Firm Age and Survival

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Firms typically do not make it to old age. We want to know whether the deterioration in performance they experience eventually drives older firms into financial failure. We find that not to be the case. Conditionally and unconditionally, the failure hazard declines as firms grow older. The competing hazard of takeover initially declines as well, yet it increases with age eventually. On average, and consistent with Schumpeter's gale of creative destruction, older firms are therefore more likely to be absorbed and recycled in other organizations. There is little evidence of survival of the fittest at old age, however, since poor performance and inefficient cost structures actually reduce the takeover hazard of old firms. New assets do not seem to help either. It looks as if old clunkers have trouble finding merger partners. We also provide novel evidence of how industry characteristics affect both hazards of financial failure and takeover.

Keywords: firm age, industry age, takeovers, financial distress, creative destruction

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"It is not the strongest of the species that survives,
nor the most intelligent, but the most responsive to change."

Charles Darwin

In January 2006, after more than 1,400 years of continuous existence, the Japanese temple builder *Kongo Gumi* had to file for bankruptcy. According to media reports, this event closed the final chapter in the history of the world's oldest firm. What makes this news so surprising is not so much the company's disappearance but rather that it lived so long. In general, firms don't make it to old age to begin with. According to Baker and Kennedy (2002), for example, the 10-year survival rate of firms trading on the New York and American stock exchanges is only 61 percent. The purpose of this study is to better understand what happens to older firms and to firms in older industries. To find an answer, it helps to know that performance falls as companies age and that a similar fate happens to firms in older industries (Loderer and Waelchli, 2010). Here we want to know whether such firms are more likely to succumb to Schumpeter's perennial gale of creative destruction. We focus on financial distress. Since takeover could be a competing restructuring mechanism (Stiglitz, 1972; Shrievens and Stevens, 1979; Pastena and Ruland, 1986), we also inquire whether takeover at old age or in older industries goes up with time.

Our investigation seems relevant for theory and practice. At a fundamental level, it is important to know what happens to firms and their resources as they and the industries in which they operate get older. Ultimately, this study should contribute to a better understanding about the dynamics and the characteristics of economic growth. A vast literature in industrial organization, organization theory, and management argues the existence of a corporate aging phenomenon. Since firms perform more poorly as they get older (Loderer and Waelchli, 2010), and since poor performance raises the odds of financial distress (see Shumway, 2001; Chava and Jarrow, 2004; Campbell, Hilscher, and Szilagyi, 2008, and the literature cited therein), we ask whether old firms go more easily bankrupt. As an alternative, we examine whether older firms are more likely to be taken over and recycled in a different organization. We also want to know how the age of an industry affects the exit hazard of its member firms.

As discussed in more detail in the next section, various strands of the literature have looked at the relation between age and firm survival. Most studies, however, define exit as the decision to leave a certain product market or close down a plant. Organization theory, for example, has focused on organizational aging and its relation to survival in a given product market (see, among many others, Stinchcombe, 1965; Le Mens, Hannan, and Pólos, 2010). In the industrial organization literature, various papers have actually documented a positive correlation between plant survival in a given industry and age (see, for example, Dunne, Roberts and Samuelson, 1989). The management literature has also studied how companies age and has suggested that, as firms get older, they become entangled in structural and process-related rigidities, which makes them increasingly unable to adapt to changes in their environment (Leonard-Barton, 1992; see also Sorensen and Stuart, 2000). Finally, in the empirical finance literature, Shumway (2001) has investigated the drivers of the probability of bankruptcy and has concluded that firm age is not one of them.

Using a sample of all listed firms with data on CRSP, COMPUSTAT, and COMPUSTAT Industry Segment between 1978 and 2004, we study financial failure (distress) in older firms and treat it as a hazard that competes with takeover. In contrast with Shumway (2001) and counter to common intuition and the predictions from the literature, we uncover evidence that the hazard of financial failure actually declines slightly as firms get older. The same result applies for firms that operate in older industries.

With respect to takeover hazard, we find a U-shaped relation with firm age, regardless of whether age is measured since the time of incorporation or that of listing: it declines in early years and then rebounds in later years. According to our numbers, takeover hazard drops by 0.3 percentage points for each additional year of age between listing age 5 and 10 years. Between listing age 20 and 30, the hazard goes back up by an annual 0.3 percentage points. Given an unconditional takeover probability of 6 percent, this effect is also economically significant. The initial decline in the U-shaped pattern of takeover hazard and company age cannot be explained by traditional learning effects about what one is particularly good at (Jovanovic, 1982) or about how to do things better, since listed firms have been incorporated for more than 32 years, on average. One possible interpretation of this decline has to do with the reservation prices that managers have for their firms. It could be that, in the early years after the IPO, managers become overconfident, in which case their reservation prices might exceed what bidders are willing to pay. In later years, the takeover hazard goes back up, possibly because older firms have an increasing collective action problem and become progressively unable to find ways to maintain independence and survive as separate organizations.

The evidence is broadly consistent with survival of the fittest and the notion that the market for corporate control reallocates resources trapped in outdated structures (Jensen, 2000). We confirm that more successful firms per se are more likely to survive both hazards of financial distress and takeover: the fittest survive. Moreover, hazard rates are higher for firms with large cash holdings, consistent with Jensen's (1986) agency argument. The picture changes, however, when we distinguish between young and old firms. Among old firms, poor performance actually reduces the threat of takeover, and so do large cash holdings. Here, the fattest and inefficient seem to survive, whereas the fittest are taken over. These results are difficult to square with the notion that takeover is a competing crisis-resolution mechanism for distressed old firms. It could be that poorly performing old firms have particularly rigid organizational structures (Loderer and Waelchli, 2010), which could deter takeover, possibly because of higher integration costs. Consistent with this claim, we find that old firms with inefficient cost structures and assets which are difficult to redeploy appear to be particularly unattractive takeover targets. The evidence also shows that listed firms fail and restructure less often during economic downturns. Schumpeter's gale of creative destruction appears to subside when things don't go well.

Not many firms actually live long enough to experience an accentuation in takeover hazard. Many disappear into other organizations before that happens. This is like what we see in nature. Few living organisms actually die of old age; many die of various causes before they reach old age. We find many reasons why firms get taken over, including poor performance and the aging of their management. Firms are therefore constantly reprocessed in other firms, and old age eventually accelerates that phenomenon. These conclusions apply whether we measure age from the time of listing or the time of incorporation. Moreover, they are robust to different specifications and different estimation techniques, including one that controls for unobserved heterogeneity.

There are explanations other than aging for the increase in takeover hazard we find, but none is convincing. For example, firm age could be a proxy for industry or management age, but the evidence rejects that possibility. Similarly, Bebchuk, Coates, and Subramaniam (2007) mention that older CEOs might be more inclined to put their firms up for sale. Our numbers, however, are inconsistent with that possibility as well. One could also argue that the increased takeover hazard over time is induced by an intertemporal decline in inside ownership and the fact that inside ownership reduces the likelihood of takeover (Jensen and Warner, 1988; Stulz, Walkling, and Song, 1990). Yet the evidence we uncover reject this hypothesis. Yet another possibility is that perhaps firms differ "genetically" from one another, accounting for why some live longer than others (Thompson, 2005). If so, age would have no causal effect on survival. Yet that hypothesis claims something about the *unconditional* probability of survival and nothing about the conditional probability. Our evidence refers to the latter.

We also examine the industry effects of exit hazard (e.g., Mitchell and Mulherin, 1996; Chawa and Jarrow, 2004). In contrast to the theoretical predictions in Berkovitch and Israel (1998), we document that firms in increasingly mature industries per se actually fail less often and are less likely to become takeover targets. It's the old firms in old industries that are taken over. Our evidence also supports Gort's (1969) economic disturbance theory of mergers, but we find no bankruptcy contagion (Lang and Stulz, 1992). Finally, we find that industry concentration reduces exit hazard, which is in line with Andrade and Stafford (2004).

All things considered, the paper makes the following three contributions to the literature. First, it finds that older firms are not more likely to run into financial distress in spite of the fact that they lag increasingly behind the competition. If anything, that hazard declines slightly, especially in industries characterized by more active competition. This is contrary to what theory and available evidence would predict.

Second, it documents that older firms eventually face a higher takeover hazard, consistent with Jensen (2000). This occurs particularly in high-tech industries and in less competitive environments. Interestingly, however, older firms with comparatively poorer performance and inefficient cost structures are less likely to be absorbed in new organizations. The same goes for older firms that have invested in new (possibly outdated) assets, older firms whose assets consist relatively more of intangible opportunities, and older firms in older industries. Old clunkers do not seem to be the merger partners of choice. Older firms with more liquidity are also comparatively less attractive merger partners, possibly because of the agency costs of free cash flows (Jensen, 1986).

Third, it shows that both failure and takeover hazards are lower in older industries. Perhaps the managers of firms in these industries have fewer attractive employment opportunities and therefore more resolute in resisting financial failure. Moreover, firms in older industries might have a harder time finding merger partners because they compete with more targets in a similar situation.

The remainder of the paper is organized as follows. Section 1 presents a short review of the literature. Section 2 offers the necessary theoretical considerations to structure the empirical analysis. Section 3 discusses the data. Section 4 examines the relation between company as well as industry age and exit hazard. Section 5 presents conclusions.

1. Review of the Literature

Various papers in the industrial organization literature have documented a negative correlation between exit hazard and age (see, for example, Dunne, Roberts and Samuelson, 1989; Caves, 1998, as well as the literature mentioned therein). Agarwal and Gort (1996, 1999, 2002), actually find evidence of a U-shaped relation. Initially, hazard rates decline, possibly because of learning (see also, for example, Audretsch, 1995). Later, however, hazard rates pick up, a phenomenon which Agarwal and Gort ascribe to an increasing obsolescence of the firms' endowments. Exit is the decision to leave a particular industry or a particular product market and does not necessarily imply that the firm ceases to exist as an independent organization (there are different products in a given industry; in the music industry, for example, there are tapes, cassettes, phonograph records, CDs, etc.).

The organization theory literature has also looked into the relation between age and firm survival. Stinchcombe (1965) argues that young firms are vulnerable to exit hazard because they lack stable internal organizational structures and a track record with stakeholders. Moreover, they often fail because the entrepreneurs do not possess the necessary management skills (Tornhill and Amit, 2003). As firms grow older, they develop closer ties with their stakeholders, which protects them against exit risk. Therefore, the argument goes, the hazard of mortality initially falls with age (see Singh and Lumsden, 1990, and the literature cited therein, as well as Hannan, Pólos, and Carroll, 2007). At older age, however, mortality rates eventually go up, as the firms' endowments depreciate and are not replenished (Brüderl and Schüssler, 1990) and because accumulated rules, routines, and structures limit an organization's ability to react to changing environmental conditions (Carroll, 1983; Barron, West, and Hannan, 1994; Hannan, 1998; Thornhill and Amit, 2003; Le Mens, Hannan, and Pólos, 2010). This organization inertia is also apparent in the firms' innovative activities. As they grow older, firms tend to exploit existing competencies rather than explore new technologies (Sorensen and Stuart, 2000). Taken together, the organization theory literature predicts a U-shaped relation between age and exit hazard. Empirical analyses have been numerous and contradictory (Hannan, Carroll, Dobrev, and Han, 1998; Le Mens, Hannan, and Pólos, 2010). Exit in these papers is not necessarily the end of the organization's life but rather simply the decision to leave the industry (exits because of merger or acquisition are mostly ignored).

As far as we know, the empirical finance literature has not investigated the relation between exit hazard and company age directly. Many bankruptcy studies, for example, have not even controlled for company age (see, for example, Altman, 1968; Ohlson, 1980; and Zmijewski, 1984).[1] The exception is Shumway (2001), who examines the possibility that firm age might be an important explanatory variable to forecast bankruptcy without finding any evidence. Subsequent bankruptcy studies, such as Chava and Jarrow (2004), Duffie, Saita, and Wang (2007), Bharath and Shumway (2008), and Campbell, Hilscher, and Szilagyi (2008), have therefore ignored age. Of course, takeover may serve as a substitute crisis-resolution mechanism for bankruptcy (Stiglitz, 1972; Shrievens and Stevens, 1979; Pastena and Ruland, 1986). Yet, to our knowledge, no merger study has addressed the explicit question of how takeover probability depends on company age. Still, several takeover hypotheses suggest possible indirect ties between the two. Manne (1965), for example, argues that firms with inefficient management attract takeover; Shleifer and Vishny (1988) make a similar argument. Since ROA and Tobin's q ratios drop as firms grow older (Loderer and Waelchli, 2010), takeover hazard could increase with firm age. Since older firms tend to be larger, and since firm size is negatively related to takeover hazard (Palepu, 1986), age could also correlate negatively with takeover hazard. An indirect relation could also be driven by uncertainty (Pastor and Veronesi, 2006) or the agency costs of excess cash holdings (Jensen, 1986). There is also industry-specific evidence of survival of the fattest rather than the fittest (Zingales, 1998).

[1] Altman (1968) indirectly controls for firm age by including the firms' retained earnings as a driver of bankruptcy risk. He argues that young firms will probably show relatively low retained earnings, because it takes time to build up cumulative profits.

2. Theoretical Considerations

The preceding studies help us structure our empirical investigation. As we mentioned, various papers report a positive relation between survival in a given industry or a given product market and company age. According to many, however, survival could become more difficult at older age. We therefore inquire into the existence of a U-shaped relation between exit hazards and age.

As mentioned, financial distress and takeover hazard could be competing, if nothing else because a firm that has been taken over cannot later go bankrupt. In keeping with a growing strand of the literature, our investigation will therefore rely on a competing hazard approach.[2] Powell and Yawson (2007) show that ignoring competing risks can lead to estimation bias.

We borrow the specification of our model for financial failure hazard from Campbell, Hilscher, and Szilagyi (2008). A firm's financial failure hazard should be negatively related with its profitability, growth, stock market performance, size, liquidity, and stock price. It should increase, however, when firms are highly levered, when their investment opportunity set includes more growth options, and when they operate in volatile environments. Specialized firms should also show higher failure rates (Agarwal and Gort, 1996, 1999, 2002). We examine whether the same happens in more competitive environments and in older industries (on the assumption that they are more likely to have mature products). Explanatory variables and expected signs of the coefficients are as follows:

[2] In that literature, Bhattacharjee, Higson, Holly, and Kattuman (2009) look at age in the context of foreign data, and Wheelock and Wilson (2000) do so in the banking industry.

Explanatory Variables	Expected Signs	
	Failure Hazard	Takeover Hazard
Age	–	–
Age^2	+	+
Control variables for failure and takeover hazard		
Profitability	–	–
Sales growth	–	?
Stock performance	–	–
Market-to-book	–	?
Size	–	–
Leverage	+	–
Liquidity	–	+
Focus	+	?
GDP growth	?	+
Volatility	+	?
Stock price	–	?
Industry concentration	–	–
Industry age	?	?
Industry age^2	+	+
Additional control variables for takeover hazard		
Free cash flow		+
Tangibility		+
Antitakeover provisions		?
Active-industry dummy		+

Since the two hazards are competing, the control variables in our takeover hazard model are the same as those in the failure hazard model. Consistent with this decision, the takeover prediction literature argues, for example, that firms with inefficient management (Manne, 1965), low valuation (Shleifer and Vishny, 1988), small size (Baker and Kennedy, 2002), in older industries (Jensen, 2000), or with an imbalance between growth and available resources (e.g., Palepu, 1986) appear to attract takeover. The same goes for specialized firms Agarwal and Gort (1996, 1999, 2002). Takeover activity also seems to change over time and vary across industries (see, for example, Gort, 1969; Mitchell and Mulherin, 1996). The takeover prediction literature has suggested additional control variables we want to include, namely free cash flows (Jensen, 1986), asset tangibility (Stulz and Johnson, 1985), antitakeover legislation (Comment and Schwert, 1995), and the existence of corporate event waves (Gort, 1969; Palepu, 1986; Colak and Tekatli, 2010). Interestingly, according to Comment and Schwert (1995), firm size is the only variable that is consistently successful across takeover prediction models.

3. Data

3.1. Sample Description

The sample consists of all listed firms with data on CRSP, COMPUSTAT, and COMPUSTAT Industry Segment between 1978 and 2004. Following Berger and Ofek (1995), among others, we exclude firm-years with total sales of less than USD 20 million, firm-years with missing values for total assets, and firm-years for which the sum of segment sales deviates from total sales by more than 1 percent. Like other studies, ours excludes firms with business segments in the financial sector (SIC 6000–6999). The final sample consists of 9,261 firms and 76,201 firm-years.

Table 1 reports the number of firms that enter and leave the sample during the 27 years under investigation. We start with 2,154 firms in 1978 and end with 2,671 firms in 2004. Turnover is remarkably high: 7,845 firms enter and 7,542 firms leave between 1978 and 2004.[3] That corresponds to an annual rate of entry and exit of 10.3 percent and 9.9 percent, respectively. Hence, 'churn' is substantially higher than in the sample of Baker and Kennedy (2002). This is

[3] Note, for example, that the sum of firms at the beginning (2,154) plus total new entrants (7,845) minus total exits (7,524), namely 2,475, does not correspond to the number of firms remaining at the end of the period (2,671). The difference is due to the few firms that drop out of the sample because they do not meet our sample selection requirements.

mostly due to the fact that our sample includes the takeover waves of the late 1990s. The results of our investigation remain the same if we exclude the years 1996-2000.

The table also shows why firms leave the sample. To distinguish, we use the delisting codes reported in CRSP. In keeping with Rauh (2006), among others, we identify takeovers with the delisting codes 200–290. We are unable to tell friendly from hostile deals. Andrade, Mitchell, and Stafford (2001), however, show that, even in the 1980s, the era of hostile takeovers, the overwhelming majority of all deals are friendly (see also Servaes, 1991). Moreover, Schwert (2000) finds that "hostility" is mainly motivated by strategic bargaining to extract higher rents, and that hostile and friendly deals are mostly indistinguishable in economic terms. One should keep that in mind when interpreting the results. Takeover hazard does not mean the risk of having to surrender to a hostile party but simply the risk of restructuring, in a broad sense, via merger or acquisition.

As for financial failure, we follow Campbell, Hilscher, and Szilagyi's (2008) broader failure definition and define it as liquidation (400–490), bankruptcy (574), or delisting for financial reasons. The latter apply when firms are unable to maintain an acceptable share-price level (552) or capitalization amount (560 and 584), or when they fail to file financial statements or pay exchange fees (580). Forms of exit other than takeover and failure are comparatively less frequent and include exchanges for other securities, switches to other stock exchanges, going-private transactions, or delistings because of an insufficient number of shareholders or market makers. The fate of these firms is not apparent from CRSP's delisting codes. Still, we take into account these firms in our competing hazard estimation approach.

Over the whole sample period, takeovers account for roughly 60 percent of all exits, 24 percent are failures, and 16 percent are other exits. Put differently, of all firms present at some time in the sample during 1978–2004, 49 percent were taken over, 19 percent failed, and 13 percent exited for other reasons. Takeovers are therefore the overwhelming exit hazard, consistent with Baker and Kennedy (2002). Some of the firms that drop from the exchange in going-private transactions may list again years later. When they do, we treat them as separate firms, which could bias the results, since we end up classifying older firms among the very young ones. According to Fama and French (2004), however, only 145 firms go public between 1973 and 2001 after having gone private. More important, the same results obtain when age is measured from the date of incorporation. Older firms are not resurrected as young firms when they relist; they maintain their incorporation age. Hence relistings cannot explain our results.

3.2. Variable Definitions

As mentioned, we measure firm age alternatively as the number of years (plus one) elapsed since the company's IPO year (*listing age*) and the number of years (plus one) elapsed since the year of incorporation (*incorporation age*). Listing age is computed with CRSP data and is available for the full sample of firms. Since CRSP goes back to 1925, the oldest a firm can be at the beginning of our sample period in 1978 is 54 years, compared with 80 years at the end of it, in 2004. Information about the firm's incorporation age is hand-collected from *Mergent Webreports* for a random subsample of 5,000 firms. Table 2 shows average listing and incorporation ages of 14 years and 32 years, respectively (the median values are 10 and 23). Interestingly, incorporation age at the time of listing varies substantially over time (see also

Jovanovic and Rousseau, 2001; Fink, Fink, Grullon, and Weston, 2010). In our sample, the average incorporation age at listing drops from 26.6 years in 1978 to 11.2 in 2004. The minimum is 7.04, at the peak of the dot-com wave in 1999. Jovanovic and Rousseau (2001) argue that, in the IT-era, “firms came in younger because the technologies that they brought in were too productive to be kept out very long.”

To reduce the influence of outliers, we winsorize all control variables at the 1th and 99th percentile of their pooled distribution. All variables are measured at year end. Moreover, throughout the analysis, all regression arguments are lagged by one year, since exit cannot occur simultaneously with its determining factors. Descriptive statistics are in Table 2 and variable definitions are in Table 4.

Table 3 computes correlation coefficients between pairs of variables. With a coefficient of 0.668, listing and incorporation age are correlated but not collinear. Moreover, older firms tend to be larger, more diversified, and in older industries, and they have a propensity for lower stock return volatility (see also Pastor and Veronesi, 2006). To examine the impact of aging on exit hazards, it is therefore important to control for the possible effect of the variables that company age correlates with. We also find that the various performance-related variables (ROA, Tobin’s q, stock return, free cash flow, and sales growth) are positively correlated with coefficients of between 0.1and 0.3.

4. Company Age and Survival

4.1. Proportional Hazard Model

Let's begin with an investigation of the delisting hazard without distinguishing among the possible reasons. Since we know only whether or not exit occurs in a given year, we are faced with *grouped duration* data. To account for this feature of the data, we use a discrete time representation of the continuous proportional hazard model known as a complementary log-log model (cloglog model; Jenkins, 2005).

Table 5 reports the coefficients of such a cloglog, single destination model for the full sample. As we just said, exit is the delisting of a given firm, for whatever reason, and age is the time since listing. We first leave out all performance-related variables to see whether company age is a proxy for performance, as suggested by the results in Loderer and Waelchli (2010). The results in column (1) show a negative dependence between hazard and age, but a positive one with respect to Age^2. Exit hazard first declines and then intensifies. When we add the performance-related variables in column (2), the results do not change. Age maintains its U-shaped relation with exit hazard with almost identical coefficients. Hence, there is an age relation and a separate performance relation. The coefficients of the control variables are mostly in line with what one would expect. Note that the performance-related variables measure different dimensions simultaneously: *ROA*, *Free Cash Flow*, and *Sales Growth* refer to current profitability; *Tobin's q* captures growth opportunities; and *Stock Return* is a metric that includes changes in expected future value creation. We will take a closer look at the coefficients of the control variables in the context of the competing-risk model.

4.2. Unobserved Heterogeneity

To scrutinize our initial findings, we control for unobserved heterogeneity, a problem we might face because of omitted variables and/or measurement error. To this end, we implement the nonparametric discrete-mixture model of Heckman and Singer (1984). As in the case of the cloglog model, we first estimate the regression while excluding the performance-related variables (not shown). Consistent with what we have found under the proportional hazard model, exit hazard first decreases during the initial years after listing and then it increases as firms age. Statistically, both the linear and the nonlinear age effects are different from zero with a high degree of statistical confidence. This pattern remains quantitatively almost identical when controlling for performance (not shown). Since controlling for unobserved heterogeneity yields almost identical age coefficients as the cloglog model, it seems that the regression model is appropriately specified.

4.3. Competing-Risk Model

Our interest, however, lies in the examination of financial distress while taking into account the possibility of merger and takeover. To do so, we estimate a *competing risk model* as outlined in Jenkins (2005). We run a pooled multinomial logistic model with the dependent variable equal to zero if the firm survives (the base outcome), one if the firm is taken over, two if the firm fails, and three if the firm leaves the exchange for other reasons ("other forms of exit"). The last category is included for econometric reasons and is not reported separately in any of the following tables. Competing risks means that we might not be able to observe financial failure because the firm in question has already been delisted because of merger. The assumption of independent risks implies that the risk of financial distress *conditional* on the effect of the covariates in the model is independent of the risk of takeover. The regression specification is the same as that in Table 5. Standard errors are corrected for heteroskedasticity and firm clustering.

4.3.1. Model Estimates

Table 6 presents the results. To control for industry effects, all company-specific control variables that could differ across industries are standardized by deducting the 3-digit SIC industry average and dividing by the industry standard deviation (the 3-digit SIC industry definition is the one recommended by Giroud and Mueller, 2010). Whereas columns (1) to (4) focus on listing age, columns (5) to (6) are dedicated to incorporation age. As in Table 5, columns (1) and (2) begin by leaving out all performance-related variables. In that case, there is essentially no relation between company age and either failure or takeover hazard. However, when we include the performance-related variables, the coefficients of age become statistically significant in the case of takeover (column (4)). Takeover hazard has the hypothesized U-shaped and highly significant relation with age. In contrast, failure hazard is still unrelated with company age.

The question is whether age should be measured from the incorporation or the IPO date. Shumway (2001), for example, claims that the economically most meaningful measure of firm age is the number of years since listing. The vast majority of studies that look at firm age, including Pastor and Veronesi (2003), Fama and French (2004), and Chun, Kim, Morck, and Yeung (2008), measure age in the same way. Still, one could argue that the aging problem, in the form of organizational inflexibilities and collective action problems (Loderer and Waelchli, 2010), go back all the way to the date of incorporation.

For a random sample of firms we therefore replicate the analysis with the incorporation date. Doing so changes the results in the case of failure hazard. Its relation to age is now U-shaped and highly significant as well (column 5). This result is in contradiction with Shumway (2001), who finds no relation between bankruptcy risk and company age when focusing on listing age. Nothing changes in the case of takeover hazard (column 6).

The convex relation between age and exit hazard is reminiscent of what we observe in living organisms. According to the life tables published by the U.S. Social Security Administration (2005 period life table), for example, the conditional probability of dying within one year initially declines until an age of about 10. Thereafter, it increases more or less constantly. Firms seem to follow a similar pattern.

In the remainder of the analysis, we perform our estimations with both listing and incorporation age. Because of the larger sample size, we discuss takeover hazard in the context of listing age. The economic justification is that going public raises the takeover threat level. In contrast, given what we just found, we examine failure hazard within the framework of incorporation age. The logic is that financial failure threatens firms from the day they start.

4.3.2. The Form of the Relation Between Company Age and Exit Hazard

The fact that few firms survive over time poses a potential estimation problem. There may not be enough observations at the far end of the age spectrum for a reliable measurement of the coefficient of the squared age term.[4] We also don't know whether a positive coefficient simply measures a bottoming-out of the hazard at higher age or whether older companies actually face a higher exit hazard. To find out more about the actual shape of the relation between age and exit hazard, we therefore estimate kernel-weighted local polynomial regressions. This nonparametric approach allows for an unspecified nonlinear relation between the two dimensions of interest. Figures (1a) and (1b) perform the analysis. The dependent variables in the regressions are the residuals from logistic regressions of the two exit hazards (failure and takeover) on the control variables from Table 6, except for *Age* and Age^2. The smoothed values (solid lines) are then obtained from local polynomial regressions of these residuals on firm age, using an Epanechnikov kernel function with a "rule-of-thumb" bandwidth estimator and local-mean smoothing. The dashed lines plot the 90-percent confidence band. To limit the impact of few observations at higher ages, we truncate the sample at listing age 35 (incorporation age 80), consistent with Agarwal and Gort (2002).

Failure hazard in Figure (1a) seems to decline more or less monotonically over time. There appears to be a slight temporary rebound at around incorporation age 30, but it would be difficult to reject the claim that this is simply part of a bottoming out of the failure hazard. As one can see by quick inspection, the average failure hazard at age 30 is not significantly lower than the subsequent apparent peak at age 50. In comparison, takeover hazard follows the U-shaped pattern noticed before. It reaches the bottom at around listing age 20 and subsequently increases until around age 28. Later still, the hazard seems to decline somewhat and then to go back up. Given the paucity of hazard events at the far end of the age distribution (only

[4] Listing age is truncated from above by construction. As we said, maximum age at the start of the sample period is 54; at the end, it is 80.

approximately 25 percent of all firms make it to age 20 in the first place), we choose a conservative interpretation of the results, namely, that takeover hazard has a U-shape.

The negative relation between failure hazard and company age is consistent with the hypothesis that firms learn how to avoid bankruptcy as they get older. The same goes for the initial decline in the U-shaped relation between takeover hazard and company age. Time might allow newly listed firms to find out how to cope with their new role as public companies and avoid restructuring (merger). The comparatively high initial takeover rates could also reflect the strategy of private firms to obtain a market valuation before selling out to acquirers (Arzac, 2004). Another possible interpretation of that decline is related to the reservation prices that managers have for their firms. Perhaps managers become increasingly overconfident after listing, which could lead to reservation prices that exceed what bidders are willing to pay. In contrast, the eventual rebound in takeover hazard that age brings about could be induced by increased collective action problems (Loderer and Waelchli, 2010), which make it difficult for older firms to rally managers to fight for independence. It could also be that the agency costs associated with organizational rigidities and rent-seeking behavior attract takeover.

4.3.3. The Economic Importance of Aging

The results suggest the existence of a monotonically declining relation with age in the case of financial distress, and a U-shaped relation in the case of takeover hazard.

Table 7 investigates the economic significance of these processes. The table estimates marginal effects from pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering similar to those in Table 6. To reduce the constraints on the relation between age and exit hazard and reflect what we learned from the kernel regressions, we use a piecewise linear specification for the age effect. In the case of failure hazard (Panel A), we allow for turning points in the relation at incorporation ages (Age_{inc}) 20 and 40, respectively. In contrast, in the case of takeover hazard (Panel B), the turning points are at listing ages (Age) 5, 10, 20, and 30, respectively (there is an insufficient number of failure events to do the same for failure hazard). Column (2) shows the marginal effect of Age_{inc} (Panel A) and *Age* (Panel B) on this exit probability if age increases by one year and the remaining covariates assume their overall average value in the sample. We can gauge the economic importance of aging with these effects. Column (3) shows standard errors.

To put the numbers in Panel A into perspective, we should bear in mind that the sample-wide unconditional annual probability of financial distress is fairly low to begin with, namely 2.4 percent (there are 1,797 failure events and 76,201 firm-years). Column (3) shows that the impact of age on the probability of financial distress is generally marginal, especially at old age. Based on these results, aging has a negative but economically negligible effect on failure hazard. Conversely, there is no evidence that older firms are more likely to fail.

Takeover hazard seems to be a different story. Remember that the sample-wide unconditional annual takeover probability from Table 1 is 6.0 percent (there are 4,540 takeover events and 76,201 firm-years). According to Panel B, the marginal impact of age on takeover hazard during the first five years after the IPO is insignificantly different from zero. For firms in the next age cohort from 5 to 11 years of age, the effect is negative and significant (0.3 percent a year). This decline amounts to 5 percent (=0.3/6.0) of the unconditional probability every year. There is no annual change in takeover probability in the following cohort of age 10 to 21, but a significant annual increase of close to 0.3 percent in the age cohort from 20 to 31. That increase is again 5 percent of the unconditional probability every year. Based on these numbers, it would seem that age has a sizable impact on takeover hazard.

4.3.4. Predicted vs. Actual Hazards

Figure 2 provides a graphical representation of our estimation technique's ability to track reality. We compute exit hazards from pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering similar to those in Table 7 and plot the implied hazards. The solid line in Figure 2(a) shows the average of the predicted failure hazards for different firm ages when the remaining covariates assume their actual values in the sample. The dashed line draws the 3-year moving average of the sample failure frequency as a function of incorporation age. The two are numerically fairly close, except in later years when the model predicts higher failure rates. Panel B looks at takeover hazard. The solid line in Figure 2(c) outlines the predicted takeover hazards. The dashed line illustrates the 3-year moving average of the sample frequency of takeover hazard. Compared to the observed frequencies, our model performs fairly accurately. Hence, our estimation approach and the regression specification seem to be appropriate.

4.3.5. Company vs. Industry Aging

In principle, the age effect we uncover could be an industry-wide phenomenon induced by the life cycle of the industry's products. Even though only moderately, company and industry age are in fact correlated (Table 3). The results in Table 6 disentangle the two phenomena, because the effect of company age is measured conditionally on industry age. Both company age and industry age matter.

According to the coefficient estimates, industry age has a U-shaped influence on both financial distress and takeover hazard. As we can see in Figure 2, however, these U-shaped patterns simply measure a convexity in the relation and not an actual rebound of the two hazards over time. The solid line in Figure 2(b) graphs the average of the predicted failure hazards for different values of Industry age when the remaining covariates assume their actual values in the sample. The dashed line graphs the 3-year moving average of failure frequency as a function of industry age. There is almost no difference between the two lines. The same holds in the case of Figure 2(d), which charts the predicted takeover hazard for different values of Industry age.

Taken together, these results indicate that firms in older industries face lower exit hazards. In the case of takeover, it could be that it is more difficult for firms in a saturated market to find merger partners, either because these firms have unattractive growth opportunities or because potential acquirers have more targets from which to choose. This finding seems to be inconsistent with Jensen (2000).

4.3.6. The Effect of the Control Variables

The results in Table 6 suggest the presence of many factors that affect the hazards of failure and takeover. Their coefficients are generally in line with previous studies and our predictions. Let’s discuss them in some detail, beginning with failure risk (column (5)), to make the relevant comparisons with the extant literature.

All coefficients are in line with Campbell, Hilscher, and Szilagyi (2008). In particular, poorly performing firms are more likely to experience financial distress, almost no matter how we measure performance: the coefficients of *ROA*, *stock return*, and *free cash flow* are all negative and highly significant. This is consistent with Darwin's notion of survival of the fittest. One could argue that, in the long run, only the overall fittest firms manage to outlive the competition and to stay out of the grasp of the "economic grim reaper" (Baker and Kennedy, 2002). However, since we are controlling for age, survivors include also the better in the cohort of companies of similar age—performance, we pointed out, gets worse with age. The coefficient of Tobin's q is positive and significant, suggesting that overvalued firms are more likely to fail (Campbell, Hilscher, and Szilagyi, 2008) or that the stock of firms that fail is an out-of-the-money option. We also find that financial distress becomes less likely in companies of larger size, higher liquidity, and greater focus, as well as in firms that are active in more competitive industries. Conversely, it goes up with financial leverage and volatility, and when the company tends to become a penny stock. All else being the same, companies tend to fail more often in a growing economy, probably because of the competitive pressure growth brings about. Interestingly, we find no evidence of failure contagion (Lang and Stulz, 1992), as the *Active industry* dummy is statistically zero. The same result applies when we add a dummy variable for 4-digit SIC industries that experience financial failure in the previous year (not shown).

In the case of takeover hazard (column (4)), the evidence is consistent with the notion that the market for corporate control disciplines and weeds out inefficient companies (Jensen, 1986), since performance has a negative coefficient, regardless of whether we measure it with accounting data (*ROA*) or with growth opportunities (*Tobin's q*). More successful firms are therefore more likely to survive as independent legal entities. Once again, the fittest in each age cohort appear to survive. Interestingly, the negative and highly significant coefficient associated with *Industry concentration* suggests that competition itself, as measured by market concentration, fuels Schumpeter's gale of creative destruction. Consistent with what we find in the case of financial distress hazard, economic growth (*Growth*) seems to do the same. Holding everything else the same, a buoyant economy induces more frequent restructuring. This is a bit surprising as it says that Schumpeter's gale blows more forcibly when things go well than during downturns, when changes might be needed. The evidence also shows that recent takeovers in the industry have spillover effects and increase the takeover hazard of existing companies (*Active industry* has a positive and significant coefficient).

We also find that *Liquidity* has a positive and highly significant coefficient in the case of takeover hazard. One interpretation is that liquidity reduces the costs of financing a takeover, and another is that lots of liquidity attract the disciplining attention of the market for corporate control, as companies in that situation are more prone to Jensen's (1986) agency costs of free cash flows (see also Palepu, 1986). Consistent with Comment and Schwert (1995) and Espahbodi and Espahbodi (2003), takeover risk is also higher for firms incorporated in the state of Delaware. Furthermore, firms that trade at a high stock price and operate in a volatile environment are more likely to be taken over. The same holds when firms are smaller.

4.3.7. Takeover of Financially Distressed Firms

Since we are modeling financial distress and takeover as competing risks, one may want to ask whether the age convexity we observe in the case of takeover hazard involves firms that would otherwise end up in financial distress. To find out, we replicate the regressions in columns (5)-

(6) of Table 6 for takeover hazard and replace the Age^2 covariate with an individual interaction term. The interaction term involves a binary variable that identifies firms older than the sample median in any given year and individual covariates that measure performance, liquidity, leverage, and volatility. The question we pursue is whether old firms with poor performance, low liquidity, high leverage, and substantial volatility, i.e., firms in situations conducive to financial distress, are more likely to be taken over. Panel A of Table 8 reports the results of this analysis. For simplicity, we show only the coefficients concerning *Age*, the covariate of interest, and the interaction term, respectively.

The evidence is mixed. If the increased takeover hazard of older firms were a surrogate for an increased financial distress hazard, we would expect the coefficient of old age and performance to be negative, since old companies that perform well should be less likely to fail. Instead, the interaction term associated with *ROA*, *Tobin's q*, *Stock return*, and *Stock price* is positive and significantly different from zero. Old, poorly performing companies are therefore *less* likely to be taken over. Moreover, unlike what one would expect, older firms with greater leverage and volatility don't face a greater takeover hazard either. In contrast, old firms with better liquidity are exposed to a smaller exit risk.

It looks as if old, relatively unsuccessful companies are less interesting merger partners, possibly because of incurable operational inflexibilities or because of diffuse collective action problems. For these particular firms, the evidence is therefore inconsistent with the notion that the market for corporate control reallocates resources trapped in outdated structures (Jensen, 2000). We also saw that older firms with larger amounts of cash (*Liquidity*) face a lower takeover hazard. According to Jensen (1986), "managers of firms with unused borrowing power and large free cash flows are more likely to undertake low-benefit or even value-destroying mergers." Hence, older firms with larger cash balances could have more diffuse managerial agency problems. According to the evidence, these firms don't appear to be interesting takeover targets either, a finding that runs contrary to the notion that the market for corporate control has a disciplining function.

We should add that, when we replicate the analysis in Panel A for failure hazard, none of the interaction terms is significant (not shown). Hence, older firms do not face a substantially higher failure hazard even when they don't perform well. On the other hand, sitting on top of more liquidity does not help them either. Together with what we just learned about takeover hazard, these results are consistent with survival of the fattest and inept among the old rather than the fittest.

4.3.8. Asset Structure, Productive Efficiency, and Industry Effects

Panel B of Table 8 performs additional tests of whether it is really the old clunkers that survive. In particular, we want to know whether old firms with unattractive asset and cost structures are less likely to end up in a takeover. Moreover, we want to find out more about how industry characteristics affect takeover at old age. Each row in the panel shows selected coefficients from regressions similar to those in Table 6, except for dropping the Age^2 term and replacing it with a specific interaction term.

Remember from Table 6 that asset tangibility is unrelated to takeover hazard once we control for firm performance, suggesting that, on average, the market for corporate control does not seem to care about intangible assets (what matters might be what the acquiring firms want to do with the resources they acquire). When interacted with the old-firm dummy in the regressions of Panel B, *Tangibility* maintains its insignificant coefficient. The coefficient of the interaction term, however, is positive and highly significant. Old firms with a larger portion of intangible assets are therefore less likely to become takeover targets, possibly because those assets are difficult to redeploy in a new organization.

We also ask whether the age of the firm's assets affects takeover hazard at old age. To the extent that the innovation activities of old firms exploit existing competencies rather than new technologies (Sorensen and Stuart, 2000), asset age could be an indicator of how heavily an old firm is investing in outdated structures. If so, we would expect old firms with relatively new assets to be particularly unattractive takeover targets. This prediction is supported by the data. We use Chun, Kim, Morck and Yeung's (2008) measure of asset age and find that old firms with relatively young assets exhibit a significantly lower takeover hazard.

Finally, inefficient cost structures, as measured by the firm's overhead-to-assets ratio, also seem to deter takeover at old age: overhead expenses per se are unrelated to takeover hazard.[5] In sum, these results suggest that weak old firms are indeed unattractive takeover targets.

Panel C of Table 8 asks how industry characteristics affect takeover at old age. We find that old firms are relatively more attractive takeover targets when they operate in old industries. In older industries, it is the older firms that are more likely to opt for restructuring in the form of merger or takeover. Younger firms seem to believe they have more promising business models (remember, however, that we are controlling for performance). Note that this result cannot be explained by economic disturbance or industry competitiveness, since the interaction terms of *Active industry* and *Industry concentration* with the old-firm dummy are both statistically zero.

[5] According to Giroud and Mueller (2010), the overhead-to-assets ratio could also be a proxy for a "quiet life."

4.3.9. Robustness Tests

To inquire into the robustness of the relation between firm age and exit hazard, we ask whether the aging effect is exasperated in high-tech industries, whether it gets compounded in competitive industries, and whether it is driven by the younger companies in the sample. The reason for being concerned about young firms is that they seem to exhibit peculiar characteristics. Fama and French (2004), for example, report that new listings in the 1980s and the 1990s are more left-skewed in their profitability and more right-skewed in their growth. Moreover, several papers document a high idiosyncratic volatility during the late 1990s (f.ex., Pastor and Veronesi, 2006; Brandt, Brav, Graham, and Kumar, 2010), a phenomenon apparently driven by the high proportion of young firms in the market (Fink, Fink, Grullon, and Weston, 2010).

If age forces older companies to give up their independence, we would expect this phenomenon to be pronounced in industries more exposed to obsolescence. We therefore replicate the analysis in Panel A of Table 9 for firms in high- and low-tech industries, separately, under the assumption that products and services fall more quickly out-of-date in high-tech industries. The definition of the two industries is from Francis and Schipper (1999). We should mention that the majority of our sample firms do not belong to either of these two industrial categories. The evidence in Table 9 suggests that failure hazard is unrelated to company age regardless of whether the firms in question are high-tech or low-tech. Given the few instances of financial distress in the two subsamples in question, however, this finding should be taken with a grain of salt. In contrast, takeover hazard has a significant relation with age, yet only in high-tech firms, consistent with the notion that corporate aging is more serious in innovative environments.

We also looked into the importance of industry age across the two subsamples (not shown). Industry age has a significant negative relation with failure hazard in high-tech environments, and a negative relation with takeover hazard in either type of environment. The latter result suggests that the propensity of older industries to restructure is unrelated to the degree of technical complexity of their products and services.

Panel B repeats the analysis by comparing low-competition (high-concentration) and high-competition (low-concentration) industries. Accordingly, failure hazard has a negative and statistically significant relation with age only in the case of competitive environments, probably because these are the more threatening environments for the firm. In comparison, the coefficients of the U-shaped relation between age and takeover hazard are always statistically significant, and especially pronounced in less competitive industries. It looks as if older firms in sheltered industries are able to stave off financial distress but are eventually more willing to seek merger relief. Industry age has a significant U-shaped relation with both types of hazard as well, except in the case of low-competition industries in which it is immaterial.

Finally, we dropped NASDAQ firms from the sample as well as, alternatively, the 1996-2000 sample years characterized by the dot-com bubble. The results (not shown), however, remain qualitatively the same. They also do not change when we exclude firms younger than 6 in terms of listing age.

4.3.10. Alternative Interpretations

We have investigated the existence of a relation between company age and financial distress hazard, as well as, by implication, the one between company age and takeover hazard. The relations we find could be spurious. One possibility, for example, is that firms accumulate antitakeover provisions over time. If so, performance could suffer and raise the probability of both financial failure and takeover. Another possibility is related to the age of managers. According to Loderer and Waelchli (2010), older firms are managed by older people, and older managers could be less willing and able to avoid financial distress, or more likely to accept takeover bids (Bebchuk, Coates, and Subramaniam, 2007). This could explain why failure and takeover hazards eventually intensify. Yet another possibility has to do with ownership structure. According to Jensen and Warner (1988) and Stulz, Walkling, and Song (1990), among others, the likelihood of a takeover is negatively related to inside ownership. Since ownership concentration falls over time, takeover hazard could ultimately increase in time as well.

To control for these potentially confounding effects, we add three control variables to our standard model in Table 6. The first one is *CEO age*, in years. The information is from *RiskMetrics*. The second is *Inside ownership*, the cumulative fraction of shares controlled by the firm's officers and directors, as reported in Dlugosz, Fahlenbrach, Gompers, and Metrick (2006). Finally, *Governance index* is the firm's score on Gompers, Ishii, and Metrick's (2003) governance index. [6] We find 895 firms with the necessary information (3,238 firm-years). This number falls even further if we require also measures of incorporation age. Hence, we focus simply on the relation between listing age and takeover hazard (there are only 22 failure events, which makes the computation of failure hazard a problem).

The results in Table 10 show that the age effect cannot be explained by older CEOs, lower inside ownership, or weaker shareholder protection. Column (1) replicates the original analysis in Table 6 for the 895 firms in question. Column (2) shows the calculations for the expanded

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[6] Our *Delaware* binary variable could control for antitakeover provisions. Yet unlike the Gompers, Ishii, and Metrick's (2003) index, this variable does not capture gradual intertemporal changes in takeover protection (unless a firm changes its state of incorporation). The index is provided on a bi- or triannual basis. To increase sample size, we interpolate the index for the missing sample years.

regression specification. For brevity, we report only the coefficients of the age covariates and the three new control variables.

The new specification yields the same U-shaped relation between age and takeover risk we observed before. Note that the marginal impact of age is numerically stronger than that reported in Table 6. The reason, however, is not the revised regression specification but rather the particular sample of 895 firms: when we estimate the original specification, the age coefficients are also numerically larger (column (1)). In line with Bebchuk, Coates, and Subramaniam (2007), we find that takeover frequency is unrelated to CEO age. Moreover, inside ownership has no connection with takeover hazard. Finally, and consistent with Core, Guay, and Rusticus (2006), firms with high G-index scores—so called "dictatorships"—do not exhibit lower takeover probabilities. The results remain the same if we control for the age of the firms' directors (as opposed to the age of the CEO only), use alternative measures of ownership structure, and allow for a non-linear relation between ownership structure and takeover risk. Overall, it is difficult to claim that the age-takeover-hazard relation we uncover is a surrogate for an underlying relation between takeover hazard and manager age, ownership concentration, or shareholder rights.

Various tests reject other interpretations of the evidence. For example, the negative relation between exit hazard and company age could reflect a sample selection problem (the fittest survive). Yet, since hazard rates are conditional probabilities as opposed to cumulative probabilities, selection cannot be driving the results.

5. Conclusions

Extant evidence documents that the performance of older listed firms falls gradually behind that of their competitors, and that industry age contributes to that circumstance (Loderer and Waelchli, 2010). We ask what mechanism disposes of older firms and of older industries. If the governance system is unable to prevent the organizational rigidities predicted by the literature in older firms, we would expect these firms to eventually fail. The same prediction follows from the bankruptcy prediction studies that show a negative relation between probability of failure and performance.

The evidence we find is inconsistent with that prediction. If anything, firm age *reduces* failure hazard. In terms of their incorporation age, failure frequency (in the respective age cohorts) goes from about 3 percent in early years down to 0.3 percent before companies get to be 75. Yet even after controlling for various factors of influence and focusing on the conditional probabilities (hazards), we come to the same conclusion. Failure hazard declines as firms and the industries they are in get older, particularly when competition is fiercer. The decline is, however, economically negligible.

So, what mechanism contributes to removing older firms and weeding out older industries? In part it is takeover, a hazard that, at least statistically, competes with that of financial distress. Takeover hazard follows a robust U-shaped relation with listing age. Initially, right after the IPO, firms might be increasingly reluctant to give up their independence to merge with or be absorbed by other firms. Managerial overconfidence could be the explanation. Later, the takeover hazard increases. This pattern is particularly pronounced in high-tech industries and, paradoxically, also in industries that are comparatively not very competitive. Older companies might find it hard to overcome common action problems and rally employees for independence. Interestingly, older companies with subpar performance or poor governance are *less* interesting takeover targets. Although the market for corporate control seems to generally reallocate resources to potentially better users, that does not seem to happen in the most extreme cases. Old clunkers, so to speak, are unattractive takeover partners.

Somewhat surprisingly, industry age actually reduces takeover hazard, which could suggest that the firms in older industries, are less attractive merger partners, perhaps because their products are at the end of their life-cycles. It could also be that it is more difficult for those firms to find a merger partner in a field crowded with potential takeover targets.

Our results remain the same in a battery of robustness tests, including controlling for unobserved heterogeneity. To be true, most companies disappear before experiencing a higher age-induced failure or takeover hazard. Half of them actually vanish before they turn 10. Drivers of higher takeover risk include old management and poor performance. The better firms survive as independent organizations, the rest fail or are taken over.

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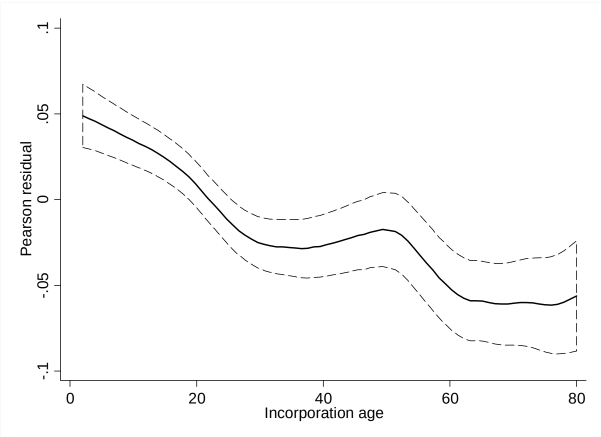
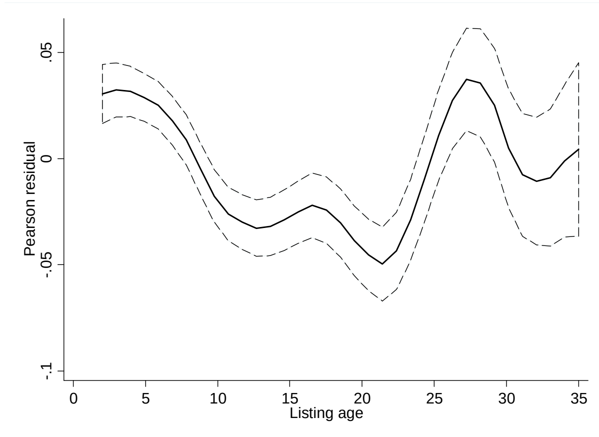
Figure 1: The Relation Between Age and Exit Hazard: Kernel Regressions

Figures (a) and (b) investigate the relation between age and exit hazard with kernel-weighted local polynomial regressions. The dependent variables in these regressions are the residuals from logistic regressions of the two exit hazards (takeover and failure) on the control variables from Table 6, except for *Age* and *Age^2*. The smoothed values (solid lines) are then obtained from local polynomial regressions of these residuals on firm age, using an Epanechnikov kernel function with a "rule-of-thumb" bandwidth estimator and local-mean smoothing. The dashed lines plot the 90-percent confidence band.



(a) Failure Hazard (Kernel)

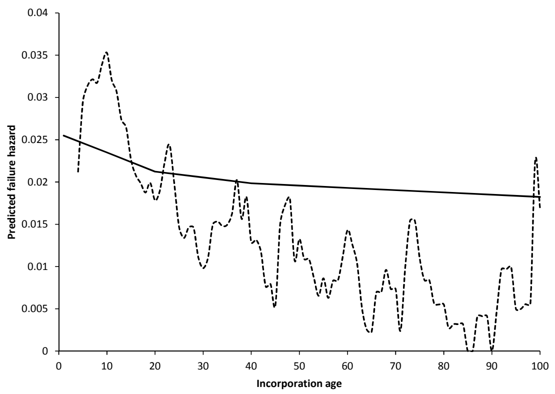


(b) Takeover Hazard (Kernel)

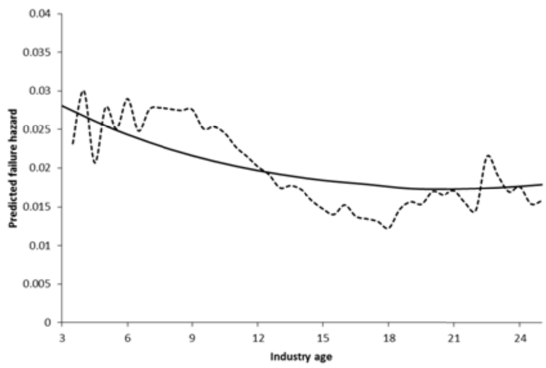
Figure 2: The Relation Between Age and Exit Hazard: Piecewise Linear Specification

The table estimates exit hazards from pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering similar to those in Table 6. Panel A looks at failure hazard and measures firm age as the log of incorporation age. The solid line in Figure 2(a) shows the average of the predicted failure hazards for different firm ages when the remaining covariates assume their actual values in the sample. To reflect the functional form suggested by Figure 1(a), we use a piecewise linear relation that allows for turning points at incorporation ages (Age_{inc}) 20 and 40, respectively. The dashed line shows the 3-year moving average of the sample failure frequency as a function incorporation age. The solid line in Figure 2(b) shows the average of the predicted failure hazards for different values of *Industry age* when the remaining covariates assume their actual values in the sample. The dashed line shows the 3-year moving average of failure frequency as a function of industry age. Panel B looks at takeover hazard. To best capture the functional form of the relation between age and takeover hazard reported in Figure 1(b), we use piecewise linear relation with firm age, which allows for turning points at listing ages 5, 10, 20, and 30, respectively. These turning points correspond roughly to the 25th, 50th, 75th, and 90th percentiles of the sample distribution of listing age. The solid line in Figure 2(c) shows the predicted takeover hazards from these piecewise linear regressions for different values of listing age when the remaining covariates assume their actual values in the sample. The dashed line shows the 3-year moving average of the sample frequency of takeover hazard. Finally, the solid line in Figure 2(d) shows the predicted takeover hazard for different values of *Industry age* when the remaining covariates assume their actual values in the sample, whereas the dashed line shows the 3-year moving average of the sample frequencies.

Panel A: Failure Hazard

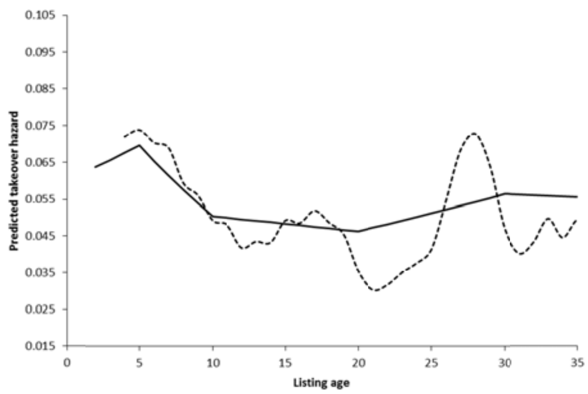


(a) Actual and predicted failure hazard as a function of incorporation age

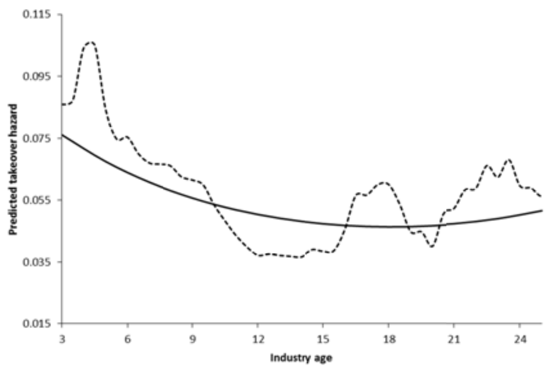


(b) Actual and predicted failure hazard as a function of industry age

Panel B: Takeover Hazard



(c) Actual and predicted takeover hazard as a function of listing age



(d) Actual and predicted takeover hazard as a function of industry age

Table 1: Turnover and Exit Reasons

The table groups the sample in various subperiods and shows the number of sample firms at the beginning of each period as well as the number of entering and exiting firms. The last three columns to the right show the reasons firms leave the sample. Using the delisting codes reported on the CRSP tapes, we distinguish among three exit reasons: takeover, failure, and other delistings. Failure is assumed if a firm is liquidated (delisting codes 400–490), drops from the exchange because of bankruptcy (574), or fails to maintain an acceptable share-price level (552) or capitalization (560 and 584), fails to file financial statements, or fails to pay exchange fees (580). Takeovers are identified with the delisting codes 200–299. Other delistings are mainly exchanges for other securities, switches to other stock exchanges, or delistings because of an insufficient number of shareholders or market makers.

Period	Firms Beginning	New Entrants	Total Exits	Exit Reasons		
				Takeover	Failure	Other
1978–1980	2,154	376	284	201	29	54
1981–1985	2,188	1,222	867	538	157	172
1986–1990	2,524	1,349	1,181	692	256	233
1991–1995	2,681	2,030	930	557	279	94
1996–2000	3,996	2,288	2,615	1,754	524	337
2001–2004	2,935	580	1,647	798	552	297
	2,671					
Total		7,845	7,524	4,540	1,797	1,187

Table 2: Descriptive Statistics

The table shows descriptive statistics. All control variables are winsorized at the 5th and 95th percentile of their pooled distribution across all firm-years. Variable definitions are in Table 4.

	Mean	Median	Min	Max	Stev	N
Listing age	14.34	10.00	1.000	80.00	13.90	76,201
Incorporation age	32.43	23.00	1.000	280.00	27.42	37,413
Age at listing	15.45	8.00	1.00	274.00	19.20	4,624
			Control Variables			
ROA	0.119	0.125	–0.362	0.425	0.118	74,747
Stock return	–0.010	–0.091	–1.025	2.699	0.599	63,913
Tobin's q	1.676	1.270	0.625	8.057	1.199	75,344
Size	–10.519	–10.578	–14.804	–5.959	1.856	75,367
Tangibility	0.306	0.250	0.000	0.902	0.237	76,189
Leverage	0.831	0.561	0.020	8.641	1.151	75,377
Liquidity	0.125	0.062	0.000	1.136	0.181	75,376
Free cash flow	0.043	0.064	–0.919	0.317	0.151	62,639
Sales growth	0.101	0.050	–0.486	1.476	0.290	64,581
Focus	0.848	1.000	0.113	1.000	0.237	76,201
Volatility	0.657	0.564	0.170	2.116	0.376	73,271
Stock price	2.121	2.565	–9.210	2.708	0.860	75,378
Delaware	0.517	–	–	–	–	71,891
Industry age	10.501	10.000	1.000	52.000	5.068	72,339
Active industry	0.577	–	–	–	–	76,201
Industry concentration	0.242	0.203	0.026	0.706	0.158	72,339
GDP growth	0.022	0.025	–0.029	0.069	0.019	76,201

Table 3: Correlations Between Pairs of Control Variables

	Age	Age$_{inc}$	*ROA*	*Stock return*	*Tobin's q*	*Size*	*Tang.*	*Lev.*	*Liq.*	*FCF*	*Sales gr.*	*Focus*	*Vola.*	*Stock price*	*Delaw.*	*Ind. age*	*Active industry*	*Concent.*
Age$_{inc}$	0.668																	
ROA	0.053	0.088																
Stock return	0.001	–0.004	0.267															
Tobin's q	–0.067	–0.105	0.306	0.339														
Size	0.293	0.249	0.353	0.203	0.343													
Tangibility	0.109	0.162	0.156	–0.036	–0.135	0.151												
Leverage	0.016	0.009	–0.323	–0.204	–0.316	–0.300	–0.032											
Liquidity	–0.063	–0.101	–0.267	–0.120	–0.161	–0.206	–0.267	0.278										
Free cash flow	0.049	0.073	0.622	0.166	–0.060	0.179	0.130	–0.312	–0.211									
Sales growth	–0.167	–0.174	0.196	0.229	0.273	0.155	–0.056	–0.159	–0.110	0.138								
Focus	–0.300	–0.240	–0.009	0.006	0.092	–0.186	–0.004	–0.037	0.055	–0.042	0.072							
Volatility	–0.291	–0.328	–0.385	–0.106	–0.015	–0.559	–0.157	0.267	0.193	–0.338	–0.039	0.160						
Stock price	0.202	0.234	0.445	0.308	0.265	0.679	0.056	–0.424	–0.223	0.379	0.212	–0.117	–0.696					
Delaware	–0.101	–0.219	–0.028	0.004	0.067	0.008	–0.067	0.021	0.038	–0.026	0.048	0.000	0.080	–0.045				
Industry age	0.252	0.219	0.009	–0.004	–0.001	0.058	0.028	–0.025	–0.020	0.004	–0.054	–0.035	–0.067	0.076	–0.058			
Active industry	–0.053	–0.071	–0.034	–0.013	0.028	–0.058	–0.044	0.002	0.015	–0.024	0.032	0.002	0.065	–0.042	0.021	0.021		
Concentration	0.081	0.077	0.016	0.002	–0.007	0.034	0.033	–0.004	–0.009	0.019	–0.025	–0.008	–0.038	0.032	–0.007	–0.007	–0.216	
GDP growth	–0.010	–0.018	0.014	0.040	0.050	–0.017	–0.027	–0.047	–0.039	0.006	0.134	0.032	–0.062	0.044	0.000	0.000	0.097	–0.045

Table 4: Variable Definitions

Variable	Definition
Active industry	Binary variable equal to 1 if at least on acquisition occurred in a firm's 4-digit SIC industry during the previous year. Otherwise, the variable is set equal to 0;
Age	Age is computed as one plus the difference between the year under investigation and the firm's year of birth. The year of birth is computed as the minimum value of: (a) the first year the firm appears on the CRSP tapes; (b) the first year the firm appears on the COMPUSTAT tapes; and (c) the first year for which we find a link between the CRSP and the COMPUSTAT tapes (based on COMPUSTAT data item LINKDT). For a subsample of randomly selected firms, we also compute age as the number of years (plus one) since incorporation;
Delaware	Binary variable equal to 1 if the firm is incorporated in Delaware. Otherwise, the variable is set to 0. The data are from COMPUSTAT's quarterly files (INCORP code 10);
Focus	The Herfindahl index, H_E, captures the degree of specialization based on the sales in the firm's different segments, as reported on the COMPUSTAT Segment tapes: $H_E = \sum_{i=1}^{N} p_i^2$, where N is the number of segments, the subscript i identifies the segments, and p_i is the fraction of the firm's total sales in the segment in question;
Free cash flow	The firm's free cash flow divided by its market value of assets. The data are from COMPUSTAT. We follow Lehn and Poulsen (1989) and compute: DATA13 – DATA15 – (DATA16 – DATA35) – DATA19 – DATA21. The market value of assets is calculated as book value of assets (DATA6) minus book value of common equity (DATA60) plus market value of common equity (DATA25×DATA199);
GDP growth	The relative change in the U.S. gross domestic product. The data are from the Bureau of Economic Analysis of the U.S. Department of Commerce;
Industry age	The median age of all sample firms in the same 3-digit SIC industry in any given year;
Industry concentration	We follow Giroud and Mueller (2010), among many others, and measure the lack of competition of the firm's industry (3-digit SIC) with a Herfindahl index, H_E: $H_E = \sum_{i=1}^{N} s_i^2$, where N is the number of firms in the same 3-digit SIC industry, the subscript i identifies the firms, and s_i is the firms' market share based on sales (DATA12 in COMPUSTAT). The higher the index, the less competitive the industry becomes. To correct for potential misclassification, we drop the top 2.5% of the firm-years at the right tail of the distribution (Giroud and Mueller, 2010);
Leverage	The firm's ratio of total liabilities (COMPUSTAT DATA181) to market value of total assets;
Liquidity	The firm's cash and short-term investments (COMPUSTAT DATA1) divided by the market value of its total assets;
ROA	Return on assets computed as the ratio of the firm's operating income before depreciation (COMPUSTAT DATA13) divided by the book value of total assets (COMPUSTAT DATA6);
Sales growth	The ratio of the firm's current sales (COMPUSTAT DATA12) divided by the sales of the previous year minus 1. Sales figures are expressed in 1978 dollars;
Size	The log of the ratio of the firm's market capitalization (COMPUSTAT DATA25×DATA199) to that of CRSP's NYSE/AMEX/ NASDAQ equal-weighted index;
Stock price	The firm's log price per share (COMPUSTAT DATA199), truncated above USD 15;
Stock return	The firm's annual market-adjusted stock return. Stock returns are computed from COMPUSTAT as the ratio of the current stock price (DATA199), including dividend payments (DATA26), divided by last year's stock price minus 1. The proxy for the market return is the return on CRSP's NYSE/AMEX/NASDAQ equal-weighted index;
Tangibility	The firm's property, plant, and equipment (COMPUSTAT DATA8) divided by its market value of total assets;
Tobin's Q	Tobin's Q, computed as the market value of the firm's assets divided by their book value. The data are from COMPUSTAT.
Volatility	The annualized standard deviation of the firm's daily stock return. We calculate volatility over a one-year window and include all firm-years with at least 100 daily returns. The data are from the daily CRSP tapes.

Table 5: Age and Exit Hazard

The table investigates the relation between listing age and exit hazard. Variable definitions are in Table 4. Columns (1) and (2) show the results from a discrete time-proportional hazard model (Cloglog, see Jenkins (2005)). The dependent variable is a binary variable equal to one if the firm exits the sample in the following year, and equal to zero otherwise. The symbols ***, **, and * indicate statistical significance with 0.99, 0.95, and 0.90 confidence, respectively.

	Cloglog Hazard Model	
	(1)	(2)
Age	–0.022 ***	–0.022 ***
	(0.003)	(0.003)
Age^2 / 100	0.028 ***	0.026 ***
	(0.005)	(0.006)
s ROA		–0.159 ***
		(0.020)
s Stock return		–0.033 **
		(0.017)
s Tobin's q		0.042 **
		(0.020)
s Free cash flow		–0.090 ***
		(0.015)
s Sales growth		–0.007
		(0.016)
s Size	–0.206 ***	–0.240 ***
	(0.021)	(0.024)
s Tangibility	0.002	0.039 **
	(0.014)	(0.016)
s Leverage	0.119 ***	0.105 ***
	(0.011)	(0.013)
s Liquidity	0.005	–0.026 *
	(0.012)	(0.014)
s Focus	–0.010	–0.022
	(0.016)	(0.017)
s Volatility	0.209 ***	0.152 ***
	(0.016)	(0.019)
Stock price	–0.162 ***	–0.053 **
	(0.022)	(0.026)
Delaware	0.034	0.030
	(0.027)	(0.029)
Industry age	–0.078 ***	–0.079 ***
	(0.008)	(0.008)
Industry age^2	0.002 ***	0.002 ***
	(0.000)	(0.000)
Active industry	0.177 ***	0.195 ***
	(0.030)	(0.032)
Industry concentration	–0.294 ***	–0.220 **
	(0.093)	(0.101)
GDP growth	0.118 ***	0.126 ***
	(0.007)	(0.008)
Constant	–1.881 ***	–2.135 ***
	(0.080)	(0.089)
Observations	65,473	55,928
Wald χ^2; log-likelihood	3,224 ***	3,417 ***

Table 6: Age and Competing Exit Hazard

The table estimates pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering. We distinguish between takeover and failure hazard. Columns (1) to (4) focus on listing age. Columns (5) and (6) look at incorporation age. Variables with the prefix "s" are standardized, using the 3-digit SIC industries. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

	Age = Listing Age		Age = Listing Age		Age = Incorporation Age	
	Failure	Takeover	Failure	Takeover	Failure	Takeover
	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.000	0.002	–0.006	–0.022 ***	–0.012 ***	–0.018 ***
	(0.008)	(0.004)	(0.008)	(0.004)	(0.005)	(0.003)
Age^2 / 100	–0.005	–0.001	0.000	0.028 ***	0.009 ***	0.011 ***
	(0.015)	(0.007)	(0.015)	(0.007)	(0.003)	(0.002)
s ROA			–0.373 ***	–0.126 ***	–0.358 ***	–0.061
			(0.041)	(0.029)	(0.061)	(0.040)
s Stock return			–0.191 ***	0.012	–0.258 ***	0.001
			(0.047)	(0.019)	(0.071)	(0.026)
s Tobin's q			0.221 ***	–0.059 **	0.237 ***	–0.015
			(0.046)	(0.027)	(0.074)	(0.037)
s Free cash flow			–0.074 ***	0.027	–0.076 *	–0.001
			(0.027)	(0.030)	(0.041)	(0.042)
s Sales growth			0.025	–0.026	0.020	–0.051 *
			(0.038)	(0.020)	(0.052)	(0.029)
s Size	–0.527 ***	–0.216 ***	–0.571 ***	–0.169 ***	–0.633 ***	–0.223 ***
	(0.051)	(0.027)	(0.057)	(0.029)	(0.091)	(0.040)
s Tangibility	–0.015	0.054 ***	0.051	0.021	0.065	0.037
	(0.033)	(0.019)	(0.035)	(0.021)	(0.052)	(0.031)
s Leverage	0.241 ***	0.011	0.232 ***	0.012	0.237 ***	0.013
	(0.021)	(0.022)	(0.024)	(0.024)	(0.035)	(0.034)
s Liquidity	–0.141 ***	0.110 ***	–0.200 ***	0.082 ***	–0.235 ***	0.106 ***
	(0.027)	(0.018)	(0.028)	(0.019)	(0.044)	(0.027)
s Focus	–0.094 ***	0.004	–0.141 ***	0.002	–0.155 ***	–0.029
	(0.035)	(0.021)	(0.036)	(0.021)	(0.052)	(0.029)
s Volatility	0.297 ***	0.171 ***	0.200 ***	0.177 ***	0.200 ***	0.196 ***
	(0.032)	(0.023)	(0.035)	(0.026)	(0.050)	(0.036)
Stock price	–0.632 ***	0.270 ***	–0.529 ***	0.309 ***	–0.546 ***	0.364 ***
	(0.042)	(0.037)	(0.046)	(0.041)	(0.066)	(0.059)
Delaware	0.020	0.182 ***	–0.030	0.144 ***	–0.070	0.060
	(0.062)	(0.036)	(0.064)	(0.037)	(0.099)	(0.053)
Industry age	–0.072 ***	–0.092 ***	–0.080 ***	–0.093 ***	–0.103 ***	–0.099 ***
	(0.019)	(0.009)	(0.021)	(0.010)	(0.029)	(0.015)
Industry age^2	0.002 **	0.002 ***	0.002 **	0.003 ***	0.003 ***	0.003 ***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Active industry	–0.177 ***	–0.064	0.095	0.214 ***	0.080	0.120 **
	(0.066)	(0.040)	(0.068)	(0.039)	(0.103)	(0.055)
Industry concent.	–0.287	–0.558 ***	–0.090	–0.346 ***	–0.672 **	–0.511 ***
	(0.210)	(0.125)	(0.216)	(0.126)	(0.332)	(0.183)
GDP growth	0.098 ***	0.124 ***	0.103 ***	0.147 ***	0.076 ***	0.133 ***
	(0.019)	(0.009)	(0.020)	(0.009)	(0.029)	(0.013)
Constant	–3.022 ***	–3.187 ***	–3.229 ***	–3.107 ***	–2.916 ***	–2.881 ***
	(0.181)	(0.120)	(0.193)	(0.125)	(0.286)	(0.180)
Observations	65,473		55,928		27,876	
log–likelihood	–20,695.03		–19,401.99		–9,209.02	
Pseudo R^2	0.102		0.125		0.134	

Table 7: Marginal Effects from Piecewise Linear Regressions

The table estimates marginal effects from pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering similar to those in Table 6. To reduce the constraints on the relation between age and exit hazard, we use a piecewise linear specification. In the case of failure hazard (Panel A), we allow for turning points in the relation at incorporation ages (Ageinc) 20 and 40, respectively. In contrast, in the case of takeover hazard (Panel B), the turning points are at listing ages (Age) 5, 10, 20, and 30, respectively. These latter turning points correspond roughly to the 25th, 50th, 75th, and 90th percentile of the age distribution in the full sample. Column (2) shows the marginal effect of Ageinc (Panel A) and Age (Panel B) on this exit probability if age increases by one year and the remaining covariates assume their overall average value in the sample. Column (3) shows the standard error of the marginal effect. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

Panel A: Failure Hazard

Age Cohort	Marginal Effect of Age_{inc} (%)	Standard Error of the Marginal Effect (%)
(1)	(2)	(3)
$Age_{inc} \leq 20$	–0.029 **	0.013
$20 < Age_{inc} \leq 40$	–0.014 (p=0.122)	0.009
$40 < Age_{inc}$	0.001	0.001

Panel B: Takeover Hazard

Age Cohort	Marginal Effect of Age_{inc} (%)	Standard Error of the Marginal Effect (%)
(1)	(2)	(3)
$Age \leq 5$	0.314 (p = 0.116)	0.199
$5 < Age \leq 10$	–0.279 *	0.148
$10 < Age \leq 20$	0.050	0.068
$20 < Age \leq 30$	0.261 ***	0.081
$30 < Age$	0.007	0.018

Table 8: Drivers of Takeover Hazard in Old Firms

In this table, we interact various individual drivers of takeover hazard with an old-firm dummy that identifies firms older than the sample median in any given year. Each row shows selected coefficients from regressions similar to those in Table 6, except for dropping the Age^2 term and replacing it with a specific interaction term. Each individual row of the table is therefore obtained from estimating this modified version of the model in columns (5)-(6) of Table 6 with the covariate of interest. The first column shows the coefficient of Age and the second that of the old-firm dummy. The third column shows the coefficient of the covariate of interest, and the fourth shows the coefficient of the interaction term. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

Panel A: Takeover of Financially Distressed Firms

	Age	Old Firm Dummy	Variable	Variable*Old Firm Dummy
s ROA	–0.005 **	–0.019	–0.160 ***	0.084 **
s Tobin's Q	–0.005 **	–0.020	–0.091 ***	0.101 **
s Stock return	–0.005 **	–0.028	–0.021	0.073 **
Stock price	–0.006 ***	–0.239 **	0.263 ***	0.103 **
s Liquidity	–0.005 **	–0.013	0.134 ***	–0.134 ***
s Leverage	–0.005 **	–0.026	0.021	–0.026
s Volatility	–0.006 **	–0.015	0.204 ***	–0.052

Panel B: Asset and Cost Structures and Takeover

	Age	Old Firm Dummy	Variable	Variable*Old Firm Dummy
s Tangibility	–0.006 ***	–0.015	–0.038	0.125 ***
s Asset age	–0.004 *	0.134 **	–0.091 **	0.117 **
s Overhead-to-assets	–0.005 **	–0.025	0.008	–0.111 **

Panel C: Industry Characteristics and Takeover

	Age	Old Firm Dummy	Variable	Variable*Old Firm Dummy
Industry age	–0.006 ***	–0.258 ***	–0.104 ***	0.248 ***
Active industry	–0.005 **	–0.032	0.213 ***	0.011
Industry concentration	–0.005 **	–0.086	–0.478 ***	0.277

Table 9: Robustness Tests

The table investigates the age-performance relation for various subsamples. In each case, there are two possible exits, namely failure and takeover. Panel A distinguishes between high- and low-tech industries. The definition of high- and low-tech industries is the one proposed by Francis and Schipper (1999). Panel B distinguishes between low-competition and high-competition industries. Low-competition industries have Lack of competition (a Herfindahl-index) above the sample median in any given year. High-competition industries have below median Lack of competition. To save space, we report only the coefficients of the age variables and the associated significance levels. The results are based on pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

Panel A: High-Tech vs. Low-Tech Industries

	Failure Hazard		Takeover Hazard	
	Age	Age^2	Age_{inc}	Age_{inc}^2
Panel A: Low-Tech vs. High-Tech Industries				
Low-tech industries	–0.009	0.015	–0.019	0.023
High-tech industries	0.011	–0.017	–0.025 ***	0.027 *
Panel B: Low-Competition vs. High-Competition Industries				
Low-competition industries	–0.005	0.006	–0.029 ***	0.042 ***
High-competition industries	–0.014 **	0.010 ***	–0.017 ***	0.020 **

Table 10: Test of Alternative Interpretations

The table tests alternative interpretations of the observed relation between firm age and takeover hazard. To do so, it estimates the pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering of Table 6. The regression specification is changed with the addition of three control variables: CEO Age, Inside Ownership, and Governance Index. Variable definitions are in Table 4. The columns show the results from pooled multinomial logit regressions with standard errors corrected for heteroskedasticity and firm clustering. Because of the limited number of observations, we cannot compute failure hazard with incorporation age. The symbols ***, **, and * indicate statistical significance with 0.99, 0.95, and 0.90 confidence, respectively.

	(1)	(2)
Age	–0.061 ***	–0.060 ***
	(0.022)	(0.023)
Age^2/100	0.075 ***	0.074 ***
	(0.027)	(0.028)
CEO age		–0.113
		(0.121)
Inside ownership		0.067
		(0.106)
Governance index		0.045
		(0.132)
Remaining control variables	Included	Included
Number of firm-years	2,419	2,419
Log-likelihood	–438.65	–435.92
Pseudo R2	0.168	0.173