00	.00	.00
Age	50.29	9.53	25.00	67.00	42.20	9.96	18.00	67.00
Female	.10	.30	.00	1.00	.18	.38	.00	1.00
Single	.15	.35	.00	1.00	.27	.44	.00	1.00
Years of education	11.68	2.82	5.00	20.00	12.25	2.57	5.00	21.00
Log wealth in year before firm foundation	13.58	1.36	9.21	16.38	13.11	1.34	9.21	20.47
Log earnings in year before firm foundation	12.71	.78	9.21	14.15	12.70	.77	9.21	17.78
Self-empl. experience over previous 10 years	.35	.41	.00	1.00	.25	.36	.00	1.00
Number of employees	3.81	4.65	1.00	33.00	3.62	5.50	1.00	139.00
Dummy: family firm	.15	.35	.00	1.00	.09	.28	.00	1.00
Dummy: Urban area	.41	.49	.00	1.00	.39	.49	.00	1.00
Log equity at firm foundation	11.72	.58	10.89	14.26	11.73	.57	10.89	18.49
Ownership share at firm foundation	.82	.19	.51	1.00	.88	.18	.50	1.00
Dummy: sole owner at firm foundation	.47	.50	.00	1.00	.64	.48	.00	1.00
Year of firm foundation	2001.79	1.94	1999	2007	2002.95	2.24	1999	2007
Agriculture and Fishery	.05	.22	.00	1.00	.02	.15	.00	1.00
Mining	.00	.00	.00	.00	.003	.06	.00	1.00
Manufacturing	.07	.26	.00	1.00	.06	.23	.00	1.00
Utilities	.00	.00	.00	.00	.0009	.03	.00	1.00
Construction	.13	.34	.00	1.00	.16	.36	.00	1.00
Commerce	.27	.44	.00	1.00	.29	.45	.00	1.00
Business Services	.24	.43	.00	1.00	.24	.43	.00	1.00
Other Services	.13	.33	.00	1.00	.17	.37	.00	1.00
Transport, storage and communication	.09	.28	.00	1.00	.05	.22	.00	1.00

Note: The table depicts summary statistics in the first year of operations for the sample of majority founders and the firms they start up, broken down by whether the founder dies (d=1) or not (d=0).

Table 2
Firms where the founder dies

Year of foundation			Year of death			Firm age at founder death		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Freq.	Percent		Freq.	Percent		Freq.	Percent
1999	17	8.29						
2000	51	24.88				1	12	5.85
2001	35	17.07	2001	5	2.44	2	19	9.27
2002	31	15.12	2002	4	1.95	3	22	10.73
2003	30	14.63	2003	13	6.34	4	38	18.54
2004	23	11.22	2004	16	7.80	5	18	8.78
2005	5	2.44	2005	13	6.34	6	28	13.66
2006	12	5.85	2006	23	11.22	7	25	12.20
2007	1	0.49	2007	24	11.71	8	10	4.88
			2008	26	12.68	9	20	9.76
			2009	43	20.98	10	8	3.90
			2010	38	18.54	11	5	2.44
Total	205	100	Total	205	100	Total	205	100

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: The table depicts summary statistics of founders and the firms they start up, for firms where the founder dies (d=1).

Table 3
Matched sample: Effect of founder death on firm performance

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall effect of founder death on firm performance					
After * Treated	-.157	-.710	-.900	-.198	-.007
	(.039)***	(.226)***	(.193)***	(.070)***	(.019)
Obs.	3274	3274	3274	3271	3274
R^2 within	.307	.233	.250	.184	.042
Panel B: Effect of founder death on firm performance over time					
Treated * (1,2) years before founder death	.004	.091	.033	.072	-.003
	(.028)	(.156)	(.130)	(.043)*	(.016)
Treated * year of founder death	-.074	-.330	-.459	-.045	-.027
	(.038)*	(.207)	(.183)**	(.059)	(.023)
Treated * (1,2) years after founder death	-.142	-.623	-.721	-.142	-.013
	(.042)***	(.238)***	(.206)***	(.070)**	(.021)
Treated * (3,4,5) years after founder death	-.154	-.609	-.906	-.167	-.011
	(.050)***	(.295)**	(.259)***	(.091)*	(.026)
Obs.	3684	3684	3684	3681	3684
R^2 within	.287	.219	.233	.173	.038

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. In Panel A, observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables in panel A and B: year effects, founder education and founder age and age squared, firm age and in panel A the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. In Panel A and B, sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table 4
Matched sample: Effect of founder death on firm performance: quantile regressions

	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)
50% percentile				
Treated	-.036	-.009	.029	-.031
	(.098)	(.118)	(.023)	(.006)***
After * Treated	-2.828	-2.716	-.377	-.004
	(.140)***	(.168)***	(.033)***	(.008)
Obs.	3274	3274	3271	3274
Pseudo-R^2	.226	.218	.273	.069
60% percentile				
Treated	.020	-.025	.036	-.043
	(.074)	(.088)	(.022)	(.008)***
After * Treated	-2.976	-2.422	-.544	-.013
	(.105)***	(.126)***	(.032)***	(.012)
Obs.	3274	3274	3271	3274
Pseudo-R^2	.191	.180	.309	.102
70% percentile				
Treated	.028	-.046	.046	-.048
	(.069)	(.091)	(.030)	(.015)***
After * Treated	-.897	-.964	-.366	-.026
	(.098)***	(.130)***	(.042)***	(.021)
Obs.	3274	3274	3271	3274
Pseudo-R^2	.173	.162	.322	.109
80% percentile				
Treated	-.009	-.096	.050	-.036
	(.054)	(.087)	(.041)	(.015)**
After * Treated	-.487	-.567	-.302	-.037
	(.077)***	(.124)***	(.057)***	(.021)*
Obs.	3274	3274	3271	3274
Pseudo-R^2	.189	.168	.323	.121
90% percentile				
Treated	.040	-.080	.021	-.023
	(.070)	(.102)	(.058)	(.017)
After * Treated	-.124	-.427	-.198	-.037
	(.099)	(.146)***	(.082)**	(.024)
Obs.	3274	3274	3271	3274
Pseudo-R^2	.211	.192	.318	.139

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table 5
Matched sample: Effect of founder death on firm performance conditional on firm active in (t-1)

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall effect of founder death on firm performance					
After * Treated	-.232	-1.119	-1.308	-.283	-.024
	(.052)***	(.302)***	(.249)***	(.089)***	(.025)
Obs.	2256	2256	2256	2255	2256
R^2 within	.303	.237	.214	.147	.066

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Sample of firms active in (t-1). Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table 6
Matched sample: Heterogeneity of the effect of founder death on firm performance

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Firm in sector with above/below median founder education					
After * Treated	-.181	-.869	-1.097	-.243	-.029
	(.059)***	(.357)**	(.288)***	(.108)**	(.027)
After * Treated * (Sector with founder education above median)	-.215	-1.040	-.879	-.168	.023
	(.123)*	(.657)	(.570)	(.179)	(.067)
Obs.	2256	2256	2256	2255	2256
R^2 within	.302	.230	.210	.136	.056
Firm in sector with above/below median R&D					
After * Treated	-.184	-.893	-1.098	-.313	-.015
	(.063)***	(.381)**	(.301)***	(.115)***	(.031)
After * Treated * (Sector R&D above median)	-.148	-.745	-.618	.052	-.017
	(.117)	(.652)	(.559)	(.175)	(.057)
Obs.	2054	2054	2054	2053	2054
R^2 within	.301	.230	.210	.131	.065
Firm in sector with above/below median wages					
After * Treated	-.163	-.815	-.983	-.234	-.021
	(.066)**	(.385)**	(.320)***	(.117)**	(.031)
After * Treated * (Sector wages above median)	-.171	-.769	-.769	-.149	.011
	(.109)	(.617)	(.508)	(.164)	(.058)
Obs.	2080	2080	2080	2079	2080
R^2 within	.292	.223	.201	.133	.056
Firm in sector with above/below median sales growth					
After * Treated	-.178	-.791	-.998	-.308	-.007
	(.073)**	(.453)*	(.365)***	(.127)**	(.038)
After * Treated * (Sector sales growth above median)	-.111	-.703	-.610	.012	-.013
	(.105)	(.607)	(.505)	(.171)	(.052)
Obs.	2054	2054	2054	2053	2054
R^2 within	.295	.229	.205	.133	.059

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Sample of firms active in (t-1). Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table 6
Matched sample: Heterogeneity of the effect of founder death on firm performance (cont'd)

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Owner works at firm in $(t-1)$					
After * Treated	-.046	.025	-.550	.092	.076
	(.086)	(.474)	(.405)	(.142)	(.042)*
After * Treated * (Owner works at firm in $(t-1)$)	-.289	-1.784	-1.182	-.561	-.151
	(.108)***	(.611)***	(.516)**	(.181)***	(.052)***
Obs.	2256	2256	2256	2255	2256
R^2 within	.305	.242	.214	.15	.061
Firm with/without family members as co-owners					
After * Treated	-.278	-1.383	-1.498	-.356	-.010
	(.055)***	(.322)***	(.268)***	(.095)***	(.028)
After * Treated * (Family firm)	.281	1.590	1.141	.437	-.082
	(.146)*	(.855)*	(.680)*	(.257)*	(.061)
Obs.	2256	2256	2256	2255	2256
R^2 within	.301	.233	.208	.141	.055

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Sample of firms active in (t-1). Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table 7
Matched sample: Effect of founder death on firm performance for minority owners and 50% owners

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Effect of founder death for minority owners					
After * Treated	-.007	-.104	-.034	-.126	.004
	(.029)	(.177)	(.160)	(.061)**	(.017)
Obs.	5578	5578	5578	5578	5578
Adjusted R^2	.223	.151	.14	.113	.022
Effect of founder death for minority owners, interacted with dummy for whether owner works at firm in $(t-1)$					
After * Treated	-.003	-.137	-.090	-.137	-.003
	(.033)	(.197)	(.181)	(.069)**	(.020)
After * Treated * (Owner works at firm in $(t-1)$)	-.022	.134	.226	.045	.031
	(.068)	(.437)	(.380)	(.150)	(.038)
Obs.	5578	5578	5578	5578	5578
Adjusted R^2	.221	.146	.137	.108	.017
Effect of founder death for 50-percent owners					
After * Treated	-.099	-.531	-.215	-.196	.005
	(.046)**	(.261)**	(.223)	(.083)**	(.023)
Obs.	2084	2084	2083	2084	2083
Adjusted R^2	.300	.240	.240	.148	.019
Effect of founder death for 50-percent owners, interacted with dummy for whether owner works at firm in $(t-1)$					
After * Treated	.004	-.013	.106	-.005	-.018
	(.052)	(.283)	(.252)	(.096)	(.027)
After * Treated * (Owner works at firm in $(t-1)$)	-.289	-1.467	-.908	-.542	.062
	(.100)***	(.586)**	(.494)*	(.179)***	(.047)
Obs.	2084	2084	2083	2084	2083
Adjusted R^2	.302	.239	.236	.150	.014

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

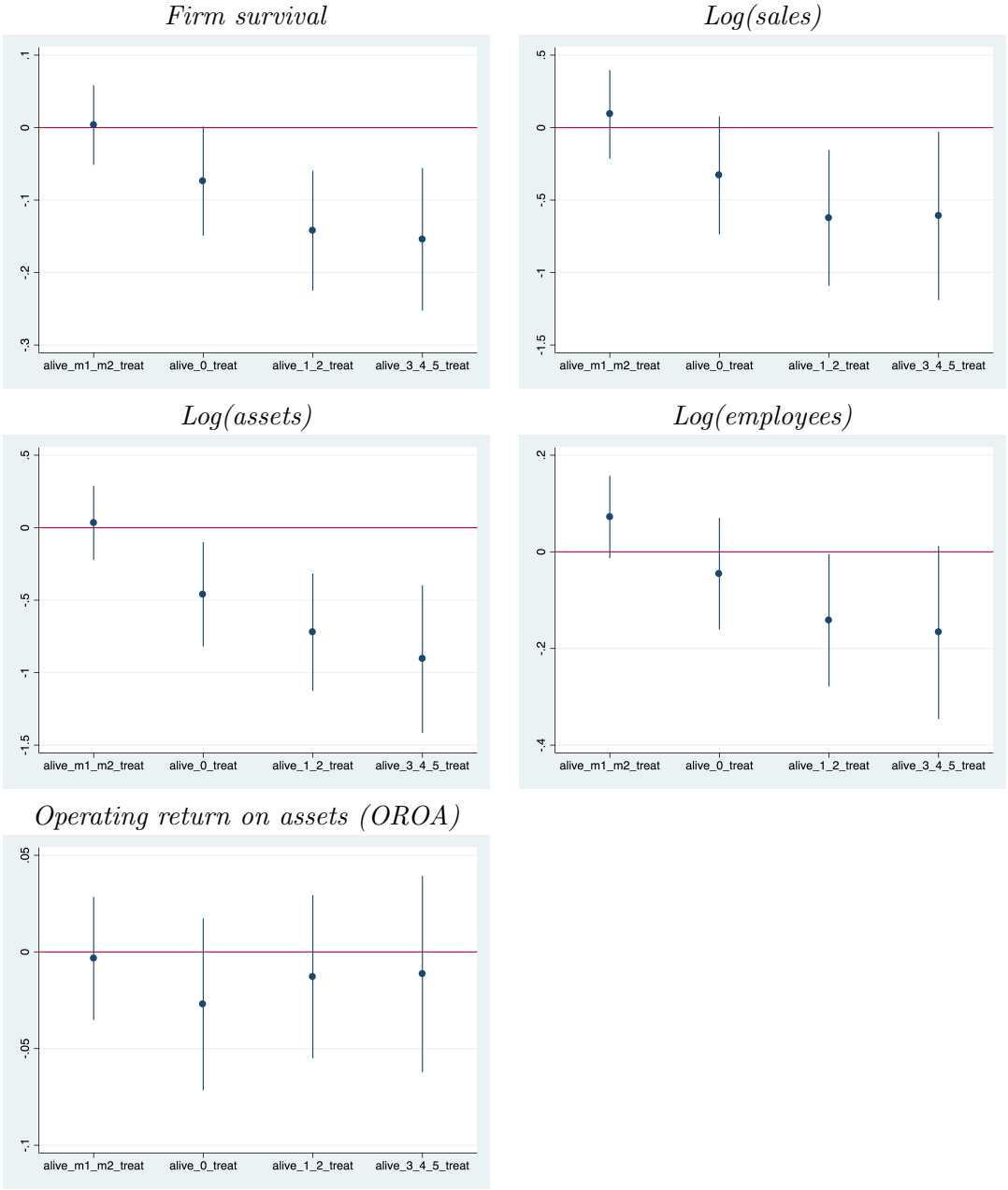
Table 8
Effect of CEO death and death of CEO family members on firm survival

	Matched sample			Unmatched sample
	No controls	With controls	Fixed effects	Fixed effects
	(1)	(2)	(3)	(4)
Panel A: Death of CEO				
After * Professional CEO	-.130	-.118	-.154	-.069
	(.077)*	(.077)	(.083)*	(.064)
After * Majority-founder CEO	-.323	-.317	-.302	-.246
	(.078)***	(.079)***	(.083)***	(.063)***
After * 50%-founder CEO	-.194	-.142	-.155	-.258
	(.153)	(.163)	(.179)	(.111)**
Obs.	2112	2112	2112	308672
Adjusted R2	.236	.262	.559	.584
Panel B: Death of close family member of CEO				
After * Professional CEO	.037	.015	.029	.044
	(.051)	(.050)	(.053)	(.031)
After * Majority-founder CEO	-.094	-.076	-.092	-.054
	(.045)**	(.045)*	(.049)*	(.033)
After * 50%-founder CEO	.030	.051	.077	.061
	(.072)	(.073)	(.087)	(.046)
Obs.	5152	5152	5152	308869
Adjusted R2	.115	.134	.478	.584

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Panel A and Panel B both use matched samples of firms who are subject to CEO death (panel A) or death of a close family member of the CEO (panel B). In Panel A and B, sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Figure 1

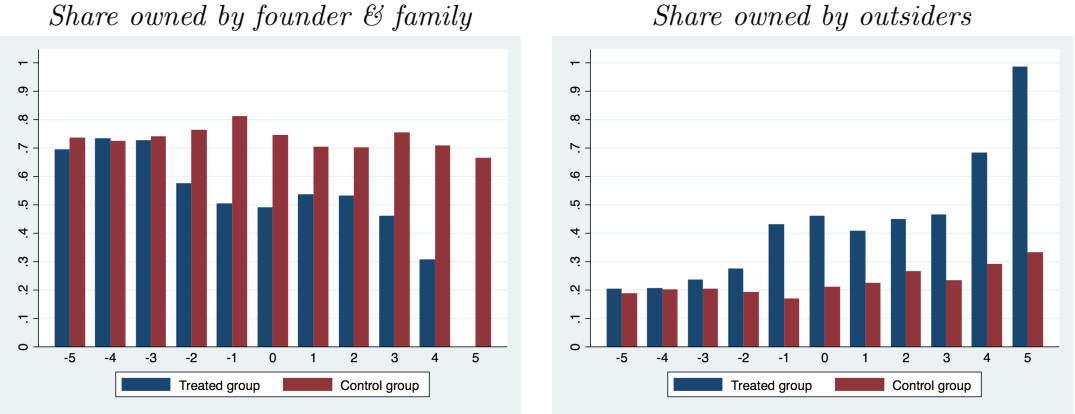
Treatment effects before and after founder death



Note: Figure displays coefficients and standard errors from Table 3, Panel B. Year 0 refers to year of founder death for treated firms and imputed year of death for matched firms.

Figure 2

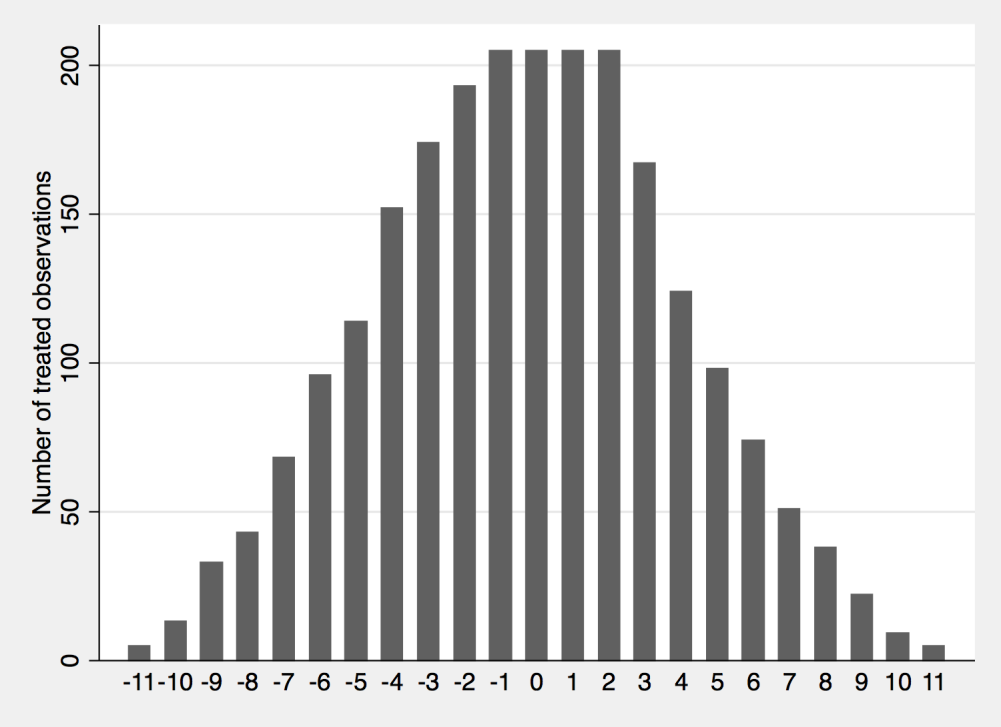
Ownership changes before and after founder death



Note: The figure plots the ownership shares of (a) founder and family and (b) "outsiders", i.e. owners that are neither founder nor family members. Outsiders could be either individual or corporate owners.

Figure A.1

Number of observations for treated firms before and after founder death

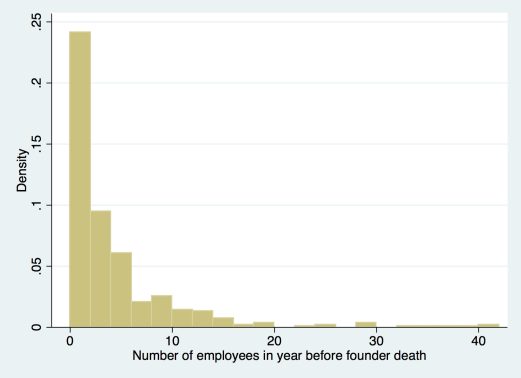


Note: Graph displays the number of observations for treated firms in a time window around founder death. Year "0" is the year of founder death.

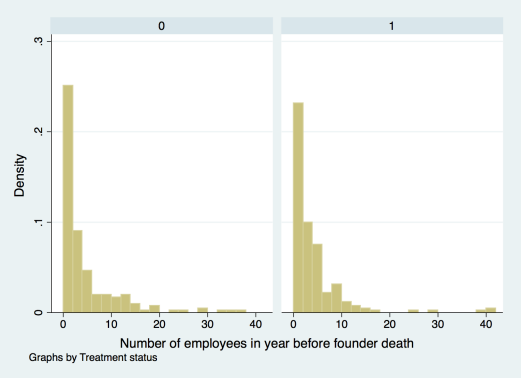
Figure A.2

Number of employees in the year before founder death.

Matched sample



By treatment status



Note: The figure plots the number of employees in the year before founder death.

Table A.1
Full (unmatched) sample

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall effect of founder death on firm performance					
After * Treated	-.177	-.874	-.972	-.263	-.020
	(.029)***	(.166)***	(.141)***	(.047)***	(.014)
Obs.	161609	161543	161594	161499	161598
Number of firms	16127	16127	16127	16127	16127
R^2	.245	.151	.135	.096	.015
Panel B: Effect of founder death on firm performance over time					
Treated * (1,2) years before founder death	-.011	-.006	-.044	.030	-.009
	(.025)	(.138)	(.112)	(.040)	(.015)
Treated * year of founder death	-.099	-.495	-.590	-.108	-.029
	(.033)***	(.176)***	(.155)***	(.049)**	(.020)
Treated * (1,2) years after founder death	-.170	-.826	-.877	-.222	-.023
	(.034)***	(.189)***	(.162)***	(.053)***	(.017)
Treated * (3,4,5) years after founder death	-.196	-.922	-1.127	-.283	-.025
	(.037)***	(.215)***	(.189)***	(.063)***	(.019)
Obs.	161814	161748	161799	161704	161803
Number of firms	16127	16127	16127	16127	16127
R^2	.245	.151	.135	.096	.015

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: This table corresponds to Table 3, but using the full sample, without propensity score matching. Estimates are based on the following regression: $Performance_{it} = \alpha + \xi_i + \beta_1 * after_{it} * treated_i + \gamma * X_{it} + \delta_t + \epsilon$, where $after_{it}$ is equal to 1 in the years after founder death in firms where the founder dies. Note that $after_{it}$ is set equal to zero in all periods for firms where the founder does not die. See main text for details.

Table A.2: Propensity score estimation

Age	.0007 (.0005)
Age squared	-7.12e-07 (5.40e-06)
Female	-.003 (.001)
Single	.002 (.002)
Years of education	-.0006 (.0002)
Dummy: Urban area	.001 (.001)
Log wealth in year before firm foundation	-.001 (.006)
Log wealth in year before firm foundation squared	.0002 (.0002)
Log earnings in year before firm foundation	.02 (.01)
Log earnings in year before firm foundation squared	-.0005 (.0005)
Interaction between log wealth and log earnings	-.0003 (.0005)
Self-empl. experience over previous 10 years	.001 (.002)
Number of employees	.0004 (.0003)
Number of employees squared	-.0000107 (9.90e-06)
Log equity at firm foundation	-.001 (.001)
Dummy: family firm	.0005 (.002)
Ownership share at firm foundation	.003 (.007)
Dummy: sole owner at firm foundation	-.005 (.003)

Continued on next page

Table A.2: continued from previous page

Agriculture and Fishery	.0004
	(.005)
Manufacturing	-.003
	(.003)
Construction	-.004
	(.003)
Commerce	-.004
	(.003)
Business Services	-.003
	(.003)
Other Services	-.004
	(.003)
Transport, storage and communication	-.0006
	(.004)
Firm started in 2000	.0005
	(.003)
Firm started in 2001	-.002
	(.002)
Firm started in 2002	-.003
	(.002)
Firm started in 2003	-.003
	(.002)
Firm started in 2004	-.005
	(.002)
Firm started in 2005	-.007
	(.001)
Firm started in 2006	-.007
	(.001)
Firm started in 2007	-.008
	(.0009)
Obs.	16060
Pseudo-R^2	.11

Note: Propensity score estimation underlying the matched sample in main regression tables.

Table A.3
Matched sample: Effect of founder death on firm performance (no firm fixed effects)

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall effect of founder death on firm performance					
Treated	-.055	-.304	-.298	-.022	-.027
	(.034)	(.214)	(.168)*	(.066)	(.018)
After * Treated	-.164	-.761	-.905	-.215	-.022
	(.043)***	(.249)***	(.210)***	(.076)***	(.019)
Obs.	3274	3274	3274	3271	3274
Adjusted R^2	.228	.250	.276	.329	.085
Panel B: Effect of founder death on firm performance over time					
Treated * (3,4,5) years before founder death	-.046	-.285	-.300	-.019	-.023
	(.037)	(.230)	(.177)*	(.067)	(.023)
Treated * (1,2) years before founder death	-.064	-.324	-.299	-.025	-.031
	(.039)	(.238)	(.190)	(.074)	(.020)
Treated * year of founder death	-.150	-.787	-.785	-.106	-.066
	(.045)***	(.267)***	(.228)***	(.083)	(.022)***
Treated * (1,2) years after founder death	-.226	-1.135	-1.201	-.270	-.039
	(.043)***	(.260)***	(.226)***	(.082)***	(.015)***
Treated * (3,4,5) years after founder death	-.212	-.997	-1.211	-.201	-.060
	(.051)***	(.311)***	(.282)***	(.098)**	(.015)***
Obs.	3684	3684	3684	3681	3684
Adjusted R^2	.217	.244	.271	.323	.081

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. This table corresponds to Table 3, but excludes firm fixed effects. In Panel A, observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables in panel A and B: year effects, founder education and founder age and age squared, firm age, as well as base-line (year 0) characteristics of firm and founder which entered the matching (to remove residual heterogeneity); in panel A, the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. In Panel A and B, sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table A.4
Treated sample only: Effect of founder death on firm performance

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall effect of founder death on firm performance					
After	-.131	-.747	-.630	-.249	-.012
	(.040)***	(.214)***	(.183)***	(.062)***	(.027)
Obs.	1637	1637	1637	1637	1637
$R^2 within$	.377	.291	.325	.26	.031
Panel B: Effect of founder death on firm performance over time					
Treated * (1,2) years before founder death	.023	.106	.124	.062	.003
	(.030)	(.157)	(.128)	(.044)	(.019)
Treated * year of founder death	-.040	-.295	-.304	-.064	-.022
	(.048)	(.244)	(.210)	(.069)	(.034)
Treated * (1,2) years after founder death	-.106	-.617	-.540	-.181	-.004
	(.060)*	(.304)**	(.252)**	(.092)**	(.042)
Treated * (3,4,5) years after founder death	-.114	-.641	-.679	-.241	.001
	(.070)	(.364)*	(.299)**	(.116)**	(.055)
Obs.	1842	1842	1842	1842	1842
$R^2 within$	.353	.273	.302	.245	.024

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated firms. Fixed effects at the firm level. In Panel A, observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables in panel A and B: year effects, founder education and founder age and age squared, firm age and in panel A the variable "After", i.e. dummy=1 for time after year of founder death. In Panel A and B, sample restricted to +/− 5 years around the year of founder death in regressions. See main text for details.

Table A.5
Effect of founder death on firm performance: matching on characteristics in (t-1)

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Panel A: Overall effect of founder death on firm performance: matching on $(t-1)$ characteristics					
Treated	.006	.171	-.068	.070	.013
	(.018)	(.158)	(.131)	(.046)	(.025)
After * Treated	-.258	-1.435	-1.155	-.367	-.055
	(.060)***	(.355)***	(.295)***	(.105)***	(.031)*
Obs.	1701	1701	1701	1700	1701
Adjusted R^2	.309	.400	.410	.584	.089
Panel B: Heterogeneity of treatment effect: matching on $(t-1)$ characteristics					
Owner works at firm in $(t-1)$					
After * Treated	-.105	-.616	-.523	-.205	.010
	(.102)	(.592)	(.456)	(.203)	(.062)
After * Treated * (Owner works at firm in $(t-1)$)	-.234	-1.282	-.988	-.246	-.099
	(.125)*	(.731)*	(.578)*	(.237)	(.072)
Obs.	1701	1701	1701	1700	1701
Adjusted R^2	.32	.409	.419	.584	.096

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Matched sample obtained by matching on (t-1) characteristics. Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Sample restricted to $+/-$ 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table A.6
Heterogeneity of the effect of founder death by firm age

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Heterogeneity by firm age in (t-1): quintiles					
After * Treated * Lowest quintile of firm age (t-1)	-.386	-2.311	-2.077	-.511	-.088
	(.106)***	(.623)***	(.491)***	(.174)***	(.073)
After * Treated * Second quintile of firm age (t-1)	-.303	-1.599	-1.203	-.526	-.104
	(.110)***	(.703)**	(.488)**	(.171)***	(.063)*
After * Treated * Third quintile of firm age (t-1)	-.221	-.916	-1.645	-.227	.034
	(.106)**	(.610)	(.492)***	(.176)	(.054)
After * Treated * Fourth quintile of firm age (t-1)	-.289	-1.673	-1.576	-.474	.004
	(.118)**	(.621)***	(.513)***	(.172)***	(.061)
After * Treated * Fifth quintile of firm age (t-1)	-.122	-.325	-.511	.011	.018
	(.107)	(.607)	(.527)	(.209)	(.042)
Obs.	1662	1662	1662	1662	1662
Adjusted R^2	.270	.211	.198	.125	.046

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to -5 years before and $+2$ years after the (imputed) year of founder death in regressions. See main text for details.

Table A.7
Heterogeneity of the effect of founder death by firm size

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
Heterogeneity by firm size in (t-1): quintiles					
After * Treated * Lowest quintile of firm size (t-1)	-.464	-1.989	-2.667	-.225	-.028
	(.112)***	(.591)***	(.491)***	(.116)*	(.062)
After * Treated * Second quintile of firm size (t-1)	-.404	-1.638	-1.806	-.431	.032
	(.107)***	(.570)***	(.443)***	(.123)***	(.058)
After * Treated * Third quintile of firm size (t-1)	-.207	-1.428	-.924	-.402	-.080
	(.108)*	(.583)**	(.546)*	(.185)**	(.060)
After * Treated * Fourth quintile of firm size (t-1)	-.290	-1.973	-1.632	-.583	-.012
	(.103)***	(.657)***	(.490)***	(.227)**	(.043)
After * Treated * Fifth quintile of firm size (t-1)	.095	.867	.118	.100	-.042
	(.111)	(.791)	(.628)	(.289)	(.052)
Obs.	2256	2256	2256	2255	2256
Adjusted R^2	.333	.256	.237	.154	.059
Further splitting up the two quintile into two deciles					
After * Treated * Lowest quintile of firm size (t-1)	-.465	-1.990	-2.664	-.225	-.028
	(.112)***	(.591)***	(.491)***	(.116)*	(.062)
After * Treated * Second quintile of firm size (t-1)	-.405	-1.639	-1.823	-.432	.031
	(.107)***	(.571)***	(.441)***	(.123)***	(.058)
After * Treated * Third quintile of firm size (t-1)	-.207	-1.429	-.914	-.401	-.079
	(.108)*	(.583)**	(.546)*	(.185)**	(.060)
After * Treated * Fourth quintile of firm size (t-1)	-.291	-1.977	-1.633	-.583	-.012
	(.103)***	(.658)***	(.491)***	(.227)**	(.043)
After * Treated * Ninth decile of firm size (t-1)	-.0005	.479	-1.183	-.053	-.120
	(.157)	(1.020)	(.813)	(.352)	(.080)
After * Treated * Tenth decile of firm size (t-1)	.207	1.331	1.598	.277	.049
	(.146)	(1.196)	(.851)*	(.466)	(.058)
Obs.	2256	2256	2256	2255	2256
Adjusted R^2	.334	.257	.248	.154	.061

Standard errors in parentheses: * significance at ten, ** five, *** one percent.
Note: Yearly panel of treated and matched control firms. Fixed effects at the firm level. Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. Additional control variables: year effects, founder education and founder age and age squared, firm age and the variable "After", i.e. dummy=1 for time after (imputed) year of founder death. Sample restricted to +/− 5 years around the (imputed) year of founder death in regressions. See main text for details.

Table A.8
Descriptive statistics in year of foundation for sample of minority owners

	Firms where founder dies (346 obs)				Firms where founder does not die (14,350 obs)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Founder death	1.00	.00	1.00	1.00	.00	.00	.00	.00
Age	52.01	10.47	20.00	67.00	40.21	10.69	17.00	67.00
Female	.18	.38	.00	1.00	.20	.40	.00	1.00
Single	.14	.34	.00	1.00	.34	.47	.00	1.00
Years of education	11.76	2.70	7.00	20.00	12.28	2.49	5.00	21.00
Log wealth in year before firm foundation	13.78	1.33	9.35	18.90	13.13	1.42	9.21	20.06
Log earnings in year before firm foundation	12.81	.74	9.21	15.16	12.75	.75	9.21	17.70
Self-empl. experience over previous 10 years	.20	.33	.00	1.00	.12	.26	.00	1.00
Number of employees	5.36	12.82	1.00	221.00	4.58	10.72	1.00	756.00
Dummy: Urban area	.35	.48	.00	1.00	.41	.49	.00	1.00
Log equity at firm foundation	12.02	.89	10.89	16.13	11.98	.80	10.20	18.36
Ownership share at firm foundation	.26	.11	.02	.49	.26	.12	.00	.50
Year of firm foundation	2001.57	1.69	1999	2007	2002.44	2.17	1999	2007
Agriculture and Fishery	.05	.22	.00	1.00	.02	.15	.00	1.00
Mining	.01	.11	.00	1.00	.005	.07	.00	1.00
Manufacturing	.08	.26	.00	1.00	.08	.27	.00	1.00
Utilities	.003	.05	.00	1.00	.002	.04	.00	1.00
Construction	.14	.34	.00	1.00	.14	.35	.00	1.00
Commerce	.23	.42	.00	1.00	.26	.44	.00	1.00
Business Services	.25	.43	.00	1.00	.26	.44	.00	1.00
Other Services	.16	.37	.00	1.00	.16	.37	.00	1.00
Transport, storage and communication	.07	.26	.00	1.00	.05	.21	.00	1.00

Note: The table depicts summary statistics in the first year of operations for the sample of minority owning-founders and the firms they start up, broken down by whether the founder dies (d=1) or not (d=0).

Table A.9
Descriptive statistics in year of foundation for sample of 50% owners

	Firms where founder dies (130 obs)				Firms where founder does not die (7,162 obs)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Founder death	1.00	.00	1.00	1.00	.00	.00	.00	.00
Age	49.67	12.16	23.00	67.00	40.14	9.85	18.00	67.00
Female	.19	.40	.00	1.00	.27	.44	.00	1.00
Single	.19	.40	.00	1.00	.30	.46	.00	1.00
Years of education	11.43	2.42	7.00	20.00	11.98	2.35	5.00	21.00
Log wealth in year before firm foundation	13.45	1.21	10.41	17.47	13.02	1.23	9.21	19.41
Log earnings in year before firm foundation	12.72	.63	9.39	14.19	12.68	.63	9.21	17.85
Self-empl. experience over previous 10 years	.31	.40	.00	1.00	.18	.32	.00	1.00
Number of employees	3.73	5.53	1.00	44.00	3.62	6.51	1.00	285.00
Dummy: Urban area	.33	.47	.00	1.00	.36	.48	.00	1.00
Log equity at firm foundation	11.72	.52	10.89	14.20	11.71	.50	10.20	17.10
Ownership share at firm foundation	.50	.00	.50	.50	.50	.00	.50	.50
Year of firm foundation	2002.18	2.09	1999	2007	2002.96	2.22	1999	2007
Agriculture and Fishery	.03	.17	.00	1.00	.02	.15	.00	1.00
Mining	.008	.09	.00	1.00	.002	.04	.00	1.00
Manufacturing	.09	.29	.00	1.00	.06	.23	.00	1.00
Utilities	.00	.00	.00	.00	.0006	.02	.00	1.00
Construction	.14	.35	.00	1.00	.17	.37	.00	1.00
Commerce	.31	.46	.00	1.00	.32	.47	.00	1.00
Business Services	.18	.39	.00	1.00	.17	.38	.00	1.00
Other Services	.16	.37	.00	1.00	.21	.40	.00	1.00
Transport, storage and communication	.07	.25	.00	1.00	.05	.21	.00	1.00

Note: The table depicts summary statistics in the first year of operations for the sample of 50% owning-founders and the firms they start up, broken down by whether the founder dies (d=1) or not (d=0).

Table A.10
Descriptive statistics for CEO analysis

	Mean	StdDev	Min	Max	Nr. of obs.
	(1)	(2)	(3)	(4)	(5)
Panel A: Death of CEO					
CEO death	.50	.50	.00	1.00	256
Age	49.30	11.73	19.00	74.00	256
Years of education	11.78	3.56	.00	21.00	256
Female	.17	.38	.00	1.00	256
Married	.61	.49	.00	1.00	256
Log equity at firm foundation	11.83	.67	10.75	15.16	256
Employees at firm foundation	3.82	3.99	1.00	31.00	256
Year of firm foundation	2002.22	1.90	1999	2006	256
Firm age	2.95	2.10	.00	8.00	256
Professional CEO	.45	.50	.00	1.00	256
Majority-founder CEO	.44	.50	.00	1.00	256
50%-founder CEO	.12	.32	.00	1.00	256
Panel B: Death of close family member of CEO					
Death of family member of CEO	.50	.50	.00	1.00	634
Age	48.31	10.01	19.00	75.00	634
Years of education	11.57	3.54	.00	19.00	634
Female	.24	.43	.00	1.00	634
Married	.77	.42	.00	1.00	634
Log equity at firm foundation	11.76	.66	10.75	15.85	634
Employees at firm foundation	3.82	4.21	1.00	33.00	634
Year of firm foundation	2001.85	1.97	1999	2007	634
Firm age	2.66	2.10	.00	8.00	634
Professional CEO	.38	.49	.00	1.00	634
Majority-founder CEO	.46	.50	.00	1.00	634
50%-founder CEO	.16	.37	.00	1.00	634

Note: The table depicts summary statistics of CEOs and the firms they work in, in the year before the (imputed) death event of the CEO (panel A) or of a close family member of the CEO (panel B). Firm employment and log(equity) are measured in year of firm foundation.

Table A.11
Effect of CEO death on firm performance

	Firm active	log(sales+10)	log(assets+10)	log(employees+1)	Return on assets
	(1)	(2)	(3)	(4)	(5)
After * Professional CEO	-.154	-.698	-.729	-.249	-.043
	(.083)*	(.496)	(.391)*	(.163)	(.050)
After * Majority-founder CEO	-.302	-1.764	-1.263	-.360	-.082
	(.083)***	(.486)***	(.424)***	(.156)**	(.039)**
After * 50%-founder CEO	-.155	-1.274	-1.128	-.446	.042
	(.179)	(.899)	(.751)	(.204)**	(.092)
Obs.	2112	2110	2112	2111	2112
Adjusted R2	.559	.643	.673	.673	.200

Note: Yearly panel of treated and matched control firms. Observations from year of founder death excluded from analysis because not clearly attributable to 'before' or 'after' the event. "After", i.e. dummy=1 for time after (imputed) year of founder death. Additional control variables: dummy variables for three CEO types, dummy variables for three CEO types interacted "After", log equity and its square in year of firm foundation, number of employees and its square in year of firm foundation and dummies for calendar year, firm age, calendar year interacted with one-digit sector. Sample restricted to +/− 5 years around the (imputed) year of CEO death. See main text for details.