Firm Age and Performance

Claudio Loderer and Urs Waelchli*

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This paper investigates how firm age affects performance. Consistent with an obsolescence of firm endowments, the existence of organizational rigidities, and the proliferation of seniority rules, performance gets worse with age. Profits fall, margins thin, sales growth drops, and costs rise. Firms do best when they are young, and roughly 15 years after listing (37 years after incorporation), they start underperforming the median firm in the industry. This relation cannot be explained away by sample selection, manager age, industry age, time-varying risk, corporate governance, and ownership structure. Stock returns, however, are unaffected. Overall, corporate geriatrics problems are real.

Keywords: firm age, organizational rigidities, firm life cycle, corporate governance, firm performance

JEL codes: G30, L20

* Loderer (corresponding author) is from the Institut für Finanzmanagement, University of Bern (claudio.loderer@ifm.unibe.ch). A large portion of this research was conducted during his visit at the Stern School of Business, New York University. Waelchli is from the Institut für Finanzmanagement, University of Bern (urs.waelchli@ifm.unibe.ch). We benefited from Nancy Macmillan's great editorial help. We wish to thank Demian Berchtold, Anita Bühler, Jonas Friedrich, and Adrian Michel for research assistance. Comments from Yakov Amihud, Artur Baldauf, Carsten Bienz, Gian Luca Clementi, Francois Degeorge, Yoram Landskroner, Michael Lemmon, Diego Liechti, John McConnell, Klaus Neusser, Erik Nowak, Adriano Rampini, Lukas Roth, Markus Senn, Heather Tookes, John Zhou, seminar participants at the University of Bern, University of Lugano, and Penn State University, and the participants at the XLII EWGFM meeting in Stockholm, the Campus for Finance in Koblenz, the European Winter Finance Conference in Klosters, the Midwest Finance Association Meetings in Chicago, as well as the SGF Conference in Geneva are gratefully acknowledged. All errors are ours.

Over time, firms discover what they are good at and learn to be more efficient (Arrow (1962), Jovanovic (1982), and Ericson and Pakes (1995)). They specialize and find ways to standardize, coordinate, and speed up their production processes, as well as to reduce costs and improve quality. The relevant literature goes back to Smith and Ricardo. Success, however, also induces firms to codify their approach with the proper organization and processes. This behavior seems to increasingly entangle firms in structural and process-related rigidities that are difficult to shed (Leonard-Barton (1992)) and that induce companies to ignore innovation signals sent by the market. Moreover, old age may make knowledge, abilities, and skills obsolete and induce organizational decay (Agarwal and Gort (1996, 2002)). On balance, it is unclear whether aging helps firms prosper or whether it dooms them. This paper is dedicated to answering that question.

Our investigation has some bearing on at least three areas of the empirical literature in economics—strategic management, industrial organization, and finance—but few if any large-scale empirical papers have looked for answers to the question we are asking. In the management literature, Leonard-Barton (1992) has pointed out that, when firms focus on core capabilities, they bring on core rigidities that make it difficult to adapt to changes in their environment. We argue that those rigidities are compounded by age. The industrial organization literature has focused on innovation, entry, exit, and survival. Yet according to Caves (1998, p. 1958), little attention has been paid to organizational geriatrics, possibly because exit hazard rates are believed to decline with age (Dunne, Roberts, and Samuelson (1989)) and better firms survive (Loderer, Neusser, and Waelchli (2009)). Finally, firm age appears in several studies in the empirical finance literature. For example, it is a control variable in papers on corporate diversification (Campa and Kedia (2002) and Villalonga (2004), among many others) and on financial constraints (such as Kaplan and Zingales (1997)). Yet none of those studies has focused on age directly.

Some studies have also proposed a life-cycle theory of the firm. Whereas biological arguments in economics go back at least to Marshall's "trees in the forest" analogy, Boulding (1950) was among the first to argue that there is an "inexorable and irreversible movement towards the equilibrium of death. Individual, family, firm, nation, and civilization all follow the same grim law."[1] If so, firms' performance over time should be inverted U-shaped: increasing initially and declining past some age.

That is not quite what we observe. We study 10,930 listed firms with data on CRSP, COMPUSTAT, and COMPUSTAT Industry Segment between 1978 and 2004 (82,845 firm-years). We define firm age alternatively from the time of listing and from that of incorporation. The latter information is hand-collected from *Mergent Webreports*. We show that getting older slows performance. Return on assets and Tobin's Q fall with age. Moreover, margins decline, sales growth slows down, and costs go up. Investments and learning are unable to overcome the deleterious effects of obsolescence and organizational inertia. It looks as if firms lose momentum as they get older. Predictably, however, stock returns are unaffected. These results hold across different time periods and for different firm samples, i.e., when sorting firms by size and when excluding young firms. The age effect we uncover cannot be explained with the post-IPO performance decline reported elsewhere (Jain and Kini (1994)). Moreover, it is distinct from such phenomena as declining risk, declining ownership concentration, older management

[1] A life-cycle argument has been offered also to explain dividend payments (Fama and French (2001) and DeAngelo, DeAngelo, and Stulz (2006)) and financing decisions (Berger and Udell (1990)).

or aging industry, intertemporal changes in corporate governance, and sample selection. Corporate geriatrics problems are real.

The paper is organized as follows. Section I presents theoretical considerations to structure the empirical analysis. Section II discusses the data. Section III inquires into the relation between age and firm performance. Section IV examines alternative interpretations of the results, and Section IV concludes.

I. Theoretical Considerations

As mentioned above, the relevance of age to firm dynamics has attracted comparatively little attention, except in the management literature. There is not much theoretical work one can rely on to guide our investigation. The prior belief would seem to be that age benefits performance. For one thing, firms learn about their abilities and about how to do things better as they get older. For another, the available empirical evidence shows that life expectancy increases with age, and that better firms survive. There are, however, reasons to disagree. What follows presents a number of arguments why age could harm performance. We also discuss reasons why the relation between age and performance could be spurious. Finally, we present the investigative design.

A. Why Age could Impair Performance

A.1. Deteriorating Trade-off between Obsolescence and Investment plus Learning

Agarwal and Gort (1996, 2002) report evidence that hazard rates initially fall and then rebound as firms get older. The authors see survival as the trade-off between obsolescence of a firm's original endowments, on the one hand, and net investments and learning-by-doing, on the other. Eventually, the increase in endowments falls below the obsolescence rate. One reason is that the stock of learning increases at a decreasing rate (important lessons are learned first and there is only a finite stock of information to be learned about a technology). Another reason is that the adaptability of old endowments diminishes and investment opportunities in new technology shrink as the product market ages. Although the hypothesis is about survival, it has implications also about the productive capacity of a firm and its performance. Accordingly, age should eventually weaken performance.

A.2. Organizational Inertia

Age can have adverse effects on performance also because of the organizational rigidities and inertia it brings about (Hannan and Freeman (1984), Leonard-Barton (1992)) and because it impairs the ability of firms to perceive valuable signals. The root of the problem is the tendency of firms to codify their success with organizational measures, rules of conduct, and best practice. This behavior often makes sense, because it helps firms focus on their core competences and raise reliability and accountability, two survival characteristics according to Hannan and Freeman. By stressing the good to prevent the bad, however, codification makes it hard to recognize, accept, and implement change when doing so would be appropriate. Yet codification takes time. The older the firm, the more capillary the codification can be. If so, age reduces flexibility and discourages change.[2] At the same time, whatever learning benefits the firm can capture in its established lines of business, they probably decline over time. As pointed out above, the stock of learning might increase at a decreasing rate. Overall, older firms could therefore lose their competitive edge.

A.3. Seniority Rules and Organization Memory

Another reason why age could harm performance is the associated seniority rules in the organization. In many firms, seniority decides how things are done, who does them, and when. Under a seniority principle, individuals who have been with the organization longer are granted preferential treatment when setting compensation and perks, and when assigning responsibilities and tasks. More subtly, seniority criteria privilege employees for services rendered in the past in deciding who should take on repetitive, unpleasant, or difficult jobs. The principle of seniority is also invoked when senior employees collude to benefit at the expense of rookie employees.

Whatever the reason for their existence and acceptance within the organization, seniority rules in compensation can provide inadequate incentives for managers to perform. In other contexts, seniority rules make it more difficult for organizations to function, since not all employees are available or willing to do a given job. Some individuals might be exempted because they have done it before. And others might be excused because of the loyalty shown in

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2 There is a vast literature on organizational inertia. See, among others, Tripsas and Gavetti (2000) and the literature cited therein.

the past.[3] Seniority criteria can be found at all levels of the organization and across all functional areas. More importantly, the number of people in the organization with a seniority status of some kind accumulates in time. If so, the performance of older firms could deteriorate with the age of the organization.

A related argument has to do with organization memory. How an organization evolves and performs is a function of its own history (Katz (1982)). Past external and internal events, such as discussions, disagreements, and related compromises, shape the form of an organization and what it does. Arguably, older firms have a heavier and more restrictive organization memory. If so, older firms might find it more difficult to perform.

B. Why the Relation between Age and Performance Could be Spurious

The relation between age and performance, however, could also be spurious. Age, could proxy for other drivers of performance. For example, for financial constraints. The industrial organization literature has pointed out the importance of those constraints. Evans (1987), for example, finds that growth decreases with firm age and that it does so at a diminishing rate. Cooley and Quadrini (2001) offer a model that explains that observation. The intuition (Clementi (2002)) is that, with financial frictions, firms do not raise all the funds necessary for the marginal product of capital to equal its opportunity cost. Consequently, as capital increases over time, its marginal product declines, and so does the firm's rate of growth. Clementi (2002) proposes a model that combines the industrial organization literature on firm dynamics and the

[3] Seniority rules are not necessarily always bad. Seasoned employees can be valuable: they have more experience, know the firm better, provide stability, understand the customers, or have proven their loyalty to the firm.

corporate finance literature on IPOs. He embeds the IPO decision in a dynamic optimization model similar to that in Cooley and Quadrini (2001). The model is able to predict the post-IPO decline in operating return on assets documented in Jain and Kini (1994). According to this strand of the literature, age could be related to performance because of financial frictions.

What looks like a relation between firm age and performance could also be induced by the age and tenure of the managers within the organization. Finkelstein and Hambrick (1990) mention three reasons why older managers could be responsible for organizational inertia. First, "as individuals spend time in an organization, and particularly as they succeed and climb the organization's hierarchy, they become convinced of the wisdom of the organization's ways" (p. 486). Second, longer tenure may increase managers' risk aversion. Third, organizational tenure tends to restrict information processing. Managers rely more and more on past experience than on new signals (Katz (1982)), a habit that makes it more difficult to design, accept, and implement policy changes.

The finance literature has also looked at age-related performance issues, although from different angles than ours. James and Wier (1990) and Berger and Udell (1990), among others, propose a risk argument. Accordingly, investors' uncertainty gets resolved over time as the firm grows older and leaves an increasingly revealing financial track record. Declining risk implies declining required rates of return. Hence, performance could appear to deteriorate with age when in fact the driving factor is declining risk.

Other finance papers have uncovered an inverse relation between age and ownership concentration (Holderness, Kroszner, and Sheehan (1999), Helwege, Pirinsky, and Stulz (2007), and Holderness (2007)). In principle, if ownership were positively related to performance, this regularity could induce a spurious negative relation between age and performance.

Age could also correlate with corporate-governance quality. Easterbrook and Fischel (1999) argue that newly listed firms start with relatively few provisions that shield them from the disciplinary forces of the takeover market, and that such takeover defenses are added only in later years (see, however, also Field and Karpoff (2002)). Since firms with weaker shareholder rights are less profitable (Gompers, Ishii, and Metrick (2003)), the adoption of takeover defenses over time could induce a negative relation between firm age and performance.

Finally, the diversification literature suggests a relation between age and performance as well. Over time, the reasoning goes, as their original industries mature, firms may be forced to enter other industries. Yet unrelated, or conglomerate, diversification harms performance (see, among others, Campa and Kedia (2002)).[4] Age could therefore correlate with diversification, and thereby indirectly with performance.

C. Investigative Design

To investigate the influence of firm age on performance, we have to differentiate it from spurious relations. That means, we have to distinguish between the contemporaneous effects of firm age, industry age, financial frictions, management age and tenure, ownership structure, corporate governance, risk, and corporate focus. We do so in a regression framework, the

4 Related diversification actually improves performance (Villalonga (2004)). Since the data we use are from COMPUSTAT, we can control only for unrelated diversification. If older firms are unable to engage in related diversification, their performance could conceivably worsen. Yet this hypothesis is essentially identical with the claim that organizational rigidities make it difficult for firms to innovate and keep up with the competition.

details of which are left for later discussion. The preceding considerations, taking into account some control variables that have been suggested in the literature, imply the following specification:[5]

Explanatory variable	**Predictions**
Age	–
Age^2	?
Financial frictions	–
Management age	–
Management tenure	–
Ownership concentration	+
Corporate-governance quality	+
Risk	?
Specialization	+
Size	–
Capital expenditures	?

We hypothesize a negative, possibly nonlinear relation between age and performance. That prediction follows from the preceding arguments concerning obsolescence of endowments, organizational rigidities, seniority rules, and organization memory. The specification we choose is a quadratic function, although the results do not change when using the natural logarithm of age instead. Potential industry-specific effects are filtered out by adopting industry-adjusted performance measures.

5 The literature on family firms has also looked at the relation between age and performance. Usually, however, it has done so in a tangential way. The main focus is the relation between ownership and performance. Still, Anderson and Reeb (2003) find that the log of firm age (measured since inception) in family firms is negatively related to accounting-based performance measures and Tobin's Q. Firm age could also be positively related to operational complexity (see, among others, and Coles, Daniel, and Naveen (2008)).

The control variables should have coefficients with the following signs. Financial frictions should impair performance (Clementi (2002) and Cooley and Quadrini (2001)). The same goes for management age and tenure. Moreover, firms with concentrated ownership or better corporate governance should have a better handle on agency problems with managers and therefore perform better. The coefficient of risk depends on the performance measure we use. As explained further down, we work with accounting rates of return on assets (ROA) and Tobin's Q ratios. ROA should correlate positively with risk (high risk, high return). The coefficient of Tobin's Q, however, should be zero in a cross-section, since Tobin's Q is a risk-adjusted measure of performance. In addition, more focused firms should perform better. Furthermore, performance should be negatively related with firm size (Cooley and Quadrini (2001)). Finally, the sign of capital expenditures cannot be assessed a priori. Firms that invest a lot may capture profitable growth opportunities and be able to stem obsolescence, but they may also throw good money after bad.

II. Data

A. 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. Unlike other studies, however, ours includes firms with business segments in the financial sector (SIC 6000–6999). The final sample consists of 10,930 firms and 82,845 firm-years, including 1,669 financials (6,644 firm-years).

We start with 2,285 firms in 1978 and end with 2,923 firms in 2004. Turnover is remarkably high: 8,654 firms enter and 7,896 firms leave between 1978 and 2004. Some of the firms that drop from the exchange may list again years later. In our approach, we treat them as separate firms. According to Fama and French (2004), however, only 145 firms go public in 1973–2001 after having gone private. We come back to this potential sample selection problem in the empirical analysis.

B. Firm Age

Our main variable of interest is firm age. Shumway (2001) claims that the economically most meaningful measure of firm age is the number of years since listing. That event is a defining moment in a company's life. Not surprisingly, listing affects ownership and capital structure, multiplies growth opportunities, increases media exposure, and demands different corporate governance structures (Loderer and Waelchli (2009)).

We follow Shumway (2001) and define firm age as the number of years (plus one) elapsed since the year of the company's IPO.[6] We refer to this variable as the firm's listing age. We add one year to avoid ages of zero. The information is from CRSP. 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

[6] More precisely, we approximate a firm's year of birth with the earliest of: (a) the year in which the firm appears on CRSP; (b) the year in which the firm is included in COMPUSTAT; and (c) the year for which we find a link between CRSP and COMPUSTAT (based on COMPUSTAT data item LINKDT). If, for example, a firm enters CRSP or COMPUSTAT in 1996, its age is one year at the end of 1996 (1+1996–1996) and five years at the end of 2000 (1+2000–1996).

80 years at the end of it, in 2004. For a random subsample of 5,000 firms, we also compute the number of years (plus one) elapsed since the year of incorporation, and denote this variable as the firm's incorporation age. The information is hand-collected from *Mergent Webreports*.

Panel A of Table I shows that, on average, listing age is 14 years; the median is 10. The distribution of firm age remains relatively stable over the sample period, except in the late 1990s, when the median drops to 7, possibly as a result of the dot-com IPO wave. Panel B of the table reports descriptive statistics for incorporation age. The typical firm is 23 years old and goes public at the age of 8.

Table I

Firm Age

The table shows descriptive statistics for the age of our sample firms. Panel A reports firm age by sample years. Panel B reports descriptive statistics for incorporation age.

Sample Year	Mean	Median	p25	p75	Max	Stdev	N
Panel A: Listing Age by Sample Year							
1978 – 2004	14.14	10.00	5.00	19.00	80.00	13.79	82845
1978	14.51	9.00	7.00	17.00	54.00	12.92	2285
1980	15.78	10.00	9.00	19.00	56.00	13.09	2277
1985	15.47	14.00	5.00	19.00	61.00	13.76	2589
1990	14.96	10.00	5.00	19.00	66.00	13.90	2808
1995	12.92	8.00	3.00	20.00	71.00	13.88	4097
2000	12.27	7.00	4.00	15.00	76.00	13.41	3523
2004	15.91	11.00	6.00	20.00	80.00	14.42	2923
Panel B: Incorporation Age							
1978 – 2004	32.06	23.00	12.00	45.00	280.00	27.36	40400
Age at listing	15.32	8.00	4.00	18.00	274	19.20	5051

C. Performance Measures and Control Variables

Our main performance measures are return on assets (ROA) and Tobin's Q. Whereas ROA measures current operating performance, Tobin's Q reflects the market's expectations about future performance. Panel A of Table II reports descriptive statistics for the two performance measures. The correlation between the two performance measures is 0.218. To account for industry-specific effects, such as industry life-cycles, we measure both performance metrics as arithmetic deviations from the median industry value (based on two-digit SIC codes) in any given year. As an alternative, we control for industry effects in the regressions using the 48 industry grouping suggested by Fama and French (1997). The results, however, are unchanged. To allow for autocorrelated performance, we add lagged performance values in our regressions. If age affects also past performance, however, this correction makes it more difficult to find an age effect. As it turns out, with and without correction, the results remain qualitatively the same.

In our robustness tests, we will also investigate alternative measures of operating performance, including sales growth and various cost measures. Moreover, for completeness, we will examine the impact of firm age on stock price performance. The details of these analyses are discussed later.

Table II

Descriptive Statistics

This table shows descriptive statistics for the performance measures and the control variables. We exclude here firms that operate in the financial sector (SIC 6000–6999) to make our data more comparable with those of other studies. All control variables are winsorized at the 5th and 95th percentile of their pooled distribution across all firm-years. Total assets and capital expenditures (net of depreciation) are in constant 1978 dollars. Variable definitions are shown in Table X. The sample period is 1978 – 2004.

Variable	Mean	Median	Min	Max	Stdev	N
Panel A: Performance Measures						
Unadjusted ROA	0.122	0.125	–0.083	0.293	0.093	74,747
Unadjusted Tobin's Q	1.591	1.270	0.780	4.050	0.858	75,344
Panel B: Control Variables (Full Sample)						
KZ index	–2.449	–0.403	20.158	2.870	5.711	61,397
Volatility	0.643	0.564	0.238	1.435	0.326	73,271
Focus	0.848	1.000	0.113	1.000	0.237	76,201
Size	–10.530	–10.578	–14.436	–6.303	1.737	75,364
Capex	–0.030	–0.025	–0.233	0.140	0.093	72,081
Total assets	587.785	82.410	0.507	127,398.2	2,730.5	75,344
Capital expenditures	14.221	1.447	–15.822	120.330	32.338	71,370
Panel C: Control Variables (Reduced Sample)						
CEO age	55.211	55.000	43.000	68.000	6.864	10,601
CEO tenure	7.663	6.000	1.000	23.000	6.045	9,979
Director age	58.440	58.778	50.500	65.166	3.927	7,589
Director tenure	9.265	8.333	3.600	14.300	3.745	5,837
Inside ownership	0.034	0.000	0.000	0.245	0.069	3,958
Governance index	9.065	9.000	5.000	14.000	2.582	11,835

Panel B and C of Table II show descriptive statistics for our control variables, which are defined in Table X at the end of the paper. To reduce the influence of outliers, we follow Campbell, Hilscher, and Szilagyi (2008) and winsorize all control variables at the 5th and 95th percentile of their pooled distribution across all firm-years. Panel B lists the control variables with data available for all sample firms. To asses financial constraints (*KZ index*), we use an index similar to that of Kaplan and Zingales (1997). Our proxy for risk is the annualized standard deviation of the firm's daily stock return (*Volatility*). A Herfindahl index based on the sales in the firm's different segments captures the degree of specialization (*Focus*). Firm size (*Size*) is approximated with the logged ratio of the firm's market capitalization divided by that of CRSP's NYSE/AMEX/Nasdaq equal-weighted index (Campbell, Hilscher, and Szilagyi (2008)). Finally, *Capex* reflects the firms' capital expenditures (net of depreciation), standardized by the market value of its assets. These variables, together with year dummies, form our so-called standard regression specification. For reading convenience, Table II also reports descriptive statistics for the firms' unstandardized market value of assets and capital expenditures.

We also collect information about the firms' management team, ownership structure, and corporate-governance quality. Descriptive statistics are in Panel C of Table II. Since these variables are available only for a limited subsample of firms, we do not include them in the standard regression. We examine their relevance in our tests of alternative hypotheses.

Finally, Table III computes pairwise correlation coefficients between the regression arguments. Except for the correlation between listing and incorporation age, which equals 0.73, most coefficients are fairly low. The largest are those of firm age with return volatility (about –0.40), governance index (around 0.35), director age (roughly 0.30), and firm size (less than 0.31). Capital expenditures are also tangibly, though moderately, correlated with the KZ index of financial constraints (0.38), and the same can be said about the various correlations between age and tenure of CEOs and directors. In no case, however, is there any concern about collinearity (listing and incorporation age do not appear jointly in any regression specification).

Table III

Correlation Coefficients between Regression Arguments

The table shows Pearson correlation coefficients between pairs of regression arguments. The sample period is 1978 – 2004.

	Age	Age_{inc}	KZ index	Vola.	Focus	Size	Capex	CEO age	CEO tenure	Dir. age	Dir. tenure	Inside own.
Age_{inc}	0.730											
KZ index	–0.026	–0.014										
Volatility	–0.394	–0.419	–0.014									
Focus	–0.327	–0.292	–0.019	0.220								
Size	0.303	0.180	–0.076	–0.264	–0.170							
Capex	0.133	0.144	0.381	–0.195	0.065	–0.027						
CEO age	0.186	0.149	0.027	–0.163	–0.078	0.080	0.051					
CEO tenure	–0.101	–0.097	–0.029	–0.021	0.001	–0.003	0.020	0.365				
Director age	0.339	0.284	0.034	–0.244	–0.154	0.079	0.147	0.408	0.084			
Director ten.	0.190	0.217	–0.045	–0.178	–0.066	0.025	0.007	0.190	0.344	0.402		
Inside own.	–0.197	–0.167	–0.011	–0.003	0.120	–0.212	0.001	0.045	0.241	–0.078	0.181	
Gov.index	0.346	0.367	0.019	–0.298	–0.298	0.136	0.072	0.124	–0.055	0.263	0.112	–0.185

III. Firm Age and Performance

A. Results

Panel A of Table IV shows the results of robust panel regressions of firm performance on listing age for the standard specification. The Hausman specification test reported at the bottom of the table prefers fixed effects to random effects. We therefore include firm fixed effects to account for firm heterogeneity. We also add period fixed effects to capture the impact of the overall state of the economy.[7] Regressions (1) and (2) are estimated for the full sample; regressions (3), (4), and (5) exclude financial firms (SIC codes 6000–6999).

Performance first declines with age and then seems to rise again. Both the linear and the squared effect are statistically significant at the 1 percent level, regardless of the performance

[7] In untabulated results, we also run pooled OLS regressions with year-dummies and firm-clustered standard errors. Since the results are qualitatively the same, we do not discuss them separately.

measure used and of whether or not we include financials. The turning point comes relatively late. In the case of the first regression, which measures performance with ROA, it takes almost 100 years after the IPO for performance to start recovering. When we measure performance with Tobin's Q, it takes an estimated 47 years before an additional year of age improves expected performance.

The control variables have coefficients mostly in line with the predictions. Financial constraints impair firm performance (Lamont, Polk, and Saá-Requejo (2001)), regardless of how we measure it. In contrast, strategic focus has a positive and significant effect on Tobin's Q. Unrelated diversification is therefore bad for business, consistent with the extant literature on the corporate diversification discount (see, among others, Campa and Kedia (2002) and Villalonga (2004)). We also find that larger firms do worse (see, for example, Lang and Stulz (1994)), and so do firms with high stock volatility, which, in the case of ROA, is difficult to square with a risk argument. Higher capital expenditures (net of depreciation) also seem to have a negative effect on performance, at least when performance is measured with ROA. At first blush, this is inconsistent with the claim that capital expenditures offset obsolescence.

In untabulated regressions, we also controlled for financial leverage, dividend payments, and R&D expenses. Leverage could be related to firm value in various ways, for example by reducing agency costs, lowering taxes, or increasing the costs of financial distress (see Harris and Raviv (1991), among many others). Dividend payments seem to identify more profitable firms (Fama and French (2001)). And R&D expenses are a proxy for growth opportunities (Mehran (1995)). The results do not change when we include these variables—performance deteriorates over time.

Table IV

Firm Age and Performance

The table investigates the relation between firm age and performance. Variable definitions are in Table X. Performance is measured with return on assets (ROA) and Tobin's Q. Both measures are adjusted for industry effects by subtracting the performance of the median firm in the industry, defined with two-digit SIC codes and based on the firms with sufficient data on COMPUSTAT. We use panel regressions with fixed effects and robust standard errors. The overall state of the economy is captured with period fixed effects (year dummies). Panel A measures age since the year of listing. Regressions (1) and (2) are estimated for the full sample. Regressions (3), (4), and (5) exclude financials (SIC codes 6000–6999). Robust standard errors are reported in parentheses. Panel B replicates the analysis by measuring firm age since the year of incorporation (Age_{inc}). To save space, we report only the coefficients for Age_{inc} and Age^2_{inc}. For convenience, the coefficients there are multiplied by 100 and 10,000, respectively. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The years under investigation are 1978 to 2004.

Panel A: Age = Listing age

	Full Sample		Non-Financial Firms		
	ROA	Tobin's Q	ROA	Tobin's Q	
	(1)	(2)	(3)	(4)	(5)
Age	–0.002 ***	–0.034 ***	–0.002 ***	–0.035 ***	–0.028 ***
	(0.0002)	(0.003)	(0.0002)	(0.003)	(0.003)
Age^2 / 100	0.001 ***	0.036 ***	0.001 ***	0.038 ***	0.030 ***
	(0.0003)	(0.005)	(0.0003)	(0.005)	(0.005)
KZ index	–0.005 ***	–0.028 ***	–0.005 ***	–0.029 ***	–0.029 ***
	(0.0004)	(0.003)	(0.0004)	(0.003)	(0.003)
Volatility	–0.071 ***	–0.304 ***	–0.071 ***	–0.288 ***	–0.294 ***
	(0.003)	(0.035)	(0.003)	(0.036)	(0.037)
Focus	0.004	0.181 ***	0.004	0.179 ***	0.322 ***
	(0.003)	(0.048)	(0.003)	(0.049)	(0.078)
Age × Focus					–0.007 ***
					(0.002)
$Size_{t-1}$	–0.007 ***	–0.046 ***	–0.007 ***	–0.043 **	–0.046 ***
	(0.001)	(0.016)	(0.001)	(0.017)	(0.017)
Capex	–0.120 ***	0.320	–0.120 ***	0.314	1.140 ***
	(0.010)	(0.201)	(0.011)	(0.210)	(0.327)
Age × Capex					–0.060 ***
					(0.011)
ROA_{t-1}	0.356 ***		0.355 ***		
	(0.014)		(0.015)		
Tobin's Q_{t-1}		0.206 ***		0.204 ***	0.203 ***
		(0.023)		(0.025)	(0.025)
Constant	–0.035 ***	–0.051	–0.033 ***	–0.026	–0.156
	(0.011)	(0.168)	(0.012)	(0.176)	(0.178)
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	64,662	64,740	59,704	59,768	59,768
F-Test	86.58 ***	40.26 ***	76.27 ***	38.24 ***	36.07 ***
Hausmann test (χ^2)	6,987.7 ***	3,220.9 ***	3,351.0 ***	3,328.6 ***	3,416.7 ***

Table IV—Continued

Panel B: Age = Incorporation age (Age_{inc})

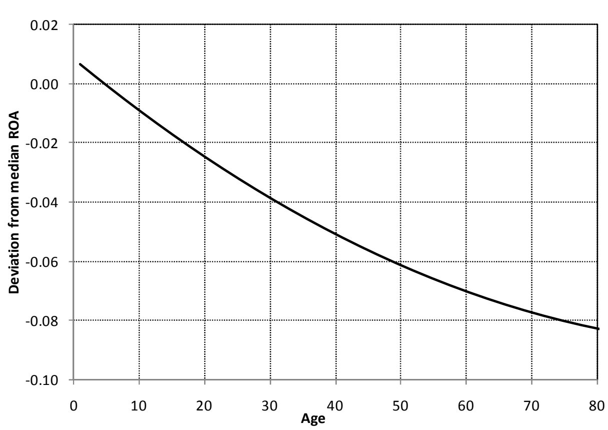
	ROA		Tobin's Q	
	$Age_{inc}/100$	$Age^2_{inc}/10000$	$Age_{inc}/100$	$Age^2_{inc}/10000$
Full sample	–0.176 ***	0.044 *	–3.406 ***	1.743 ***
Non-financials	–0.158 ***	0.037	–4.344 ***	2.708 ***

Figure 1 plots the relation between listing age and performance, holding the other variables at their median value. Figure 1(a) refers to ROA, Figure 1(b) examines Tobin's Q. Two aspects are noteworthy. First, the overall contribution of age to performance is negative over the range of ages observed in the sample (the maximum age is 80). Second, very few firms in the sample actually live long enough to experience the possible turning point in the age-performance relation, since only four out of 100 firms in the sample reach age 50.

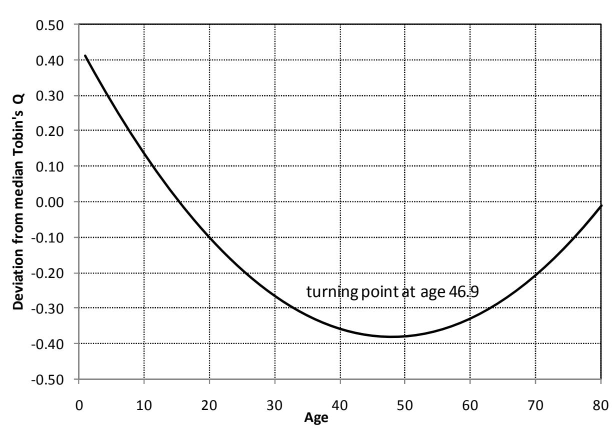
Figure 1

The Relation between Age and Performance

Figures (a) and (b) plot the relation between age and performance based on regressions (1) and (2) of Table IV, measuring all other variables in the regression equation at their median value.



(a) Age and ROA



(b) Age and Tobin's Q

The coefficients imply that newly listed firms (*Age* = 1) outperform the median firm in their industry by 0.6 percentage points in ROA and 0.41 in Tobin's Q. This advantage, however, wanes over time. For each additional year of life, industry-adjusted ROA (Tobin's Q) declines by roughly 0.18 percentage points (0.03). At the age of 5 (16 for Tobin's Q), firms start underperforming their industry peers—and they never recover.

One could argue that older firms are more likely to operate in relatively old and unattractive industries. Therefore, the relation between firm age and performance could simply reflect a negative link between industry age and performance. Yet our performance measures are industry-adjusted, so industry-specific effects cannot explain our results.

The results are robust to age definition. In Panel B of Table IV, we reestimate the standard regression but measure firm age since the year of incorporation. To save space, we report only the coefficients of the two age covariates. The message in the data is still that firm performance deteriorates over time. This is especially true if we measure performance with Tobin's Q. The coefficients imply that firms start underperforming their industry peers around incorporation age 35. The evidence of a positive quadratic effect of incorporation age, however, is more tenuous, at least when ROA is the performance proxy.

These findings can help us gauge the importance of our decision to ignore the fact that some firms relist after having gone private. As mentioned in the data section, we classify these firms as newly listed companies. In principle, since firms that relist are presumably doing well, our classification could make the average performance of older firms look worse than it really is, which could induce the age effect we observe. Yet only few firms in the sample relist after having gone private. More important, the same results obtain when measuring age since the date of incorporation. Older firms do not resurrect as young firms when they relist, they maintain their incorporation age. The evidence therefore shows that relistings can hardly explain our results.

Since the findings for listing age and incorporation age are generally the same, what follows reports the results only for one age definition. We choose listing age, because it is available for the full sample of firms.

B. Signs of Corporate Obsolescence

The negative age-performance relation is consistent with the idea that there are such things as corporate obsolescence and organizational rigidities. The ultimate question, of course, is what additional observations we can muster to support our claim. For obvious reasons of space, much of this paper is dedicated to uncovering the relation in question, but some observations are close to the proverbial "smoking gun" in our investigation of the crime that age commits against corporations.

First, when we add the interaction term *Age*×*Capex* in the regressions involving Tobin's Q of Table IV, it has a negative and significant coefficient, whereas *Capex* alone has a positive and significant effect in that specification. Hence, whereas net capital expenditures per se appear to enable the firm to realize profitable growth opportunities, they seem to have a deleterious effect in older firms. Perhaps older firms that invest do so in increasingly outdated structures and antiquated processes. The regressions involving ROA yield the same results (not shown).

Second, the interaction term *Age×Focus* in the same regression has a negative and significant coefficient. Older firms that are focused perform significantly worse than others. This could suggest the presence of operational rigidities. Being old and focused may reveal an inability to adjust to changes.

Third, when we replicate the analysis in Table IV for the sample of low-tech and high-tech firms separately, the coefficients associated with firm age are less extreme for low-tech firms (not shown). In the case of Tobin's Q, the difference is significant with better than 0.99 confidence in a test against zero.[8] That means age has a stronger impact on the performance of high-tech firms, consistent with the intuition that age plays a more important role in industries where obsolescence is more likely to manifest itself.

Finally, and perhaps more importantly, age also leaves its fingerprints on growth, profit margins, and cost structures. Consistent with the notion that older firms operate with increasingly outdated structures and processes, Table V documents that growth slows and profit margins deteriorate as firms grow older, whereas overhead expenses and costs of goods sold (COGS) increase with age. Sales growth, margins, and costs are expressed as deviations from the median industry value based on two-digit SIC codes. The control variables in these regressions are those from Table IV. To save space, we report only the coefficients of the two age covariates.

The coefficients are also economically meaningful. If we keep all covariates at their median value and allow only for age to vary, the numbers imply that a newly listed firm's sales growth exceeds that of the industry by 7.1 percentage points. Growth slows by approximately

---

[8] We use the industry classification of Francis and Schipper (1999, p. 343) to distinguish between low-tech and high-tech firms.

0.8 percentage points each year and falls behind the industry median after eleven years. Similarly, the profit margin of newly listed firms is roughly 2.9 percentage points above the industry median. After ten years, this advantage is down to 1.2 percentage points, and after 17 years the margin falls below that of the typical firm in the industry. Firms also start with relatively lean cost structures and few overhead expenses—their overhead-to-assets ratio is 3.7 percentage points below the industry median. It takes only nine years, however, for this advantage to turn into a disadvantage. After fifteen years, the firms' overhead-to-assets ratio is already 2.6 percentage points above that of the industry.

Table V

Firm Age, Profit Margins, and Cost Structure

The table asks how profit margins and cost structures are related to firm age. Variable definitions are in Table X. The dependent variable is sales growth in regression (1) and gross profit margin in regression (2). In regression (3), the dependent variable is overhead expenses, and in regression (4), it is cost of goods sold (as a fraction of sales). All four variables are expressed as deviations from the median industry value, based on two-digit SIC codes. The control variables are those from Table IV. To save space, we report only the coefficients for *Age* and *Age*^{2}. For convenience, we multiply the coefficients by 100 and 10,000, respectively. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

	Sales growth	*Gross margin*	Cost Structure	
			Overhead	*COGS*
	(1)	(2)	(3)	(4)
Age / 100	–0.813 ***	–0. 196 ***	0.493 ***	0.179 ***
Age^2 / 10000	0.860 ***	0. 055 **	–0.279 ***	–0.045 *
Turning point	47.24	177.57	88.37	197.5

C. Robustness Tests

Overall, the evidence suggests the existence of a significant age effect. This section inquires into the robustness of that finding. We want to know more about the shape of the age-performance relation, whether the deterioration in performance is confined to specific time periods, and whether it is driven by the presence of many small firms in the sample.

C.1. Piecewise Linear Regressions

To find out more about the shape of the age-performance relation, we follow Morck, Shleifer, and Vishny (1988) and run piecewise linear regressions that allow for changes in the coefficient of age at age 5, 10, 20, and 30, respectively. Age 5 defines the first quartile of the age distribution; 10 is the median age; 20 is the third quartile; and approximately 10 percent of all observations are beyond age 30. In our standard regression from Table IV, we therefore substitute *Age* and Age^2 with the following variables:

$$
\begin{aligned}
Age.1to5 &= Age \text{ if } Age < 5, \\
&= 5 \text{ if } Age \geq 5;
\end{aligned}
\qquad
\begin{aligned}
Age.6to10 &= 0 \text{ if } Age < 5; \\
&= (Age - 5) \text{ if } 5 \leq Age < 10, \\
&= 5 \text{ if } Age \geq 10;
\end{aligned}
$$

$$
\begin{aligned}
Age.11to20 &= 0 \text{ if } Age < 10 \\
&= (Age - 10) \text{ if } 10 \leq Age < 20; \\
&= 10 \text{ if } Age \geq 20;
\end{aligned}
\qquad
\begin{aligned}
Age.21to30 &= 0 \text{ if } Age < 20 \\
&= (Age - 20) \text{ if } 20 \leq Age < 30; \\
&= 10 \text{ if } Age \geq 30;
\end{aligned}
$$

$$
\begin{aligned}
Age.over30 &= 0 \text{ if } Age < 30 \\
&= (Age - 30) \text{ if } Age \geq 20.
\end{aligned}
$$

A firm age of 18 years, for example, would imply that *Age.1to5* = 5; *Age.6to10* = 5; *Age.11to20* = 8; *Age.21to30* = 0; and *Age.over30* = 0. The results are in Table V. For brevity, we report only the coefficients of the five age covariates.

Table VI

Piecewise Linear Regressions

The table inquires into the shape of the age-performance relation with piecewise linear regressions. The age covariates are *Age.1to5*, *Age.6to10*, *Age.11to20*, *Age.21to30*, and *Age.over30*. Firm age of 18 years, for example, implies that *Age.1to5*=5; *Age.6to10*=5; *Age.11to20*=8; *Age.21to30*=0; *Age.over30*=0. The control variables and the estimation techniques are those from Table IV. To save space, we report only the coefficients of the age variables and the associated significance levels. For convenience, we multiply the coefficients by 100. The dependent variables are *ROA* (Column 1), *Tobin's Q* (Column 2), *Sales growth* (Column 3), *Gross margin* (Column 4), and *Overhead* (Column 5), respectively, all adjusted for industry effects. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

	ROA (1)	*Tobin's Q* (2)	*Sales growth* (3)	*Gross margin* (4)	*Overhead* (5)
Age.1to5 / 100	–0.251 ***	–9.344 ***	–6.731 ***	–0.203 ***	1.056 ***
Age.6to10 / 100	–0.256 ***	–4.645 ***	–2.002 ***	–0.220 ***	0.632 ***
Age.11to20 / 100	–0.125 ***	–0.502 *	–0.611 ***	–0.174 ***	0.248 ***
Age.21to30 / 100	–0.104 ***	–2.124 ***	–0.315 ***	–0.157 ***	0.367 ***
Age.over30 / 100	–0.112 ***	0.056	–0.042	–0.142 ***	0.250 ***

Overall, the results confirm what we found so far: performance deteriorates as firms grow older. There is no evidence, however, of a U-shaped relation—performance does not rebound at very old age. It seems that the significance of Age^2 in the standard specification is induced by a *marginal* age effect that slowly melts away. According to regression (1), ROA drops by an annual 0.25 percentage points during the first ten years and by roughly 0.1 percentage points thereafter. This change is statistically significant with confidence 0.95. Tobin's Q (regression 2) behaves similarly. Its decline is pronounced at very young age and relatively moderate as firms grow older. Similar results obtain when investigating sales growth (regression 3), profit margins (regression 4), and overhead (regression 5). Sales growth, for example, drops by an annual 6.7 percentage points between age 1 and 5, 2.0 percentage points between age 6 and 10, 0.6 percentage points between age 11 and 20, and 0.3 percentage points between age 21 and 30; thereafter, the marginal effect of age is zero.

For simplicity of exposition, we will continue our investigation with the original specification and measure age with *Age* and Age^2. The results remain the same, however, if we rely on piecewise linear measures.

C.2. Different Sample Years and Large Firms

We also ask whether the results hold across different time periods. Table VII shows the coefficients of *Age* and Age^2 if we replicate our standard regression for the years 1978–1985, 1986–1995, and 1996–2004, respectively. The coefficient of *Age* is always negative and significant and the coefficient of Age^2 is generally positive and significant with confidence 0.95 or better. The overall message therefore remains the same.

The results could also be due to the presence of many small firms. The evidence rejects that conjecture, however. When we limit the analysis to S&P 500 firms, we observe the same convex age-performance relation.

Table VII

Robustness Check of the Relation between Firm Age and Performance

The table replicates the regressions of Table IV for subperiods of the sample years and when focusing on the firms in the S&P 500 index. For brevity, we report only the coefficients of *Age* and Age^2 and the associated significance levels. For convenience, we multiply the coefficients by 100 and 10,000, respectively. Columns (1) and (2) show the results if we measure firm performance with industry-adjusted ROA. In columns (3) to (4) we measure firm performance with industry-adjusted Tobin's Q. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

	ROA		*Tobin's Q*	
	Age/100	Age^2/10000	*Age*/100	Age^2/10000
1978–1985	–0.340 ***	0.452 ***	–1.841 ***	2.725 ***
1986–1995	–0.224 ***	0.139 **	–0.897 **	0.158
1996–2004	–0.496 ***	0.152	–9.935 ***	7.480 ***
S&P-500 firms	–0.154 ***	0.095 **	–3.532 ***	3.680 ***

D. Alternative Hypotheses

In short, the age regularity we uncover appears to be quite robust. What follows, examines alternative interpretations of the evidence and therefore inquires whether it is driven by firms in the early years after their IPO, risk, ownership structure, age of management, corporate governance, or sample selection.

D.1. Is the Age Effect a Reincarnation of the Post-IPO Regularities?

Jain and Kini (1994) find that operating performance deteriorates after the IPO. Loughran and Ritter (1995), among others, document that the stock of newly listed firms underperforms in the years after the IPO as well (see, however, Fama (1998)). Our findings could in principle reflect this IPO effect. There are, however, several reasons to doubt. First, as we have seen in Panel B of Table IV, the same results obtain when measuring age from the date of incorporation rather than that of listing. Second, the piecewise linear regressions in Table VI indicate that the marginal contribution of age to performance is negative also several years after the IPO. Third, when we estimate our standard regressions in Table IV and exclude, alternatively, all firms younger than 3, 5, and 10 years, we obtain the same results (not shown). Overall, it is difficult to believe that our results simply replicate the IPO effect. In fact, the IPO effect could be an age effect.

D.2. Is the Age Effect a Manifestation of Declining Risk?

As mentioned in Section B, age could also be a proxy for risk. Older firms have a longer track record and the investment risk they represent could therefore fall over time. A few considerations, however, cast doubts on a pure risk interpretation of the observed age effect. First, we do control for risk (return volatility). Second, as we have already seen, costs go up with age. Risk considerations cannot explain that finding. Third, the same results obtain when we restrict the analysis to public utilities, a subset of firms with comparatively few operational uncertainties to begin with (not shown). And fourth, the relation remains the same in separate cross-sectional analyses of individual years when performance is measured with Tobin's Q. Tobin's Q should be unrelated to risk in a cross-section (not shown).

D.3. Is the Age Effect a Manifestation of Declining Ownership Concentration?

The empirical literature finds a negative relation between ownership concentration and firm age. At the same time, agency theory suggests that ownership correlates positively with performance. It is therefore conceivable that increasing age could simply be a proxy for declining ownership concentration.

To find out whether this is so, we use blockholder data from Dlugosz, Fahlenbach, Gompers, and Metrick (2006) for the years 1996 to 2001. There are matching data for 1,180 firms (3,992 firm-years). Consistent with previous studies, we find that ownership concentration is lower in older firms (Panel A of Table VIII). We then run random-effects panel regressions with year dummies and firm-clustered standard errors to account for the relatively shortness of the matched panel. When extending the standard specification from Table IV with the cumulative fraction of shares controlled by the firm's officers and directors (*Inside ownership*) and its squared value, we still find a U-shaped relation between firm age and performance (regression 1 of Table VIII B).[9] These results do not change when we control for the stake of the largest shareholder, the blockholders as a group, and the outside shareholders (not shown). Overall, therefore, it is difficult to claim that the age-performance relation is a surrogate for an underlying relation between ownership concentration and performance.

D.4. Is the Age Effect a Manifestation of Older People in the Organization?

Faleye (2007) finds a negative relation between the average age of a firm's directors and Tobin's Q. If older firms are managed by older people, firm age could be a proxy for the age of the firm's managers and directors. To find out whether it is the age of the organization or that of its people that impairs performance, we collect age and tenure data for the sample firms' CEOs and directors. The information is from *RiskMetrics* and *ExecuComp*, respectively. We find

[9] However, there is no significant relation between age and performance if we estimate the fixed-effects model from Table IV. Adding measures of ownership concentration does not change that conclusion.

matching data for 1,830 CEOs (11,447 firm-years) in 1992–2004 and for 1,896 boards (8,176 firm-years) in 1996–2004.

Panel A of Table VIII shows that the CEOs and the directors of older firms are indeed older themselves, and they have been with the company for a longer time. For example, the CEO of firms older than the median is 56, on average; in younger firms, he is 53. Similarly, directors of older firms are 59, on average, whereas in younger firms they are 56. Including these variables in our standard regression from Table IV, however, does not affect our conclusions. We can confirm Faleye's (2006) negative relation between director age and performance, but we still find a U-shaped relation between firm age and Tobin's Q (regression 2 of Table VIII B). The same conclusions follow when measuring performance with ROA (not shown). The results remain the same when we add the squared value of the CEO's and of the directors' age, as well as the squared value of their tenure (not shown).

D.5. Is the Age Effect a Manifestation of Sample Selection?

Survival bias could also explain our results.[10] Let us illustrate this interpretation with an analogy. Firms can be thought of as antelopes. In our story, the M&A market plays the role of lions that feed on antelopes. We can assume that young antelopes taste better than old ones—young firms seem to be more attractive takeover targets (Loderer, Neusser, and Waelchli (2009)), possibly because the old ones have lost their flexibility and are therefore more difficult to integrate into a new organization. Suppose now the agility of antelopes is a random variable independent of age. If so, the young antelopes that survive will tend to be more agile than the old survivors, simply because the weak among them will be caught and eaten by the lions.

[10] We are indebted to Yakov Amihud for suggesting this interpretation.

Natural selection will therefore induce a negative relation between agility and age of the antelopes. The same happens in the M&A market, since poor performers are less likely to survive (Loderer, Neusser, and Waelchli (2009)). This more radical weeding out of poor performers in the cohort of young firms could therefore induce the negative relation between performance and firm age, even if unconditional firm performance is unrelated to firm age.

Table VIII

Test of Alternative Interpretations

The table tests alternative interpretations of the observed relation between firm age and performance. Variable definitions are in Table X. Panel A displays descriptive statistics for the firms' ownership structure, the age and tenure of their CEOs and directors, and their score on the corporate governance index from Gompers, Ishii, and Metrick (2003). The first column shows average values of these new variables for the younger firms in the sample (listing age < industry median). The second column shows average values for the older firms (listing age > industry median). The third column tests for differences. Note that a high governance index means weaker shareholder rights. Panel B shows the results from random-effects panel regressions with year dummies and firm-clustered standard errors. The specification is the same as in regression 2 of Table IV, with the additional control variables *Inside ownership*, *CEO age*, *CEO tenure*, *Director age*, *Director tenure*, and *Governance index*. For brevity, we do not report the coefficients of the other control variables. Panel C tests the sample selection hypothesis by re-estimating our standard regression from Table IV for firms with superior performance. In column (1) and (2), we include only firms with ROA above the industry median. Similarly, in columns (3) and (4) we include only firms with Tobin's Q above the industry median. We report only the coefficients for *Age* and Age^2. For convenience, we multiply the coefficients by 100 and 10,000, respectively. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1978 – 2004.

Panel A: CEO and Director Age, and Corporate Governance Index

	Age < Industry Median	Age > Industry Median	t-Test
Inside ownership	0.050	0.038	–3.245 ***
CEO age	52.71	56.42	–23.729 ***
CEO tenure	7.35	8.52	–7.501 ***
Director age	55.98	59.24	–30.726 ***
Director tenure	8.59	10.77	–2.546 **
Governance index	7.90	9.37	–25.911 ***

Table VIII—Continued

Panel B: Test of Manager Age and of Corporate Governance Effects

	Tobin's Q				
	(1)	(2)	(3)	(4)	(5)
Age	–0.021 ***	–0.026 ***	–0.010 ***		–0.025 **
	(0.007)	(0.006)	(0.002)		(0.011)
Age^2 / 100	0.018 **	0.025 ***	0.009 ***		0.024 **
	(0.008)	(0.006)	(0.003)		(0.012)
Inside ownership	–0.338			–1.015	–1.511
	(1.392)			(2.231)	(2.260)
Inside ownership^2	3.982			8.562	9.612
	(7.673)			(14.173)	(14.187)
CEO age		0.006		0.001	0.002
		(0.005)		(0.007)	(0.007)
CEO tenure		0.006		0.016 **	0.013 *
		(0.004)		(0.008)	(0.008)
Director age		–0.027 ***		–0.023	–0.019
		(0.009)		(0.014)	(0.014)
Director tenure		0.012		0.006	0.021
		(0.010)		(0.017)	(0.017)
Governance index			–0.003	–0.052 ***	–0.034
			(0.005)	(0.020)	(0.021)
Remaining control variables	Included	Included	Included	Included	Included
Number of firm-years	3,940	4,840	11,799	2,134	2,134

Panel C: Test of Sample Selection

	ROA		Tobin's Q	
	Age/100	Age^2/10000	*Age*/100	Age^2/10000
	(1)	(2)	(3)	(4)
Age = Listing age	–0.112 ***	0.042	–3.521 ***	6.160 ***
	(0.017)	(0.028)	(0.498)	(0.932)
Age = Incorporation age	–0.101 ***	0.008	–3.264 ***	2.417 ***
	(0.024)	(0.018)	(0.679)	(0.578)

To discriminate between this lion hypothesis (a sample selection hypothesis) and our claim that it is age itself that reduces performance, we replicate our regressions for the firms in the sample with superior performance (i.e., above the industry median). Since lions supposedly feed on the weaker antelopes, they should have no effect on the observed conditional mean agility of the faster antelopes. By analogy, natural selection in the market for corporate control should have no direct effect on the observed mean performance of the better firms. As it turns out, our results don't go away: there is still a strong negative relation between age and performance. Even the better among the older firms fail to keep up with the competition (Panel C of Table VIII).

E. Age and Stock Returns

The last step of our investigation inquires into the relation between firm age and stock returns. If market participants understand the effects of firm age, then stock returns and firm age should be unrelated. To conduct our analysis, we reestimate both our standard regression from Table IV and the extended regression from Table VIII with annual market-adjusted stock returns as the dependent variable. 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 ($DATA199_{t-1}$) minus 1.[11] Our proxy for the market return is the return on CRSP's NYSE/AMEX/Nasdaq equal-weighted index. To control for industry effects, the regression specifications include industry dummies based on 2-digit SIC codes (so far, we controlled for industry effects by expressing performance as a deviation from the industry average). The results are shown in Panel A of Table IX. Columns 1 and 2 look at listing age, whereas columns

[11] To account for stock splits, equity offerings, etc., we adjust stock prices and dividend payments with COMPUSTAT's cumulative adjustment factor (DATA27). The results remain the same if we use industry-adjusted stock returns (2-digit SIC) as the dependent variable. We also included the market-to-book ratio of the firm's equity—a proxy for its growth opportunities—as an additional control variable. Again, the results do not change.

3 and 4 focus on incorporation age. As before, we report only the coefficients of the two age covariates.

Table IX

Firm Age and Stock Returns

The table inquires into the relation between firm age and stock returns. Panel A estimates the standard regression (Table IV) and the extended regression (Table VIII) specifications using annual market-adjusted stock returns as the dependent variable. Age is measured alternatively from the date of listing and that of incorporation. 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 ($DATA199_{t-1}$) minus 1. The proxy for the market return is the return on CRSP's NYSE/AMEX/Nasdaq equal-weighted index. Panel B replicates the standard regression using a piecewise linear approach to measure age. The age covariates are *Age.1to5*, *Age.6to10*, *Age.11to20*, *Age.21to30*, and *Age.over30*. Firm age of 18 years, for example, implies that *Age.1to5*=5; *Age.6to10*=5; *Age.11to20*=8; *Age.21to30*=0; *Age.over30*=0. For incorporation age, the relevant age limits are 12, 23, 45, and 88, respectively. To conserve space, Panels A and B report only the coefficients of the age covariates and the associated significance levels. Panel C examines portfolio returns. To this end, we assign our sample firms with CRSP data to one of five portfolios, based on their listing age. Portfolio 1 contains the youngest 20 percent of all firms listed in a given year, portfolio 5 includes the oldest 20 percent. Portfolios are value-weighted and reshuffled in June of each year, starting in 1978 and ending in 2004. Our zero-investment strategy goes long in Portfolio 2 and short in Portfolio 5. The dependent variable in the regressions is the return on our zero-investment portfolios. The risk factors are the returns on the three zero-investment portfolios suggested by Fama and French (1993) and reported on Ken French's Web site. We also include Carhart's (1997) momentum factor. Numbers in parentheses are Huber-White robust standard errors. 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* = Incorporation age	
	Standard regression (1)	Extended regression (2)	Standard regression (3)	Extended regression (4)
Panel A: Nonlinear regression				
Age / 100	–0.617 ***	–0.132	–0.954 ***	–0.321
Age^2 / 10,000	–1.230 ***	0.032	–0.338 ***	0.125
Panel B: Piecewise Linear Regression				
Age.1to5 / 100	–2.206 ***	–7.363	–1.528 ***	0.757
Age.6to10 / 100	–1.104 ***	3.090 **	–1.000 ***	0.397
Age.11to20 / 100	–0.562 ***	–0.349	–1.034 ***	–0.775 **
Age.21to30 / 100	–1.459 ***	–0.774	–1.484 ***	0.017
Age.over30 / 100	–1.830 ***	0.014	–1.691 ***	–0.068

Table IX—Continued

Panel C: Portfolio Returns

Zero-investment strategy: Young minus old				
Return (Average; % positive)	–0.206%		50.29%	
t-Test; proportion test (z)	–0.906		0.108	
Factor regressions:	(1)		(2)	
Intercept	–0.509	**	–0.067	
	(0.204)		(0.192)	
MRP	0.472	***	0.221	***
	(0.058)		(0.075)	
SMB			0.700	***
			(0.057)	
HML			–0.672	***
			(0.098)	
Momentum			–0.043	
			(0.049)	
R^2	0.247		0.691	
F-Value	67.11	***	103.58	***

Somewhat surprisingly, the results from the standard regression (columns 1 and 3) seem to indicate that stock returns decline significantly as firms grow older. For each additional year of listing (incorporation) age, excess returns drop by 0.62 (0.95) percentage points. However, there is no evidence of convexity in this relation. On the contrary, the coefficients of Age^2 are negative and significant, suggesting that the decrease in performance *accelerates* as firms grow older. Consistent with market efficiency, this apparent age effect, however, goes away as soon as we switch to the extended regression and include the additional control variables from Table VIII, namely ownership structure, management age, and governance quality (column 2). Under that specification, the coefficients of *Age* and Age^2 are statistically zero, regardless of how we measure firm age. Hence, there is no apparent age effect in stock returns. Since we can estimate the extended regression specification only for a subset of the sample firms, however, our conclusion could be sample-specific and therefore not general. Yet when we estimate our standard regression specification for the subset of firms in question, the coefficients of *Age* and Age^2 are once again statistically significant. Hence, it is the control variables that erase the significance of age, not the particular sample. Piecewise linear regressions lead to the same conclusions (Panel B).

As an alternative approach to unearth a possible relation between age and stock returns, we finally simulate investment strategies. Under the assumption that prices do not fully reflect company age, we go long young firms and short old ones. To this end, we assign our sample firms with CRSP data to one of five portfolios, based on their listing age. Portfolio 1 contains the youngest 20 percent of all firms listed in a given year, portfolio 5 includes the oldest 20 percent. Portfolios are value-weighted and reshuffled in June of each year, starting in 1978 and ending in 2004. Since the performance of very young firms might reflect an IPO effect (Loughran and Ritter (1995)), we go long in portfolio 2 and short in portfolio 5. As it turns out, including portfolio 1 does not change our conclusions.

Panel C of Table IX shows that our zero-investment portfolio yields an average monthly return that is insignificantly different from zero. The proportion of positive portfolio returns is also insignificantly different from the 50 percent we would expect by chance. Consequently, based on our simple simulation, age-related investment strategies do not yield any significant abnormal returns. We have not controlled for risk, however. To assess the portfolio returns on a risk-adjusted basis, we therefore estimate factor regressions similar to those in Core, Guay, and Rusticus (2006), among others. The associated results are shown in Panel C. The dependent variable is the return on our zero-investment portfolios. The risk factors are the returns on the three zero-investment portfolios suggested by Fama and French (1993) and reported on French's Web site. We also include Carhart's (1997) momentum factor. In regressions that control only for market risk (*MRP*), we find evidence of abnormal performance (regression 1). The average risk-adjusted excess return is actually negative (–51 basis points per month). However, when we control for the other three risk factors, our investment strategy generates monthly abnormal returns of only –7 basis points (regression 2). The statistical significance goes away. Hence, from this perspective as well, there is no evidence of successful age-related investment strategies. Of course, space limitations allow us to investigate only one possible strategy.

Taken together, the evidence indicates that stock returns are unrelated to firm age. That is not surprising if market participants are able to correctly assess the impact of age on corporations. A more detailed analysis, however, has to be left to future research.

V. Conclusions

This paper investigates how age affects a corporation's financial performance. We study listed firms. The results show that age progressively impairs performance, defined as ROA, Tobin's Q, and sales growth. This phenomenon could be the result of a deteriorating tradeoff between learning, new investments, and decay (Agarwal and Gort (1996, 2002)). It could also be the reflection of organizational rigidities and inertia that make it difficult for the firm to recognize, accept, and implement innovation signals from the market. Aging could also be associated with a proliferation of harmful seniority rules across the organization.

Young firms are the best, but then profits start to fall, margins thin, sales growth drop, and costs increase. Around 15 years after listing, firms can no longer keep up with the median company in the industry. There is little evidence that performance rebounds at a very old age, at least in the general context of piecewise linear regressions.

Taken together, these findings suggest that firms face a serious aging problem. They are robust to different estimation techniques and specifications, and cannot be explained away with alternative interpretations related to factors such as risk, ownership structure, age of officers and directors, industry age, quality of corporate governance, and sample selection.

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Table X

Variable Definitions

Variable	Definition
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.
CEO age	The age of the firm's CEO, measured in years. The information is from *RiskMetrics* for a subsample of 1,830 firms for the years 1992 to 2004 (11,447 firm-years).
CEO tenure	The number of years the CEO has been in office. The information is from *RiskMetrics* for a subsample of 1,830 firms for the years 1992 to 2004 (11,447 firm-years).
Capex	The ratio of capital expenses (DATA178) net of depreciation and amortization charges (DATA14) to the market value of assets. The market value of the assets is approximated by the book value of assets (DATA6) minus the book value of common equity (DATA60) plus the market value of common equity (DATA25×DATA199). The data are from COMPUSTAT.
COGS	The firm's COGS-to-sales ratio, defined as the cost of goods sold (DATA41) divided by net sales (DATA12). To account for industry-specific effects, we measure COGS as the deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
Director age	The average age of the firm's directors, measured in years. The information is from *ExecuComp* for a subsample of 1,896 firms for the years 1996 to 2004 (8,176 firm-years).
Director tenure	The average tenure of the firm's directors, measured in years. The information is from *ExecuComp* for a subsample of 1,896 firms for the years 1996 to 2004 (8,176 firm-years).
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: $H_E = \sum_{i=1}^{N} p_i$, 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.
Governance index	The firm's score on the governance index from Gompers, Ishii, and Metrick (2003). The index is provided on a bi- or tri-annual basis. To increase sample size, we interpolate the index for missing sample years. This yields a matching sample of 2,113 firms for the years 1990 to 2004 (12,690 firm-years).
Gross margin	The gross profit margin, defined as net sales minus cost of goods sold (DATA12–DATA41), divided by net sales (DATA12). To account for industry-specific effects, we measure the gross margin as the deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
Inside ownership	The cumulative fraction of shares controlled by the firm's officers and directors. This information is from Dlugosz, Fahlenbach, Gompers, and Metrick (2006) for a subsample of 1,242 firms for the years 1996 to 2001 (4,272 firm-years).
KZ index	The Kaplan and Zingales (1997) index that measures a firm's level of financial constraints. We follow Lamont, Polk, and Saá-Requejo (2001, p. 552) and compute the KZ index as: $-1.001909\times[(\text{DATA18}+\text{DATA14})/\text{DATA8}_{t-1}] + 0.2826389\times[(\text{DATA6}+\text{MV Equity}-\text{DATA60}-\text{DATA74})/\text{DATA6}] + 3.139193\times[(\text{DATA9}+\text{DATA34})/(\text{DATA9}+\text{DATA34}+\text{DATA216})] - 39.3678\times[(\text{DATA21}+\text{DATA19})/\text{DATA8}_{t-1}] - 1.314759\times[\text{DATA1}/\text{DATA8}_{t-1}]$.

Table X—Continued

Variable	Definition
Net margin	The firm's net profit margin, defined as income before extraordinary items (DATA18) divided by net sales (DATA12). To account for industry-specific effects, we measure the net margin as the deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
Overhead	The firm's overhead expenses (DATA189), standardized by the market value of its assets. To account for industry-specific effects, we measure overhead as the deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
ROA	Return on assets computed as the ratio of the firm's operating income before depreciation (DATA13) divided by the book value of total assets (DATA6). To account for industry-specific effects, we measure ROA as absolute deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
Sales growth	The change in net sales (DATA12, expressed in constant 1978 USD) relative to the previous year. To account for industry-specific effects, we measure sales growth as the absolute deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
Size	The log of the ratio of the firm's market capitalization (DATA25 $\times$ DATA199) to that of CRSP's NYSE/AMEX/Nasdaq equal-weighted index. The data are from CRSP and COMPUSTAT.
Tobin's Q	Tobin's Q, computed as the market value of the firm's assets divided by their book value. To account for industry-specific effects, we measure Tobin's Q as absolute deviation from the median industry value (based on two-digit SIC codes) in any given year. The data are from COMPUSTAT.
Volatility	The annualized volatility of the firm's daily stock return. We calculate the 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.