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Three Essays on Age and Firm Performance

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Old captains at the helm: Chairman age and firm performance

Urs Waelchli and Jonas Zeller*

December, 2012

This paper examines whether the chairmen of the board (COBs) impose their life-cycles on the firms over which they preside. Using a large sample of unlisted firms we find a robust negative relation between COB age and firm performance. COBs age much like 'ordinary' people. Their cognitive abilities deteriorate and they experience significant shifts in motivation. Deteriorating cognitive abilities are the main driver of the performance effect that we observe. The results imply that succession planning problems in unlisted firms are real. Mandatory retirement age clauses cannot solve these problems.

Keywords: age, chairman of the board, cognitive abilities, firm performance, corporate governance, unlisted firms.

JEL codes: G30, L20

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1. Introduction

Extensive literature in economics, psychology, and sociology documents a negative relation between an individual's age and job performance. On average, older individuals perform more poorly in a broad spectrum of cognitive tasks (see, for example, Verhaeghen and Salthouse, 1997), experience a shift in motivation (see, for example, Ebner et al., 2006), and seem to prefer a quieter life (Bertrand and Mullainathan, 2003; Li et al., 2011). These effects often emerge before the age of 50, evolving progressively as individuals grow older. This paper asks whether aging agents affect firm performance and why that could be the case. Because firms, in principle, can adjust their control structures, one would expect performance to be unrelated to the age of the company's captain.

The data tell a different story. Using a unique dataset from a recent survey of more than 1,500 chairmen of the board (COBs) of unlisted corporations in Switzerland, we document a strong and robust negative relation between COB age and various measures of firm performance. In a linear estimation, the numbers indicate that an increase in COB age of one standard deviation (9.6 years) is associated with a drop in return on assets of 0.8 percentage points. This corresponds to a performance decline of approximately 10 percent for the average firm. Non-parametric regressions reveal that the deleterious effect of COB aging starts at approximately age 50 and bottoms out at approximately age 65—Switzerland's official retirement age. Therefore, it appears that underperforming COBs use the official retirement age as a face-saving exit option.

To the best of our knowledge, we are the first to document a COB age effect in unlisted firms. This finding should contribute to the literature that asks whether individual managers matter for firm performance (see, for example, Bertrand and Schoar, 2003). It also corroborates the view that COBs are among the most prominent players in a corporation (Parker, 1990; Mace, 1986). It is their responsibility to establish and secure effective corporate governance (Florou,

2005) and to make sure that the board fulfills its central duties. According to the Swiss Code of Obligation (§716a), the board's non-transferable and inalienable duties include, among other things, the overall management of the company, the appointment and dismissal of management, and the monitoring of management. A growing body of literature on CEO-COB duality argues that the COB has important monitoring functions (Yermack, 1996; Dahya et al., 2002). Such internal monitoring would seem particularly relevant for unlisted firms because they often lack external mechanisms that could act as substitutes (Booth et al., 2002; Kim and Lu, 2011) and have no liquid stock market that allows (minority) shareholders to walk away.

The puzzling question is why COBs overstay. Several tests indicate that the answer to this question is related to the relatively weak corporate governance standards of unlisted firms (see also Loderer and Waelchli, 2010). When we replicate our analysis for a comparison sample of listed Swiss firms, we find profitability to be unrelated to the individual age of the COB (and other top managers). This finding is consistent with previous studies for listed firms in the U.S. (see, for example, Bhagat et al., 2010). Therefore, our results seem to apply to unlisted firms and not to firms at large. Corporate governance also plays an important role within the sample of unlisted firms. For example, we find the COB age effect to be stronger for firms with a more dispersed ownership structure, possibly because collective action problems among shareholders make it more difficult to monitor the monitor (Brickley et al., 1997).

Previous literature shows that the more extensive experience of older individuals can at least partially counteract the deleterious effects of aging (see, among others Korniotis and Kumar, 2011). This finding is also true for our sample. However, the combined effect of age and experience is still negative and significant.

In addition to experience, a factor that we control for throughout the investigation, Salthouse (2012) argues that an individual's cognitive abilities ('can do') and motivation ('will do') are the two main age-related determinants of job performance. Our unique dataset allows us to construct various measures of these determinants of job performance and to inquire into their relevance. Consistent with the extant literature, we find that cognitive abilities decline with age: older COBs perform significantly worse on a simple speed measure—the time it takes to fill in the questionnaire (see, among others, Park and Reuter-Lorenz, 2009)—and they are more likely to concede that job complexity has increased. Also the 'will do' function seems to deteriorate with age. We find that 1) older COBs are less likely to focus on shareholder value maximization; 2) older COBs prefer 'bureaucratic' activities over strategic tasks; and 3) older COBs are less appreciative of performance-sensitive compensation. This evidence is broadly consistent with the typical patterns of older individuals as documented in the extant literature.

We ask whether the age-related changes in abilities and motivation that we observe explain why performance slows as COBs grow older. We show that the COB age effect is mainly driven by deteriorating cognitive abilities. In particular, profitability is significantly lower in firms with 'slow' COBs (that is, COBs who perform poorly on our speed measure) than in firms with 'quick' COBs. We also find motivational factors to be important, albeit to a lesser extent. Accordingly, COBs who state a commitment to shareholder value maximization are associated with slightly better firm profitability. Together, these two factors are able to fully explain the COB age effect.

To the best of our knowledge, our study is the first to identify the channels through which COB age and firm performance are related. This finding should add to the literature in at least two ways. First, knowing that 'age' essentially reflects cognitive abilities at the corporate helm contributes to a better understanding of the existing findings in the literature, for example with respect to age-related differences in investment (Korniotis and Kumar, 2011) and acquisition (Yim, 2010) behavior. Second, it is important to understand the sources of the age effect before trying to find a possible remedy. Stricter monitoring and more performance-sensitive compensation do not cure cognitive aging. A more promising way to prevent ossification at the helm could be the reallocation of tasks and responsibilities inside the firm and, of course, effective succession planning.

In the last step of the investigation, we ask whether mandatory retirement age limits prevent directors from overstaying, as stipulated by various corporate governance standards, including the report of NACD's Blue Ribbon Commission on Director Professionalism in 2005. Our data cast doubt on the effectiveness of mandatory retirement policies to induce a timely succession plan. We find that COB age is actually *higher* in firms with mandatory retirement age limits. Moreover, the presence of an age limit does not affect the relation between COB age and firm performance. This finding suggests that the ongoing debate about board retirement policies should be taken with a grain of salt.

Problems such as small sample size, measurement error, insufficient control variables, and simultaneity concerns often plague studies based on surveys. While we are aware of these concerns, we believe that they do not significantly affect the interpretability of our results. First, our investigation is based on more than 1,500 usable questionnaires, more than three times the sample size of recent studies, such as Graham and Harvey (2001) and Brav et al. (2005). Second, the design of the survey should help us to limit the typical sources of measurement error, including satisficing, acquiescence, and social desirability bias (Weisberg, 2005). The following section addresses these issues in detail. We also run Heckman (1979) selection models and find no evidence of non-response bias. Third, the questionnaire itself was quite extensive, which allowed us to collect important control variables such as tenure, firm size, firm age, leverage, and industry, along with information about the firms' ownership structure, board composition, and family affiliation. Finally, we conduct a series of additional tests to address possible concerns about endogeneity. In particular, the results are maintained if we control for the possibility that poorly performing firms are more likely to hire older COBs. Moreover, the results do not seem to reflect the inability of poorly performing firms to attract competent successors because we find the same results in a subsample of relatively large and well-performing firms. We recognize, however, that such tests only provide a response to specific endogeneity concerns. Without a valid instrument for COB age, we are unable to address the problem of endogeneity in general. Therefore, a careful interpretation of our results treats them as correlations instead of causal relations.

The paper proceeds as follows. Section 2 presents our survey in more detail. Section 3 studies the relation between COB age and firm performance. Section 4 asks how cognitive abilities and motivation change as COBs grow older. Section 5 asks whether changes in abilities and motivation help explain the COB age effect. Section 6 concludes.

2. Survey methodology

Our data come from a survey conducted in 2007. The questionnaire of 11 pages contained 38 questions and was written in German and French—Switzerland's two major languages. The survey was divided into five sections to collect information on the following: 1) board composition; 2) board compensation; 3) the COB's demographics, preferences, tasks, and responsibilities; 4) ownership structure; and 5) other firm characteristics such as age, industry, and financial performance.[1] The main advantage of surveys is that they can provide access to valuable information that is commonly unavailable in register data. At the same time, survey-based research is also prone to several biases. According to Weisberg (2005), the three common pitfalls in survey-based research are non-representativeness, measurement error, and survey

[1] A copy of the survey is available from the authors upon request.

administration issues. We briefly discuss these issues and describe the countermeasures taken when designing the questionnaire, conducting the survey, and analyzing the data.

2.1. Representativeness: Sample selection, survey, and non-response bias

To obtain a representative picture of corporate Switzerland, we begin the sample selection procedure with Dun & Bradstreet's database, which relies on the official Swiss Commercial Register and covers the vast majority of Swiss corporations. Similar to Brounen et al. (2006), we select unlisted firms with more than 25 full-time equivalent employees, sales above CHF 3 million, and at least two directors. This procedure leaves us with 11,875 firms. We eliminate the 2,432 firms that do not have a unique COB to avoid multiple deliveries to the same individual.[2] The remaining 9,443 firms constitute the population of (relatively large) unlisted Swiss corporations with a unique chairman. We survey the population to avoid sampling error.

A hard copy of the questionnaire was sent in February 2007, along with a pre-stamped envelope and a separate response form to order a free summary report. To increase the response rate, we established a telephone hotline to answer questions related to the survey and resent the questionnaire to all 9,443 COBs in March 2007. A total of 1,514 COBs returned the questionnaire, resulting in a comparatively high response rate of 16.2 percent.[3]

Following Graham and Harvey (2001), among others, we test for non-response bias in several ways. We find the responding firms to be representative in terms of sales, geographic distribution, and general industry classification. This finding holds for the 9,443 firms we initially

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[2] If successful individuals are more likely to chair multiple companies, this restriction could exclude a disproportionately high fraction of well-performing firms. However, when we compare firms with and without a unique COB, we find no difference in sales, number of employees, and board size, suggesting that our sample is not tilted towards poorly performing firms.

[3] From the 9,443 mailed surveys, 98 were undeliverable and are therefore excluded from the calculation of the response rate. Typical response rates of surveys in North America are 16% in Brav et al. (2005), and 9% in Graham and Harvey (2001). In Europe, Brounen et al. (2006) obtained a response rate of 5%. In Loderer and Waelchli's (2010) survey of Swiss COBs, 21% have participated.

targeted, as well as for the broader population of corporate Switzerland as described by the Swiss Federal Statistical Office (except for sales because we filter by sales). Moreover, we compare early and late respondents and find no significant difference in their answers. According to Filion (1975), late respondents are similar to non-respondents. Therefore, we conclude that neither sample selection nor non-response bias significantly affects our investigation and that our sample is representative for unlisted firms in Switzerland.

2.2. Measurement error

Another challenge for survey-based research is measurement error. In our investigation, such bias could arise if participants choose not to respond to specific questions or if their response differs from the actual true response, in particular because of satisficing, acquiescence, leading questions, or social desirability. This section focuses on measurement error in actual responses. Item non-response bias is discussed in more detail in the empirical section.

Bias is often induced because wording is not understandable, not universal, or pushes answers one way or another (Weisberg, 2005). To ensure that the wording and survey design are free of such problems, we have developed the questionnaire in close cooperation with a survey expert and a communication specialist and we have pre-tested the survey extensively with a selected group of representatives from various industries. Furthermore, at the end of the survey, we have asked the participants to identify questions that are difficult to understand. Less than 20 percent of the respondents indicate that there is such a question in the survey. Most of the statements refer to one specific question about the ownership structure, which we therefore exclude from the analysis. In untabulated tests, we also exclude all COBs who indicate that there is an incomprehensible question in the survey. The results do not change. Therefore, we believe that the wording and structure of the questionnaire do not induce systematic bias in responses.

To counteract satisficing, we enclosed a cover letter in which we introduce the survey team (with pictures and signatures), describe the relevance of the project, and explain how important it is to participate in the survey and how the results will be used (Krosnick et al., 2004). We also perform a series of tests on the actual data, none of which supports satisficing. First, as we will see in more detail below, the typical COB spends a considerable amount of time filling in the survey. This result is inconsistent with satisficing. Second, the results do not change if we drop the 25 percent of respondents with the shortest survey times. These individuals would seem to be particularly prone to satisficing. And third, we find no difference in the item response rate to open questions and choice questions. With satisficing, we would expect respondents to select the first best response from choice questions and to skip open questions.

With respect to acquiescence, Krosnick (1999) argues that bias can be contained by avoiding agree-disagree questions. Therefore, most of our key data are collected with open questions. The exception is a statement about the ultimate target of the company, which we use as a proxy for the COBs' financial orientation. Approximately 20 percent of the respondents declare a commitment to shareholder value maximization. Such a low approval rate is inconsistent with acquiescence. More importantly, the approval rate is in line with Loderer et al. (2010), who collect information about corporate targets from company websites and find that 25 percent of listed Swiss firms express a commitment to shareholder value.

Finally, answers could be biased because of social desirability. This scenario is particularly true if questions address potentially sensitive issues. The literature suggests several procedures to reduce such bias. According to Presser and Stinson (1998), self-administered surveys are less prone to social desirability bias than interviews. Moreover, Ong and Weiss (2000) find that anonymity dramatically reduces the bias. Our survey is both self-administered and anonymous. Finally, as suggested by Presser and Stinson (1998) among others, we administer time-use questions instead of direct questions when inquiring about the relevance of the various board tasks—a potentially sensitive issue. Taken together, these measures should help us reduce bias from social desirability.

2.3. Survey administration issues

The third source of error stems from survey administration and data processing. In particular, post-survey error could arise because we manually enter the data from the returned questionnaires. Therefore, we double check all data entries. Moreover, coding difference should not be an issue because there are no items with long text answers. Finally, because all data are from the same survey, we do not have to worry about potential mode effects, i.e., the phenomenon that a particular survey administration mode can affect the results that the respondents give.

As in all survey-based research, we are unable to completely rule out survey error. We believe, however, that the careful design and execution of the survey, together with the additional measures described above, minimize potential sources of bias.

3. COB age and firm performance

3.1. Empirical strategy

In what we refer to as our standard regression, we regress various measures of firm profitability on COB age and a broad range of variables, which should help us control for potential confounding effects:

Profitability = f(*COB age*, *COB tenure*, *CEO-COB duality*, *Board size*, *Board independence*, *Family status*, *Block ownership*, *Inside ownership*, *Firm age*, *Size*, *Leverage*, *Industry*). (1)

It is well-documented that the adverse effects of cognitive aging operate jointly with learning processes. As noted by Korniotis and Kumar (2011), among others, it is important to control for experience when investigating potential age effects. Studying the portfolio positions and investment behavior of more than 60,000 private investors, the authors find that whereas investment skills deteriorate with age, older investors' portfolio decisions reflect greater knowledge about investing. We use the COBs' tenure as a proxy for experience and expect a positive relation with performance.

Because longer tenure could also lead to higher entrenchment (see, among many others, Rose and Shepard, 1997; Yim, 2010), we include additional variables suggested by the literature to capture potential entrenchment effects. In particular, we control for board size (Yermack, 1996; Eisenberg et al., 1998), board independence (Bhagat and Black, 2002), CEO-COB duality (Dalton and Rechner, 1991), family status (Anderson and Reeb, 2003), inside ownership (Morck et al., 1988; Himmelberg et al., 1999) as well as for the presence of blockholders (Holderness, 2003).

Finally, we control for firm age, size, and leverage to disentangle the life cycle of the COB from that of the firm. Loderer et al. (2012) document a strong negative relation between firm age and profitability, which they ascribe to the older firms' inability to generate new growth opportunities. If older COBs are more likely to chair older firms, the negative relation between COB age and performance could in fact reflect more general geriatric problems in older organizations. Similar arguments can be made for firm size (Cooley and Quadrini, 2001) and financial leverage (Jensen, 1986). Together with the industry dummies, financial leverage should also help us control for risk.[4]

[4] In later regressions, we will also include the COBs' subjective risk assessment as a further control for risk. The inclusion of this variable does not alter the results, which is why we exclude it from the main investigation.

3.2. *Descriptive statistics*

Let us now turn to the results of our investigation. Variable definitions are shown in Table 10. Table 1 describes the data and Table 2 shows Pearson correlation coefficients. As shown in Panel A of Table 1, the median (mean) sample firm has CHF 10 (28) million assets, sales of CHF 15 (35) million, a net income of CHF 0.39 (1.36) million, and a debt ratio of 44 (43) percent. At the time of the survey, the CHF traded at an exchange rate of approximately 0.84 USD. Therefore, our firms are somewhat larger than those in other studies of unlisted firms. For example, Bennedsen et al., (2008) report an average book value of assets of approximately USD 3 million for Denmark, and Asker et al., (2011) find an average book value of USD 7 million in the U.S. Because we filter the population of firms by size, this difference is not particularly surprising. Still, when interpreting our results, we must keep in mind that we study relatively large unlisted firms.

Our typical sample firm is also quite mature and has been in business for a median number of 43 years. This period is considerably longer than reported in other studies. For example, the median age in the sample of Asker et al., (2011) is 15 years. The difference in age can be ascribed to two factors. First, as we have just mentioned, we survey relatively large unlisted firms. Bartholdy and Mateus (2008) show that age is positively related to firm size, also in unlisted firms. Second, whereas most other studies of unlisted firms measure the age since incorporation, our proxy for age is the number of years since founding. The two proxies for age can differ for various reasons. For example, the incorporation age could be reset to one if a firm changes its legal form (e.g., from a limited liability company, LLC, to a corporation), re-incorporates in a different state, or in the case of corporate restructuring (e.g., a statutory consolidation). The difference between the two age proxies can be sizable. A case in point is the Bechtel Corporation, one of the largest private firms in the U.S. According to the company history published on the website, the firm was founded in 1898 and incorporated in the current form in 1945. Therefore, the difference between the founding age and the incorporation age is 47 years. We also consult Worldscope, which contains both founding and incorporation years for 931 listed firms outside the U.S. For Swiss firms, the reported difference between the two age measures is approximately 20 years. Similar numbers result for the full sample.

The second panel of Table 1 shows descriptive statistics for the age of the COBs as well as their tenure in office, our proxy for experience (Vafeas, 2003; Korniotis and Kumar, 2011). The median COB age is 57 years, which is the same as reported in Grinstein and Valles Arellano (2008) for a large sample of S&P 1500 firms. The median tenure is 14 years, which is slightly higher than what studies in other countries find. There is considerable cross-sectional variation in the two variables, as indicated by a standard deviation of 9.6 and 10.3 years for COB age and tenure, respectively. Taken together, the numbers imply that the typical sample firm has been in business for approximately 30 years before the COB took office. This should help us disentangle the life-cycle of the firm from that of its COB.

The third panel summarizes the various performance measures. Our main metrics of firm profitability are return on assets (ROA; mean 7.7 percent; median 5.1 percent) and return on equity (*ROE*; mean 12.0 percent; median 7.2 percent). For robustness tests, we collect additional performance metrics, namely net profit margin, return per employee, and the sales-to-assets ratio. In terms of profitability, our sample firms are comparable to other studies of unlisted firms that were conducted at approximately the same time. For example, Asker et al. (2011) report an average ROA of 7.5 percent for the U.S., and Bartholdy and Mateus (2008) find an average ROA of 7.3 percent in a large sample of unlisted firms from 16 European countries.

Finally, the fourth panel shows the various control variables. In slightly less than 50 percent of the cases, the COB is also the CEO of the firm (*bCEO-COB duality*). This fraction is much higher than that for listed Swiss firms (20 percent, according to Loderer and Waelchli, 2010). The typical sample firm has four directors (*Board size*), of which one is independent (*Board independence*) and one or two are members of the founding family (*Family directors*). Overall, the board structures of our sample firms seem to be comparable to those in other studies of unlisted firms (e.g., Bennedsen et al., 2008). Our sample firms are also relatively closely held. Typically, the largest shareholder controls 53 percent of the voting rights (*vr Largest*) and is usually an insider (*vr Executives*; median 60 percent). The members of the founding family (*vr Founders*; median 42 percent) also play a key role in the ownership structure of unlisted firms. Loderer and Waelchli (2010) report similar ownership structures for larger unlisted Swiss firms.

The table also allows us to assess the issue of item non-response and the potential bias it induces. As we have mentioned in the previous section, we have received a total of 1,514 usable questionnaires. However, not all of these questionnaires were filled out in full. The last column of Table 1 shows the item response rate, i.e., the number of usable answers per item divided by the number of returned questionnaires. While the scores for the COB and board characteristics are very high, respondents seem to be more reluctant to disclose financial data and information about the ownership structure, possibly because they believe this information is confidential. For example, 63.6 percent of the questionnaires contain information about return on assets (ROA) and 73 percent disclose net profit margin.

In untabulated tests, we investigate whether firms that report financial information differ from those that withhold it. We find no differences in COB characteristics. Firm demographics such as age, board structure, and ownership structure are also the same. We find, however, than non-reporters tend to be larger in terms of sales and assets and have lower leverage. These firms also seem to be slightly more successful.[5] Therefore, the item non-response in our dependent variables could tilt our sample towards smaller, less successful firms. In the robustness tests, we will estimate Heckman selection models to address this issue. Moreover, to counteract bias from missing control variables, we add nondisclosure dummies (Himmelberg et al., 1999). The results do not change.

3.3. *Multivariate regressions*

This section studies the relation between COB age and firm performance by estimating the standard regression described in equation (1) above. To account for industry specific differences in firm performance, we include industry fixed effects based on the Industry Classification Benchmark (ICB) provided by Dow Jones and FTSE.[6] Standard errors are heteroscedasticity-consistent (Huber-White). Table 3 shows the results for our main performance measures ROA (regression 1) and ROE (regression 2), as well as the three additional performance metrics (regressions 3 to 5).

Performance declines as COBs grow older. The coefficient of *COB age* is negative and significantly different from zero in four of the five regressions. An increase in *COB age* of one standard deviation (9.6 years) is associated with a decline in *ROA* of 0.79 percentage points. Given a sample mean *ROA* of 7.67 percent, this corresponds to a performance decline of 10.3 percent.[7] In the case of *ROE*, the decline is approximately 11.5 percent. Similarly, both *NPM* and *ROEMP* drop by approximately 9 percent if COB age increases by one standard deviation. Hence, the performance decline in COB age is not dramatic, but it adds up over time. These

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5 For example, 163 firms that do not disclose ROA tell us their net profit margin. The average net profit margin of these 163 firms is higher than that of the 947 firms that disclose both net profit margin and ROA (not shown).

6 Our investigation includes 61 firms from the financial industry. The results are qualitatively and quantitatively the same if we exclude these firms.

7 To facilitate the interpretation of our results, the second argument in the parentheses below the regression coefficients reports such sensitivity measures for all significant coefficients.

sensitivities underline the fact that the COB is a focal player in the organization. Only in regression (5), where the dependent variable is the sales-to-asset ratio, do we find no significant association with *COB age*. One possible interpretation could be that firms headed by older COBs do not have lower output, as measured by sales, but rather, less efficient cost structures.

To find out more about the functional form of the relation between COB age and firm performance, we estimate piecewise linear regressions that allow for changes in the COB age coefficient at ages 50 and 65. We choose age 50 as the lower turning point because, according to Verhaegen and Salthouse (1997), job performance begins to deteriorate after age 49. The upper turning point of 65 years denotes the official retirement age in Switzerland. Therefore, to implement the piecewise approach, we replace *COB age* with the following three variables in our regression:

$$
\begin{array}{lcl}
\textit{COB age<50} & = & \textit{COB age if COB age} < 50 \\
 & = & \textit{49 if COB age} \geq 50 \\
 & & \\
50 \leq \textit{COB age} < 65 & = & \textit{0 if COB age} < 50 \\
 & = & (\textit{COB age}-49) \textit{ if } 50 \leq \textit{COB age} < 65 \\
 & = & \textit{15 if COB age} \geq 65 \\
 & & \\
65 \leq \textit{COB age} & = & \textit{0 if COB age} < 65 \\
 & & (\textit{COB age}-64) \textit{ if COB age} \geq 65
\end{array}
$$

If, for instance, the COB age is 68, *COB age<50* takes a value of 49, *50≤COB age<65* is 15, and *65≤COB age* is 4. The results of the piecewise linear regressions are shown in Table 4. Accordingly, COB age is unrelated to firm performance until age 50. Thereafter, and consistent with previous literature, performance slips as COBs grow older. *ROA*, for example, drops by 0.13 percentage points for each additional year of COB age. Again, the effect is not dramatic, but it cumulates. If we measure the impact of a one standard deviation change of COB age around its mean (from age 49 to 65), *ROA* declines by 14.9 percent. After COB age 65, performance seems to bottom out (*ROA* and *ROE*) or even rebound slightly (*NPM* and *ROEMP*). Presumably, COBs can step down without losing face when they reach the official retirement age. It looks as if underperforming COBs are more likely to exercise this exit option. However, because of the relatively few observations at the far end of the COB age distribution, the coefficient of *65≤COB age* should be interpreted with caution.

Finally, we also estimate non-parametric kernel regressions. To preserve space, Figure 1 only reports the results for our two main performance measures, *ROA* and *ROE*. The graphical illustration confirms the functional form of the age-performance relation from the piecewise linear regressions. For reading convenience, we switch back to the linear age measure for the remaining investigation. To avoid clutter, we only report the results for *ROA*. The results for *ROE*, *NPM*, and *ROEMP* are qualitatively the same throughout the analysis.

Before inquiring into the robustness of the results, let us briefly turn to the control variables in our standard regression. Contrary to our predictions, *COB tenure* is statistically zero in all regressions. Therefore, more extensive experience does not seem to increase performance, on average. Older firms generally exhibit poorer performance, which is consistent with Loderer et al.'s (2012) findings for the U.S. *Board size*, and *Board independence* have generally negative but insignificant coefficients.[8] The same result is true of *vr Founders* and *vr Executives*. We find, however, that the *ROA* of firms with CEO-COB duality is approximately 1 percentage point (15.6 percent) lower than for firms that split the role. In untabulated regressions, we interact *bCEO-COB duality* with all control variables to find out to what extent the CEO-COB effect could be driven by differences in firm characteristics. In that regression, *bCEO-COB duality* is statistically zero, indicating that duality per se is not associated with lower profitability. More importantly, *COB age* maintains its negative and significant coefficient.

8 In untabulated tests, we follow Bennedsen et al. (2008) and identify boards with more than 6 members. In line with their results, we find that firms with board sizes larger than 6 are significantly less profitable, whereas board sizes below 6 are unrelated to profitability. The coefficient of *COB age* remains the same.

With respect to the fraction of family directors on the board, we find a negative relation with profitability. Accordingly, an increase of *Family directors* by one standard deviation is associated with a drop in *ROA* of 8 percent. Along similar lines, Bennedsen et al. (2008) find that firms with large families that appoint many directors exhibit poorer performance. We find a positive association between *vr Largest* and profitability, suggesting that large shareholders are an important governance mechanism in unlisted firms. Finally, the coefficients of *Size* and *Leverage* are in line with previous literature. Large firms exhibit lower profitability (Cooley and Quadrini, 2001). More specifically, an increase in *Size* of one standard deviation is associated with a decline in ROA of 5.6 percent. *ROE* and the *Sales-to-asset* ratio behave similarly, whereas larger firms have higher *NPM* and *ROEMP*, possibly because of economies of scale. Higher leverage reduces overall profitability (*ROA*, *ROEMP*, *Sales-to-asset*), possibly because of frictions induced by financial constraints (see also Brav, 2009). Higher leverage is also associated with a lower profit margin but increases the shareholders' required rate of return.

3.4. Robustness tests

3.4.1. Listing status

Previous studies, most of which have been conducted for listed U.S. firms, document that the demographics of individual managers, typically the CEO, can affect corporate policy (see, for example, Bertrand and Schoar, 2003; Yim, 2010; Li et al., 2011; however, see also Fee et al., 2011). Individual age, however, seems to be unrelated to profitability in listed firms (Bhagat et al., 2010). This finding raises the question of how the negative relation between COB age and profitability documented in this paper can be interpreted. Is this relation a genuinely Swiss effect or could it be the result of much weaker formal governance rules in unlisted firms?

To shed some light on this question, we re-estimate our standard regression from Table 3 for a control sample of 197 listed Swiss firms in 2006, the year to which the financial data in our survey refer.[9] In untabulated regressions, we find no relation between COB age and firm performance, regardless of how we measure profitability. Neither is an extended panel that covers all listed Swiss firms over the period 1995 to 2009 able to produce a significant relation between COB age and firm performance. Possibly, the relatively strict rules that govern listed Swiss firms provide sufficient monitoring of the monitor and prevent COBs from overstaying, as seems to be the case in other countries. Therefore, the results of our investigation apply to unlisted firms. Studies of unlisted firms in other countries also report a negative correlation between individual age, typically that of the CEO, and profitability.[10]

3.4.2. Owner-managed firms

A firm that is fully controlled by insiders need not necessarily focus on financial profitability to foster shareholder value. Instead, the owner-managers could consume private benefits of control such as excessive salaries, quiet lives, or other perks, including company resources for private use.[11] Therefore, declining profitability metrics do not necessarily imply that shareholders are worse off. If older COBs are more likely to be such owner-managers, what looks like a decline in performance could actually be a tax-efficient way to disseminate shareholder value. It is difficult to believe, however, that this tax argument can be extended to firms with a relatively dispersed ownership structure, because (external) minority shareholders typically have no direct access to the company's resources.

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[9] Most board and ownership data are from Waelchli (2009). We update the information on director age, board composition, and ownership structure. Financial data are from Compustat Global.

[10] For example Bennedsen et al. (2008) for Denmark.

[11] Because of the double-taxation of dividend payments, such behavior could constitute a tax-efficient way to extract cash from the firm.

In regression (1) of Panel A of Table 5, we therefore extend our standard regression with an indicator variable that equals 1 if the minority shareholders together own less than 10 percent of the voting rights (*bClosely held*), as well as an interaction term of this indicator with *COB age*. The coefficients of both variables are statistically zero, indicating that the age-related decline in profitability is not restricted to very closely held firms. The same results obtain when we identify firms in which minority shareholders together control up to 50 percent of the shares (*bMajority shareholder*) and interact this indicator with *COB age*. In fact, the coefficient of that interaction term is positive and significant; suggesting that the age-related performance decline is actually stronger in firms with significant minority shareholders. This result is in line with the predictions from standard agency theory. The reduced monitoring function of minority shareholders seems to aggravate the detection and removal of underperforming managers. It could also be that a dispersed ownership structure invites COBs to consume more private benefits of control because they must bear a smaller fraction of the associated costs. In either case, overstaying COBs seem to posit a real agency problem in unlisted firms.

3.4.3. The old guard and the superstars

To the extent that CEOs retire to the chairmanship (Brickley et al., 1997; Brickley et al., 1999; Fahlenbrach et al., 2011), they might maintain a significant amount of control over the firm's activities and thereby undermine the authority of the new CEO. Hence, what looks like a negative relation between COB age and performance could actually be the result of governance voids caused by members of the old guard who are reluctant to hand over the reins.

Under this alternative hypothesis, we would expect firms with CEO-COB duality to outperform firms with a dual leadership structure. As we have seen in the discussion of the control variables in Tables 3 and 4, this does not seem to be the case. The effect of CEO-COB duality on profitability is statistically zero once we add interaction terms to allow for differences in the control variables. In that regression, the interaction term of *bCEO-COB d*uality and *COB age* is insignificant. This finding suggests that the COB age-performance relation is not driven by firms with a dual leadership structure (not shown).

Similar arguments could be made for founders who fail to relinquish full control to their successors. However, as we have mentioned above, our typical sample firm has been in business for approximately 30 years before the current COB took office. Hence, the typical COB is not the founder of the company. It turns out that only 22 percent of the COBs have been involved with the company from its inception and could, therefore, be classified as founders. To find out whether these founders drive our results, we identify them with a dummy variable and add an interaction term with *COB age*. The coefficients of the additional variables are insignificant. Therefore, it is difficult to believe that members of the old guard are the driving force behind the negative relation between COB age and performance.

Finally, one could also argue that, because there is considerable cross-sectional variation in abilities, the age at which a COB takes office could be a proxy for talent. If particularly talented individuals are appointed COB at a relatively young age, the negative relation between COB age and performance could reflect such differences in talent. To test this alternative interpretation, we follow Korniotis and Kumar (2011) and sort our sample by the age at which the COB took office. We then re-estimate our standard regression for the sub-samples of firms with relatively low and relatively high COB appointment age, respectively. The COB age effect is statistically the same in the two sub-samples (not shown). Therefore, our results do not seem to be driven by superstar COBs who are appointed at young age.

3.4.4. Sample selection and non-disclosure

We have seen in Table 1 that approximately one third of the returned questionnaires contain no information about our main performance measures. To assess whether this could bias our results, we estimate a two-step Heckman (1979) selection model. In the survey, we have asked the participants whether there are questions that touch on confidential issues (*bConfidential*). Of the 1,350 answers we receive to this question, 43 percent are affirmative. Because confidentiality concerns would seem to reduce the willingness to disclose information, we use *bConfidential* as our selection variable.

Panel B of Table 5 shows the results of the selection model. To preserve space, we only report the coefficients of the main variables. The first step regression shows that *bConfidential* is associated with significantly lower survey item participation. In the second step, COB age is still negative and significant, regardless of profitability measure. More importantly, for both the *ROA* and *ROE* regression, the inverse mills ratio is statistically zero, indicating that our selection model is unable to detect selection bias.

In untabulated regressions, we also include nondisclosure dummies for control variables with low item response rates (in particular, the firm's ownership structure). This increases the sample size of the ROA regression by more than 30 percent to 919 observations. The results do not change. Moreover, all nondisclosure dummies are statistically zero.

Taken together, these results indicate that neither sample selection nor item non-response seem to add a severe bias to our investigation. In what follows, we will, therefore, continue to use our standard regression.

3.4.5. Endogeneity

Obviously, endogeneity concerns resulting from omitted variables, simultaneity, and measurement error are difficult to rule out in our investigation. In particular, an open issue is whether we can interpret our results as simple correlations or as causal relations. Econometrically, there is little we can do to address these concerns. Economically, however, we find it difficult to believe that the physical age of the COB could be driven by the profitability of the firm in a way that could explain our results. For poor performance to increase COB age, one would have to posit that poor performance *reduces* the turnover probability, which is rejected by the extant evidence (see, for example, Brickley, 2003), also for Switzerland (Waelchli, 2009). Alternatively, one would have to assume that poorly performing firms are more likely to hire older COBs, whereas well-performing firms are more likely to attract younger COBs. If that were true, we would expect poorly performing firms to be chaired by older COBs with relatively short tenure.

The data do not support this proposition. In a univariate analysis, COB age and tenure are *positively* correlated in a sub-sample of poorly performing firms (not shown). Moreover, we identify all COBs with tenure of less than 5 years (*bTenure < 5*) and interact this dummy variable with *COB age* in our standard regression. It is difficult to believe that the poor performance that could have led to the appointment of an older COB remains visible in the data five years after the COB took over. Therefore, under the alternative hypothesis that poorly performing firms attract older COBs, we would expect the interaction term to pick up the COB age effect, but that is not the case. As shown in regression (4) of Panel A of Table 5, the coefficients of the indicator variable and the interaction term are both insignificant, whereas *COB age* maintains its significantly negative coefficient.

An alternative hypothesis of reverse causality could be that relatively small and poorly performing family firms are unable to attract competent outside successors.[12] Therefore, the incumbent team either stays in office or opts for a family succession, which could induce the owner-manager to stay longer. While this argument seems plausible, we believe that it does not fully explain our results. First, remember from the robustness tests that our results do not change if we control for the presence of founders. Therefore, the age effect per se does not seem to be driven by founders who fail to relinquish control. Second, in untabulated regressions, we constrain the sample to relatively large (*Size* above the sample median) and well-performing (ROA above the sample median) firms. Such firms would seem to be relatively attractive employers, also for outside successors. In this subsample, COB age still takes on a negative and significant coefficient, regardless of whether we control for the presence of founders.

Such tests allow us to address the concerns about specific manifestations of endogeneity. In principle, instrumental variable regressions would offer a more general way to address this issue. However, to the best of our knowledge, the relevant literature has not identified a valid instrument for age. In fact, many finance papers that report age-induced differences in behavior do not directly address endogeneity. Without a valid instrument, we are unable to estimate instrumental variable regressions. Therefore, a careful interpretation of our results treats them as correlations instead of causal relations.

4. Age-related changes in abilities and motivation

Aging is a manifold collection of changes that render human beings progressively more likely to die (Medawar, 1952). Of the many physical, psychological, and social changes that are associated

[12] We are grateful to the anonymous referee for pointing this out to us.

with aging, the declining cognitive abilities and shifting preferences of older individuals seem to be particularly relevant to our investigation.

4.1. COB age and cognitive abilities

According to Verhaeghen and Salthouse (1997), the cognitive abilities such as efficiency and effectiveness of information processing (e.g., speed, reasoning and memory) begin to decline before age 50, on average, and deteriorate progressively thereafter. Executive functions seem particularly prone to aging effects (see, for example, Rhodes, 2004). Consistent with that finding, Taylor (1975) documents that managerial decision-making performance declines with age.

To measure the COBs' cognitive abilities, we use a speed proxy as well as the self-reported perception of job complexity. The concept of speed is well established in the literature and considered the strongest predictor of age-related declines in cognitive abilities currently available, according to Verhaegen and Salthouse (1997) and Park and Reuter-Lorenz (2009), among others. Because slowing is task-independent (Birren and Fisher, 1995), a broad range of speed measures can proxy for cognitive abilities. Our speed measure is the (self-reported) time in minutes that the COBs took to fill in the questionnaire (*Survey time*). We have also asked the COBs to assess the complexity of their tasks (*Complexity*). We use this variable as an alternative proxy for cognitive abilities. It is indicated on a 5-point Likert scale with 1 being the lowest and 5 the highest level of complexity. Descriptive statistics of the two variables are shown in Panel A of Table 6. Panel B reports the results of multivariate regressions of the two variables on *COB age* and the standard set of control variables.

In line with the predictions from previous literature, speed significantly decreases as COBs grow older. According to regression (1), an increase in *COB age* of one standard deviation is associated with a *Survey time* that is 2.3 minutes longer. Given a sample mean of 21.6 minutes, this corresponds to a time increase of approximately 11 percent. More importantly, the piecewise linear regression (2) reveals that the largest change in speed occurs between ages 50 and 65, which is consistent with the extant literature. The regressions for *Complexity*, our alternative proxy for cognitive abilities, corroborate these findings. Older COBs are significantly more likely to concede that job complexity has increased in recent years—and the main effect again takes place between ages 50 and 65 years. This finding is consistent with Rhodes (2004), who documents that individuals find it increasingly difficult to execute complex tasks as they grow older.[13] Taken together, and consistent with the extant literature, we conclude that the cognitive abilities of our COBs decrease significantly as they grow older.

4.2. COB age and motivation

Aging also seems to affect an individual's motivation. Ebner et al. (2006) report that younger individuals are more likely to strive for gains, whereas older individuals tend to maintain the status quo and aim at preventing loss. This pattern finds support in the finance literature, according to which younger CEOs pursue more acquisitions (Yim, 2010) and invest more aggressively than their older peers (Li et al., 2011). Moreover, Ferris et al. (2003) argue that older directors are prone to last-period problems such as the reluctance to update their skills and a reduced willingness to work hard (Jagannathan and Loon, 2011). Based on this literature, we hypothesize a negative relation between the age of the COB and her job performance.

To assess whether the COBs' motivation changes as they grow older, we use various proxies for business objectives, job activities, and compensation.

[13] Note that, because the coefficient of *COB tenure* is negative and significant in these regressions, this result does not seem to be driven by the older COBs' more extensive job experience or better ability to make intertemporal comparisons.

4.2.1. *Business objectives*

We have asked the COBs to specify which ultimate goal they pursue with their activities. Specifically, they could indicate on a Likert scale from 1 to 5 whether they believed that the interests of the shareholders were more important than those of the other stakeholders. Previous studies find that older individuals are less driven by money (Ebner et al., 2006) and more strongly committed to organizational citizenship behavior (Ng and Feldman, 2008). Accordingly, we would expect older COBs to shift away from shareholder value to a broader corporate target that embraces all stakeholders.

This prediction is supported by the data. The descriptive statistics in Panel A of Table 7 show that, with a mean score of 1.8 out of 5, the typical COB only expresses a lukewarm commitment to shareholder value. In the multivariate framework reported in regression 1 of Panel C, *COB age* takes on a significantly negative coefficient, indicating that shareholder value maximization becomes less important as COBs grow older.

4.2.2. *Job activities*

Job activities also seem to shift with age. In particular, according to Ng and Feldman (2008) among others, older individuals prefer clearly defined tasks over less structured activities. Moreover, they seem to favor the status quo (Ebner et al., 2006), are more resistant to change (Cornelis et al., 2009), and have fewer career concerns (Li et al., 2011).

To find out whether job activities change as COBs grow older, we have asked them to indicate the actual amount of time (in percent) as well as the subjective optimal amount of time (in percent) they spend on the following activities: 1) strategic tasks; 2) monitoring; 3) controlling, reporting, and auditing; 4) interaction with business partners; and 5) other activities, which they could freely list. If older COBs prefer more structured activities, we would expect them to shift from strategic tasks to controlling, reporting, and auditing activities.

Panel B of Table 7 describes the data. As one would expect, COBs spend most of their time on controlling, reporting, and auditing (28 percent), monitoring activities (28 percent), and strategic tasks (27 percent). Interestingly, according to the last column of the panel, there are some notable differences between the actual and the target time allocation. In particular, COBs, on average, would prefer to spend significantly more time on the firm's strategy and significantly less time on monitoring and financial planning.

To find out whether the activities and job preferences change as COBs grow older, we estimate a multivariate fractional logit model with a quasi-maximum likelihood estimator, as proposed by Papke and Wooldridge (1996).[14] The results in Panel D of Table 7 are generally in line with our predictions. Each row of the panel reports the coefficients from a separate regression of the time allocated to a specific task on *COB age*, *COB tenure*, and our standard set of control variables (including industry fixed effects). For reading convenience, we only report the coefficients of *COB age* and *COB tenure*. The left (right) part of the panel refers to the actual (target) time allocation.

With respect to the COBs' actual activities, we find that the time spent on controlling, reporting, and auditing increases significantly with age, which is consistent with the increased safety performance of older individuals. Moreover, older COBs spend more time on 'other activities.' Popular other activities are 'alumni reunion', 'art and culture', 'colleagues and friends', 'use of fleet', and 'visit expositions'—most of which seem to be indicators of quiet life.

[14] This is the method of choice if the dependent variables are continuous and bound between zero and one. The results remain qualitatively the same if we estimate a fractional multinomial logit model to account for the fact that, by construction, the time proportions allocated to the various tasks are negatively correlated.

It is important to note that the same age-related differences obtain if we look at the target time allocation. Hence, older COBs actually prefer to spend more time on 'bureaucratic' tasks and other activities. Moreover, the coefficient of *COB age* is borderline significant (p-value of 0.102) in the regression involving the target time allocation to strategic tasks. Because strategic initiatives can be disruptive to the organization and its products and processes, this result could indicate the higher resistance to change of older COBs.

4.2.3. COB age and compensation

Finally, we take a brief look at the compensation packages of COBs. According to Adams et al. (2010), financial incentives are important in the board room. We have asked the COBs whether they participate in an incentive plan (*bVariable compensation*) and whether they would prefer a more performance-sensitive compensation (*Higher incentives*). Descriptive statistics are reported in Panel A of Table 7. Only 19 percent of the COBs receive variable compensation.[15] Moreover, the typical COB does not seem to prefer a more performance-sensitive compensation plan.

Panel C takes the COBs' compensation packages to the multivariate framework and asks whether the actual and the desired structure of the compensation are related to the age of the COB. According to regression (2), older COBs are significantly less likely to receive variable compensation. At the mean, an increase in *COB age* of one standard deviation reduces the probability of receiving variable pay by approximately 5 percentage points (from 19 to 14 percent). Hence, firms do not seem to increase the performance sensitivity of compensation to counteract potential last period problems of older COBs (see, among others, Ferris et al., 2003; Jagannathan and Loon, 2011). Moreover, as regression (3) shows, the desire for variable compensation also declines as COBs age.

[15] For the average COB with an incentive plan, approximately 48 percent of total compensation depends on firm performance (not shown).

An alternative interpretation could be that older COBs are more risk-averse and, therefore, request more stable compensation packages (Morin and Fernandez Suarez, 1983). To shed some light on the COBs' risk assessment and whether it drives compensation preferences, we have asked the COBs whether they believed that being a director has become riskier in recent years (*bRisk perception*). 81 percent of the respondents agree with this statement. When we add *bRisk perception* to the regression, *COB age* remains negative and significant (regression 4). Interestingly, and contrary to the presumption of risk-averse COBs, the coefficient of *bRisk perception* is positive and significant with confidence 0.9, indicating that COBs actually want to participate financially in the risks they take. Adding an interaction term of *bRisk perception* and *COB age* does not alter this result (not shown). We conclude that risk affects the compensation that COBs desire, but cannot explain the negative relation between age and performance.

Taken together, this section documents significant age-related shifts in cognitive abilities, business objectives, job activities, and compensation packages. Our COBs seem to age much like 'ordinary' people. Because cognitive abilities and motivation are shown to drive job performance (Salthouse, 2012), the following section asks whether these channels are responsible for the COB age effect that we observe.

5. What drives the relation between COB age and firm performance?

5.1. Results

To find out whether changes in cognitive abilities and motivation help explain the COB age effect, we extend our standard performance regression with the proxies presented in the previous section. The results are shown in Table 8. For reading convenience, regression (1) repeats the coefficients from our standard regression in Table 3. When we add *Survey time*, our main measure of cognitive abilities (regression 2), the coefficient of *COB age* declines in magnitude and significance. Instead, *Survey time* takes on a negative and highly significant coefficient, suggesting that much of the COB age effect we observe can be ascribed to a decline in cognitive abilities.

The changes in motivation can also help explain parts of the COB age effect that we observe. We find that COBs, whose business objective is to foster shareholder value, are associated with higher profitability (regression 3). This result is in line with Loderer et al. (2010), who document that firms walk the talk in regard to commitments to shareholder value maximization. The time that COBs spend on the various tasks has no impact on performance, according to regression (4).[16] In addition, the presence of a COB with a preference for more performance sensitivity in compensation leaves profitability unaffected (regression 5). Note that in all three regressions involving the proxies for motivation, the coefficient of *COB age* remains negative and significant. Finally, regression (6) includes all five proxies for cognitive abilities and motivation. The results are the same as in the individual regressions. The main change we observe is that the coefficient of *COB age* is still negative but no longer significant. This finding implies that when viewed together, changes in cognitive ability and motivation seem to fully explain the COB age effect. The coefficients and significance levels of various proxies are the same as in the individual regressions (2) to (5). Therefore, multicollinearity does not seem to be a major concern.

5.2. Discussion

The unique survey data allow us to open the black box of aging agents and their impact on performance. Of the various age-related changes we document for the COBs of unlisted firms, cognitive aging and, to a lesser extent, reduced focus on shareholder value are relevant for

[16] The correlation coefficient between the time spent on strategic tasks and the time spent on controlling, reporting, and auditing is –0.22. Hence, multicollinearity does not seem to be a major concern when including these two variables in the same regression.

performance. This finding seems relevant for both academia and practice. First, there is a growing literature in finance that relates the individual characteristics of managers to firm policy and performance. Many of these studies control for individual age. Our results confirm that the age of the COB is an important dimension and that COB age is significantly related to firm performance in unlisted firms. Second, of the many things that age can represent, we show that, at the corporate helm, age essentially reflects cognitive abilities. This result contributes to a better understanding of existing findings in the literature, for example with respect to reported differences in investment (Korniotis and Kumar, 2011) and acquisition (Yim, 2010) behavior. Understanding the source of the age effect is also important when trying to find a possible remedy. Cognitive aging cannot be cured with compensation packages or stricter monitoring. A more promising approach could be the reallocation of tasks and responsibilities inside the firm and, of course, an effective succession plan. In this regard, our results suggest that unlisted firms may have a fundamental governance problem, when they do not prevent their COB from overstaying. In fact, inert retirement policies in corporate boards have attracted considerable attention from shareholder activists, policy makers, and the popular press. Various codes of best practice around the world require that firms enforce a mandatory retirement age to prevent directors from overstaying.[17]

Our results cast doubt on the effectiveness of such policies. It is difficult to believe that enforcing a strict retirement age or limiting tenure can prevent the performance decline we observe. As we have seen, aging is a gradual process that sets in relatively early but also has considerable cross-sectional variation. Therefore, a general age limit appears to be an inefficient mechanism to prevent COBs from overstaying. A more promising approach could be to have key

[17] The NACD's Blue Ribbon Commission on Director Professionalism (2005), for example, states that "the board should establish procedures for the retirement or replacement of board members. These procedures may, for example, include a mandatory retirement age [...]."

agents undergo routine tests of their physical and mental fitness to fulfill their tasks—similar to the tests that pilots must undergo to maintain their rating.

In fact, setting a mandatory retirement age could actually be counterproductive. As we have seen, the kink in the age-performance relation near age 65 suggests that the official retirement age of 65 offers aging COBs a face-saving exit option. In practice, firms often set the mandatory retirement age at 70 or older, which could dilute the attractiveness of the 'official' exit option and induce COBs to stay longer.

Tentative evidence is unable to reject this conjecture. We have asked the COBs whether their position is subject to any age restrictions (*bAge limit*). As it turns out, only 19 percent of our sample firms set a maximum retirement age. According to Panel A of Table 9, COB age is slightly higher, on average (57.7 vs. 56.5 years), whereas *Survey time*, our proxy for cognitive abilities, is statistically the same in both sub-samples.[18] In regression (1) of Panel B, we extend the standard performance model with *bAge limit* as well as an interaction term of *bAge limit* and *COB age*. The coefficients of both additional variables are statistically zero, whereas *COB age* maintains its sign and significance. When we add *Survey time*, the coefficient of *COB age* again declines in magnitude and significance (regression 2). More importantly, *bAge limit* and the interaction term are unaffected by the inclusion of this variable. Setting a mandatory retirement age, therefore, does not seem to help firms overcome the problems associated with aging COBs. A more thorough analysis of the unlisted firms' apparent succession planning problem must be left open for future research.

[18] We have also asked the COBs whether the firms restrict board tenure. Only 6 percent of the firms have such restrictions.

6. Conclusion

Around the world, life expectancy has been increasing for decades and so has the median age of the working population. A large body of literature in economics, psychology, and sociology examines the challenges posed by this demographic change. Recently, the finance literature has jumped the bandwagon by investigating, among other things, how investment and financing decisions are related to the physical age of the CEO. This paper takes the issue to the board room of unlisted firms, the backbone of every economy. We want to know whether aging COBs affect firm performance, and if so, why that could be the case. The data come from a recent survey of almost 10,000 COBs of unlisted Swiss firms. The resulting sample is representative of corporate Switzerland in various ways.

We find a statistically and economically significant negative relation between COB age and various measures of firm profitability. The deleterious effect of age begins at approximately 50 years. COBs, on average, manage to impose their own life-cycle on the firms they lead. Moreover, and consistent with standard agency theory, the age effect is stronger in firms with significant minority shareholders. To the best of our knowledge, we are the first to document such a COB age effect. The dataset allows us to take the analysis one step further and crack open the black box surrounding 'aging.' Previous literature finds that cognitive abilities and motivation are two of the main age-related determinants of job performance. Consistent with this literature, we show that older COBs are significantly slower and experience substantial shifts in motivation. COBs seem to age much like 'ordinary' people do.

Finally, we ask whether the changes in abilities and motivation help explain the age effect we observe. The negative relation between COB age and firm performance is mainly driven by the deterioration of the captain's cognitive abilities. Motivation also seems to play a role, but its effect is considerably smaller.

Taken together, our results suggest that unlisted firms could have a problem with succession planning. Various codes of best practice stipulate mandatory retirement age limits to prevent directors from overstaying. Tentative evidence casts doubts on the effectiveness of this simple remedy. If anything, the COB age is higher in firms with such clauses. Moreover, the presence of board age limits leaves the relation between COB age and firm performance unaffected. This result implies that the ongoing debate on board retirement policies should be taken with a grain of salt.

Figure 1: Non-parametric regressions

The Figure shows the results of kernel-weighted local polynomial regressions to investigate the functional form of the COB age-performance relation. As the dependent variable, the graph uses residuals from OLS regressions of ROA (ROE) on the same control variables as in Table 3, except for COB age. The independent variable is COB age, winsorized at the bottom and top decile. The values are obtained 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.

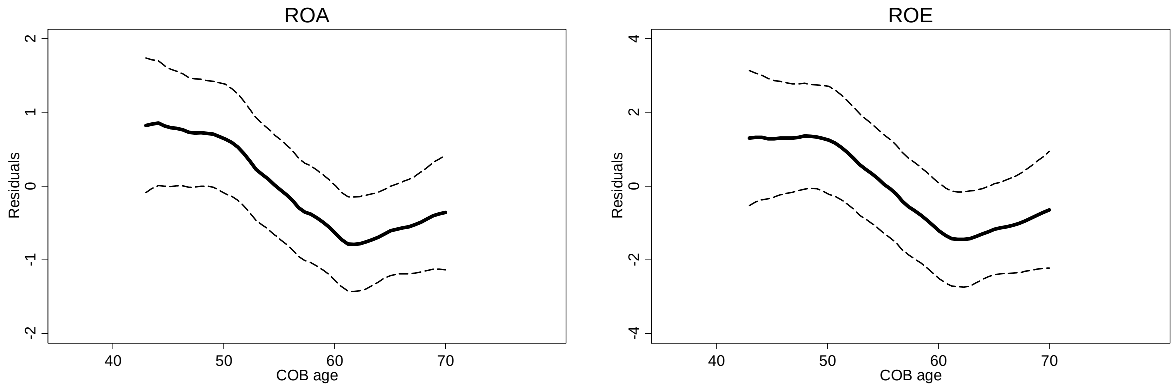

Table 1: Descriptive Statistics

The table shows the descriptive statistics. Variable definitions are in Table 10 at the end of the paper. All variables are winsorized at the 5th and the 95th percentile of their distribution (except for the binary variable *bCEO-COB duality*). The data refer to unlisted Swiss firms in 2006.

	Mean	Std.	p25	Med.	p75	N	IR (%)
				Panel A: Firm characteristics			
Assets (mio. CHF)	28	47	4	10	25	1'101	72.7
Sales (mio. CHF)	35	51	6	15	35	1'342	88.6
Net income (mio. CHF)	1.36	2.45	0.10	0.39	1.20	1'133	74.8
Leverage	0.43	0.27	0.19	0.44	0.66	1'022	67.5
Firm age (years)	51.18	37.4	19.0	43.0	77.0	1'479	97.7
				Panel B: COB characteristics			
COB age (years)	56.8	9.6	49.0	57.0	64.0	1'502	99.2
COB tenure (years)	15.5	10.3	7.0	14.0	22.0	1'488	98.3
				Panel C: Firm performance measures			
ROA (%)	7.67	6.89	2.96	5.13	10.47	963	63.6
ROE (%)	11.98	13.43	2.64	7.20	16.67	950	62.7
NPM (%)	4.30	4.57	0.96	2.83	6.25	1'110	73.3
ROEMP (thousand CHF)	14.39	19.89	1.82	6.07	16.90	1'110	73.3
Sales-to-assets	1.85	1.26	0.92	1.54	2.50	1'081	71.4
				Panel D: Control Variables			
bCEO-COB duality	0.47	–	–	–	–	1'503	99.3
Board size	3.90	1.48	3.00	4.00	5.00	1'500	99.1
Board independence	0.24	0.30	0.00	0.00	0.40	1'487	98.2
Family directors	0.38	0.37	0.00	0.33	0.67	1'487	98.2
vr Largest	0.59	0.31	0.35	0.53	0.90	1'354	89.4
vr Founders	0.46	0.45	0.00	0.42	1.00	1'176	77.7
vr Executives	0.56	0.41	0.05	0.60	1.00	1'246	82.3

Table 2: Correlation coefficients between pairs of control variables and performance measures

The table shows Pearson correlation coefficients. Variable definitions are in Table 10 at the end of the paper. The data refer to unlisted Swiss firms in 2006.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) ROA (%)	1.00															
(2) ROE (%)	0.91	1.00														
(3) NPM (%)	0.64	0.58	1.00													
(4) ROEMP (1'000 CHF)	0.52	0.46	0.76	1.00												
(5) Sales-to-assets ratio	0.36	0.30	–0.22	–0.08	1.00											
(6) COB age	–0.10	–0.07	–0.05	–0.03	–0.10	1.00										
(7) COB tenure	–0.06	–0.05	0.02	–0.01	–0.12	0.49	1.00									
(8) Firm age	–0.17	–0.15	–0.02	0.00	–0.20	0.09	0.19	1.00								
(9) bCEO-COB duality	–0.03	–0.05	–0.07	–0.09	0.06	–0.21	0.13	–0.08	1.00							
(10) Board size	–0.05	–0.05	0.09	0.13	–0.11	0.04	–0.09	0.07	–0.28	1.00						
(11) Board independence	0.04	0.02	0.05	0.09	–0.04	0.02	–0.13	0.03	–0.23	0.30	1.00					
(12) Family directors	–0.10	–0.09	–0.12	–0.09	–0.04	0.08	0.27	0.10	0.22	–0.28	–0.35	1.00				
(13) vr Largest	0.08	0.07	0.02	0.04	0.07	0.01	0.09	0.07	0.12	–0.22	0.09	0.02	1.00			
(14) vr Founders	0.06	0.04	–0.01	0.00	0.14	0.07	–0.02	–0.40	0.09	–0.08	–0.04	0.00	0.02	1.00		
(15) vr Executives	0.01	–0.01	–0.08	–0.14	0.07	–0.08	0.16	–0.05	0.47	–0.34	–0.29	0.28	0.07	0.07	1.00	
(16) Leverage	–0.05	0.10	–0.19	–0.17	–0.10	0.04	–0.05	0.04	–0.06	–0.04	0.03	0.07	–0.04	–0.05	–0.04	1.00
(17) Assets	–0.10	–0.10	0.21	0.35	–0.24	0.05	–0.03	0.14	–0.19	0.34	0.26	–0.17	–0.01	–0.05	–0.26	0.01

Table 3: COB age and firm performance

The table investigates the relation between COB age and firm performance. Variable definitions are in Table 10 at the end of the paper. In regressions (1), the dependent variable is ROA. In regressions (2), (3), (4) and (5), the dependent variable is ROE, NPM, ROEMP, and Sales-to-asset respectively. All regressions are estimated with OLS. The first argument in parentheses shows robust standard errors. For significant coefficients, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. In the case of *bCEO-COB duality*, the sensitivity is for a change from 0 to 1. ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

	ROA (1)	ROE (2)	NPM (3)	ROEMP (4)	Sales-to-asset (5)
COB age	–0.082**	–0.144**	–0.042**	–0.151*	–0.004
	(0.033; –10.3)	(0.067; –11.5)	(0.020; –9.4)	(0.085; –10.1)	(0.006)
COB tenure	0.039	0.072	0.033	0.083	–0.006
	(0.033)	(0.067)	(0.020)	(0.087)	(0.006)
ln(firm age)	–0.779**	–1.538**	–0.111	–1.366	–0.168***
	(0.324; –5.6)	(0.669; –7.0)	(0.233)	(0.863)	(0.061; –5.0)
bCEO-COB duality	–1.268**	–2.662**	–0.495	–1.329	–0.043
	(0.608; –16.5)	(1.192; –22.2)	(0.384)	(1.531)	(0.107)
Board size	–0.078	–0.254	0.002	–0.452	–0.000
	(0.212)	(0.433)	(0.146)	(0.596)	(0.035)
Board independence	0.453	–1.162	–0.240	–0.564	0.076
	(1.012)	(1.972)	(0.646)	(2.681)	(0.180)
Family directors	–1.703**	–3.790**	–0.860*	–0.948	–0.136
	(0.843; –8.2)	(1.654; –11.7)	(0.516; –7.4)	(2.038)	(0.135)
vr Largest	2.105**	4.539**	0.516	1.936	0.331**
	(0.919; 8.5)	(1.908; 11.7)	(0.567)	(2.276)	(0.160; 5.5)
vr Founders	0.144	0.073	0.183	0.543	0.069
	(0.627)	(1.294)	(0.425)	(1.585)	(0.107)
vr Executives	–0.040	–0.686	–0.086	–1.232	–0.050
	(0.742)	(1.528)	(0.506)	(1.907)	(0.138)
Leverage	–3.568***	6.127***	–2.707***	–12.277***	–0.361**
	(1.022; –12.6)	(2.118; 13.8)	(0.603; –17.0)	(2.392; –23.0)	(0.163;–5.3)
Size	–0.831***	–1.340***	0.622***	5.583***	–0.330***
	(0.240; –5.6)	(0.465; –5.8)	(0.172; 7.5)	(0.716; 20.1)	(0.046; –9.2)
Constant	17.256***	23.056***	8.015***	31.070***	3.245***
	(2.991)	(5.690)	(2.472)	(10.396)	(0.524)
Industry fixed effects	Included	Included	Included	Included	Included
Observations	694	685	684	683	722
Adjusted R-squared	0.084	0.058	0.141	0.227	0.162

Table 4: Piecewise COB age and firm performance

The table investigates the functional form of the relation between COB age and firm performance by estimating piecewise linear regressions. Variable definitions are in Table 10 at the end of the paper. The dependent variables are the same as in Table 3. All regressions are estimated with OLS. The first argument in parentheses shows robust standard errors. For significant control variables, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. For the piecewise COB age measure, we investigate the impact of plus/minus half a standard deviation (4.8 years) around mean COB age (56.8). Therefore, the two cases we project are COB age 52 (*COB age < 50* = 49; *50 ≤ COB age < 65 = 3*) and COB age 61.6 (*COB age < 50* = 49; *50 ≤ COB age < 65 = 12.6*). In the case of *bCEO-COB duality*, the sensitivity is for a change from 0 to 1. ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

	ROA (1)	ROE (2)	NPM (3)	ROEMP (4)	Sales-to-asset (5)
COB age < 50	–0.063	–0.063	–0.007	0.230	0.005
	(0.135)	(0.271)	(0.081)	(0.282)	(0.022)
50 ≤ COB age < 65	–0.127**	–0.248**	–0.119***	–0.471***	–0.003
	(0.064; –14.9)	(0.126; –18.2)	(0.039; –26.3)	(0.156; –31.1)	(0.010)
65 ≤ COB age	0.051	0.123	0.178***	0.542**	–0.020
	(0.104)	(0.212)	(0.068)	(0.246)	(0.022)
COB tenure	0.035	0.064	0.028	0.059	–0.006
	(0.033)	(0.067)	(0.020)	(0.087)	(0.006)
ln(firm age)	–0.774**	–1.526**	–0.107	–1.287	–0.164***
	(0.325; –5.5)	(0.675; –7.0)	(0.232)	(0.857)	(0.062; –4.9)
bCEO-COB duality	–1.199*	–2.536**	–0.380	–0.964	–0.055
	(0.613; –15.6)	(1.205; –21.2)	(0.382)	(1.527)	(0.109)
Board size	–0.068	–0.232	0.020	–0.366	0.000
	(0.212)	(0.430)	(0.145)	(0.591)	(0.036)
Board independence	0.498	–1.036	–0.183	–0.203	0.077
	(1.012)	(1.977)	(0.649)	(2.679)	(0.180)
Family directors	–1.728**	–3.796**	–0.910*	–0.767	–0.120
	(0.849; –8.3)	(1.664; –11.7)	(0.514; –7.8)	(2.014)	(0.137)
vr Largest	2.055**	4.458**	0.437	1.774	0.340**
	(0.926; 8.3)	(1.923; 11.5)	(0.566)	(2.288)	(0.161; 5.7)
vr Founders	0.109	0.003	0.115	0.401	0.077
	(0.626)	(1.287)	(0.419)	(1.561)	(0.109)
vr Executives	–0.084	–0.760	–0.155	–1.434	–0.044
	(0.745)	(1.538)	(0.507)	(1.894)	(0.139)
Leverage	–3.599***	6.089***	–2.775***	–12.267***	–0.354**
	(1.024; –12.7)	(2.125; 13.7)	(0.604; –17.4)	(2.386; –23.0)	(0.163; –5.2)
Size	–0.825***	–1.341***	0.632***	5.575***	–0.333***
	(0.240; –5.6)	(0.464; –5.8)	(0.171; 7.6)	(0.707; 20.1)	(0.046; –9.3)
Constant	16.491**	19.651	6.541	13.831	2.769**
	(6.830)	(13.559)	(4.313)	(15.317)	(1.183)
Industry fixed effects	Included	Included	Included	Included	Included
Observations	694	685	684	683	722
Adjusted R-squared	0.083	0.057	0.150	0.233	0.161

Table 5: Robustness tests

The table tests the robustness of the results in Table 3. Variable definitions are in Table 10 at the end of the paper. In Panel A, we interact COB age (demeaned) with the following dummy variables: (1) *bClosely held*: firms with a single shareholder who owns more than 90% of the voting rights; (2) *bMajority shareholder*: firms in which a single shareholder owns more than 50% of the voting rights; (3) *bNot founder*: firms where the COB is not founder; and (4) *bTenure < 5*: firms with COB tenure below 5 years; All regressions are estimated with OLS. The dependent variable is *ROA*. To preserve space, we do not report the coefficients of the control variables. Panel B estimates Heckman (1979) selection models with *ROA* and *ROE* as dependent variables. The selection variable is *bConfidential*, a dummy variable that identifies respondents who state that the questionnaire contains questions that touch on potentially confidential issues. The first argument in parentheses shows robust standard errors. For significant control variables, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. For the interaction term, we keep *bMajority shareholder* at 1 and vary *COB age*. ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

Panel A: Owner-managed firms and the old guard

	Dependent variable: *ROA*			
	(1)	(2)	(3)	(4)
COB age	–0.105***	–0.156***	–0.139**	–0.082**
	(0.037; –13.1)	(0.052; –19.5)	(0.063; –17.4)	(0.035; –10.3)
bClosely held	–0.131			
	(0.976)			
COB age × bClosely held	0.087			
	(0.061)			
bMajority shareholder		–0.210		
		(0.853)		
COB age × bMajority shareholder		0.110*		
		(0.058; 13.8)		
bNot founder			0.039	
			(0.815)	
COB age × bNot founder			0.072	
			(0.069)	
bTenure < 5				0.625
				(0.965)
COB age × bTenure < 5				–0.001
				(0.094)
COB tenure	0.039	0.041	0.038	0.050
	(0.033)	(0.033)	(0.034)	(0.035)
Other controls	Included	Included	Included	Included
Industry fixed effects	Included	Included	Included	Included
Observations	694	694	694	694
Adjusted R-squared	0.075	0.077	0.074	0.073

Panel B: Sample selection

	Dependent variable: ROA	Dependent variable: ROE
First step: *bConfidential*	–0.870***	–0.859***
	(0.090)	(0.090)
Controls (selection)	Included	Included
Second step: *COB age*	–0.077**	–0.132***
	(0.034; –9.6)	(0.067; –10.6)
Controls	Included	Included
Inverese mills ratio	1.306	3.898
	(1.279)	(2.607)

Table 6: COB age and cognitive abilities

The table asks whether the COBs' cognitive abilities change with age. Our proxies for cognitive abilities are *Survey time* and *Complexity*, respectively. Variable definitions are shown in Table 10 at the end of the paper. Panel A reports descriptive statistics. Panel B shows the results from multivariate OLS (regressions 1 and 2) and ordered logit regressions (3 and 4). In regression (1) and (2), the dependent variable is *Survey time*. Regression (3) and (4) investigates the determining factors of *Complexity*. In addition to the linear COB age measure (regressions 1 and 3) we also estimate piecewise linear models (regressions 2 and 4). The first argument in parentheses shows robust standard errors. For significant control variables, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. For the piecewise COB age measure, we investigate the impact of plus/minus half a standard deviation (4.8 years) around mean COB age (56.8). Therefore, the two cases we project are COB age 52 (*COB age < 50* = 49; *50 ≤ COB age < 65 = 3*) and COB age 61.6 (*COB age < 50* = 49; *50 ≤ COB age < 65 = 12.6*). To assess the marginal effects in the ordered logit regressions 3 and 4, we compute the change in the cumulative predicted probabilities of the two categories 'I strongly agree' and 'I agree.' ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

Panel A: Descriptive statistics

	Mean	Std.	Med.	N
Survey time	21.56	9.34	20.00	1'347
Complexity	4.11	1.20	5.00	1'449

Panel B: Multivariate regressions

	Dependent variable: *Survey time*		Dependent variable: *Complexity*	
	(1)	(2)	(3)	(4)
COB age	0.243***		0.020**	
	(0.047; 10.8)		(0.009; 4.2)	
COB age < 50		0.147		0.009
		(0.149)		(0.034)
50 ≤ COB age < 65		0.269***		0.046**
		(0.088; 9.7)		(0.018; 8.0)
65 ≤ COB age		0.261		–0.051
		(0.186)		(0.033)
COB tenure	0.023	0.024	–0.018**	–0.017*
	(0.045)	(0.045)	(0.009; –3.8)	(0.009; –3.5)
Other controls	Included	Included	Included	Included
Industry fixed effects	Included	Included	Included	Included
Observations	697	697	719	719
Adjusted R-squared	0.084	0.082	0.033	0.036
Wald chi-2			62.525***	67.567***

Table 7: COB age and motivation

The table asks whether the COBs' job-related motivation changes with age. Variable definitions are in Table 10 at the end of the paper. Our proxy for business objectives is *Shareholder value*. To examine the COBs' job activities, we investigate how much time the COBs actually dedicate to a) strategic tasks, b) monitoring activities, c) controlling, reporting, and auditing, d) interaction with external stakeholders, and e) other activities. We both measure the actual as well as the target time allocation to these functions. To assess the COBs' financial incentives, we use the actual structure of the compensation package (*bVariable compensation*) as well as the desired structure (*Higher incentives*). Panel A shows descriptive statistics for the COBs' business objectives and compensation packages. Panel B summarizes the COBs' actual and desired job activities. Panel C shows the results from multivariate regressions of business objectives and compensation on COB age and controls. Regressions (1), (3), and (4) are estimated with an ordered logit model. Regression (2) uses a logit model. Finally, Panel D studies the relation between COB age and job activities in a multivariate framework. Each row shows the results of two separate regressions of the job activity listed to the left of the table on *COB age*, *COB tenure*, and the standard controls (including industry fixed effects, IFE). To preserve space, we only report the coefficients of *COB age* and *COB tenure*. The left part of the table refers to the COBs' actual time allocation whereas the right part studies the target time allocation. The first argument in parentheses shows robust standard errors. For significant variables, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. In the case of *bRisk perception*, the sensitivity is for a change from 0 to 1. To assess the marginal effects in the ordered logit regressions 1, 3, and 4 of Panel B, we compute the change in the cumulative predicted probabilities of the two categories 'I strongly agree' and 'I agree.' For the logit regression, it's the change in the probability of a positive outcome. ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

Panel A: Descriptive statistics for business objectives and compensation

	Mean	Std.	Med.	N
Shareholder value	1.82	1.17	1.00	1'443
bVariable compensation	0.19	–	–	1'144
Higher incentives	2.18	1.38	2.00	1'434
bRisk perception	0.81	–	–	1'448

Panel B: Descriptive statistics for job activities

	Actual time allocation				*Target time allocation*				*Mean comparison*
	Mean	Std.	Med.	N	Mean	Std.	Med.	N	
Strategic tasks	0.272	0.186	0.20	1'255	0.312	0.172	30.00	831	***
Monitoring activities	0.278	0.158	0.26	1'251	0.262	0.139	25.00	831	**
Controlling, reporting, and auditing	0.280	0.172	0.25	1'255	0.253	0.147	25.00	832	***
Interaction with external stakeholders	0.145	0.168	0.10	1'253	0.151	0.155	10.00	831	–
Other activities	0.036	0.103	0.00	1'228	0.028	0.081	0.00	808	**

Panel C: Multivariate regressions for business objectives and compensation

	Shareholder value	bVariable compensation	Higher incentives	
	(1)	(2)	(3)	(4)
COB age	–0.024**	–0.032**	–0.023**	–0.022**
	(0.010; –17.2)	(0.014; –20.6)	(0.010; –15.0)	(0.010; –14.7)
COB tenure	–0.009	0.031**	–0.004	–0.004
	(0.010)	(0.014; 26.5)	(0.009)	(0.009)
bRisk perception				0.300*
				(0.181; 25.5)
Other controls	Included	Included	Included	Included
Industry fixed effects	Included	Included	Included	Included
Observations	718	595	715	713
Adjusted R-squared	0.040	0.063	0.019	0.020
Wald chi-2	61.180***	35.088***	792.579***	853.604***

Panel D: Multivariate regressions for job activities

	Actual time allocation			*Target time allocation*		
	COB age	COB tenure	Controls, IFE	COB age	COB tenure	Controls, IFE
Strategic tasks	–0.003 (0.005)	–0.003 (0.004)	Included	–0.007 (0.005)	–0.005 (0.004)	Included
Monitoring activities	0.000 (0.004)	–0.007* (0.004; –4.8)	Included	0.000 (0.005)	–0.003 (0.004)	Included
Controlling, reporting, and auditing	0.012*** (0.004; 8.5)	0.002 (0.004)	Included	0.011** (0.005; 8.2)	0.002 (0.005)	Included
Interaction with external stakeholders	–0.010* (0.006; –8.0)	0.009 (0.006)	Included	–0.005 (0.006)	0.009 (0.007)	Included
Other activities	0.027** (0.013; 27.6)	–0.007 (0.014)	Included	0.053*** (0.017; 61.9)	–0.020 (0.017)	Included

Table 8: COB age, determinants of job performance, and firm performance

The table asks whether changes in cognitive abilities and motivation help explain the COB age effect we observe. Variable definitions are in Table 10 at the end of the paper. The dependent variable is *ROA.* All regressions are estimated with OLS. To preserve space, we only report the coefficients of COB age, COB tenure, the proxies for abilities and motivation, as well as various interaction terms. The first argument in parentheses shows robust standard errors. For significant variables, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. In the case of *Shareholder value*, the sensitivity is for a change from 'neutral' to 'strongly agree.' ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

	Dependent variable: *ROA*					
	(1)	(2)	(3)	(4)	(5)	(6)
COB age	–0.082**	–0.063*	–0.071**	–0.074**	–0.074**	–0.043
	(0.033; –10.3)	(0.034; –7.9)	(0.033; –8.9)	(0.036; –9.3)	(0.033; –9.3)	(0.038)
Cognitive abilities						
Survey time		–0.093***				–0.104***
		(0.027; –11.3)				(0.030; –12.7)
Motivation						
Shareholder value			0.463*			0.444*
			(0.251; 11.0)			(0.268; 10.5)
Strategic tasks (actual)				1.912		1.695
				(1.560)		(1.710)
Controlling, rep., aud. (actual)				–0.221		0.607
				(1.675)		(1.761)
Higher incentives					0.139	0.041
					(0.194)	(0.211)
COB tenure	0.039	0.040	0.037	0.041	0.035	0.038
	(0.033)	(0.034)	(0.033)	(0.036)	(0.033)	(0.039)
Other controls	Included	Included	Included	Included	Included	Included
Industry fixed effects	Included	Included	Included	Included	Included	Included
Observations	694	661	681	619	678	583
Adjusted R-squared	0.084	0.099	0.085	0.081	0.081	0.102

Table 9: Firm performance and board retirement policy

This table investigates whether the presence of a mandatory retirement age (*bAge limit*) affects the relation between COB age and firm performance. COB age is demeaned. Variable definitions are in Table 10 at the end of the paper. Panel A performs a mean comparison test of *COB age* and *Survey time* for firms with and without *bAge limit*. Panel B shows the results from multivariate OLS. The dependent variable is *ROA*. To preserve space we do not report the coefficients of the control variables. The first argument in parentheses shows robust standard errors. For significant variables, we add a second argument, which shows the sensitivity of the dependent variable (in %) to an increase in the independent variable by one standard deviation. ***, **, and * denote statistical significance with confidence 99%, 95%, and 90%, respectively. The data refer to Swiss firms in 2006.

Panel A: Univariate results

	bAge limit = 1		*bAge limit = 0*		*Mean comparison*
	Mean	N	Mean	N	
COB age	57.68	285	56.52	1'195	**
Survey time	21.82	257	21.51	1'074	–

Panel B: Multivariate regressions

	Dependent variable: *ROA*	
	(1)	(2)
COB age	–0.093***	–0.073**
	(0.035; –11.6)	(0.036; –9.1)
bAge limit	0.304	0.326
	(0.753)	(0.751)
COB age × bAge limit	0.099	0.090
	(0.088)	(0.088)
Survey time		–0.096***
		(0.027; –11.7)
COB tenure	0.040	0.042
	(0.033)	(0.035)
Other controls	Included	Included
Industry fixed effects	Included	Included
Observations	690	658
Adjusted R-squared	0.082	0.098

Table 10: Variable Definitions

Variable	Definition
bAge limit	Binary variable equal to 1 if the firm has a mandatory retirement policy, and equal to 0 otherwise.
bCEO-COB duality	Binary variable equal to 1 if the same person is simultaneously CEO and COB, and equal to 0 otherwise.
bClosely held	Binary variable equal to 1 if a single shareholder owns more than 90 percent of the voting rights, and equal to 0 otherwise.
bConfidential	Binary variable equal to 1 if respondent states that the questionnaire contains questions that touch on potentially confidential issues, and equal to 0 otherwise.
bMajority shareholder	Binary variable equal to 1 if a single shareholder owns more than 50 percent of the voting rights, and equal to 0 otherwise.
bNot founder	Binary variable equal to 1 if the COB is not founder, and equal to 0 otherwise.
bRisk perception	Binary variable equal to 1 if the COB agreed to the statement 'The risks associated with a directorship have increased in recent years', and equal to 0 otherwise.
bTenure < 5	Binary variable equal to 1 if the COB's tenure is below 5 years, and equal to 0 otherwise.
bVariable compensation	Binary variable equal to 1 if the COB receives performance sensitive compensation, and equal to 0 otherwise.
Board independence	Fraction of independent directors on the board. A director is classified as independent if he does not have business-ties to the firm and did not have so over the preceding three years.
Board size	Number of directors on the board.
COB age	Age of the COB (years).
COB tenure	Term during which the COB held his position (years).
Complexity	The COB's assessment of the statement 'in recent years, it has become more difficult to be a director', measured on a 5-point Likert scale.
Family directors	Fraction of directors which are members of the founding family.
Firm age	Number of years since the foundation of the company (years).
Higher incentives	The COB's assessment of the statement 'the COB prefers a more performance sensitive compensation package', measured on an ordinal 5-point Likert scale.
Leverage	The firm's leverage, calculated as the book value of debt divided by total assets.
ROA	The firm's return on assets, calculated as operating profit after taxes (= net income + interest expenses after taxes) divided by book value of assets. We assume a cost of debt of 4%.
ROE	The firm's return on equity, calculated as the net income divided by the book value of the firm's equity times 100.
ROEMP	The firm's annual return per full time equivalent employee, calculated as the net income divided by the number of full time equivalent employees (thousand CHF).
NPM	The firm's net profit margin, also known as return on sales, calculated as the net income divided by the total annual sales of the firm times 100.
Sales-to-assets	The firm's ratio of annual sales to total assets.
Shareholder value	Based on the COB's assessment of the statement 'for our board the firm's interests come prior to the shareholders' interest'; measured on an ordinal 5-point Likert scale. To enhance readability, we compute Shareholder value as 6 minus the COB's answer to the above statement.
Size	The natural logarithm of the firms total assets (million CHF).
Survey time	The time it took the COB to fill in the questionnaire (minutes).
vr Executives	Fraction of voting rights controlled by all executives.
vr Founders	Fraction of voting rights controlled by the founders.
vr Largest	Fraction of voting rights controlled by the largest blockholder.

Corporate Aging around the World

Jonas Zeller*

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This paper examines whether firms internationally age as US firms do (Loderer, Stulz, and Wälchli, 2013). Using a large panel, I find that Tobin's Q monotonically falls with firm age across all nineteen countries in the sample. The decrease varies across countries but is generally extremely robust and economically significant. ROA, sales growth, and market share decrease over a firm's lifetime in most countries as well. Furthermore, older firms reduce their capital expenditures and R&D outlays. Instead, they distribute more cash to their shareholders. Overall, the results suggest that corporate aging is not confined to the US but is a genuine phenomenon that affects listed firms worldwide. This evidence supports the hypothesis that corporate aging is driven by managers who optimally focus on managing their assets in place and neglect the development of growth opportunities. I finally ask whether the managers' choice and with it the magnitude of the decline in Tobin's Q is a function of country-level institutional settings. I find that most notably firms age faster in countries where employees are relatively well protected by labor regulation.

Keywords: age, firm performance, cross country.

JEL codes: G30, L20

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1. Introduction

In this paper I examine whether internationally firms age in a similar way as in the US and whether differences in institutional settings cause variation in the speed of corporate aging. Loderer, Stulz, and Wälchli (2013; hereafter LSW) are the first to comprehensively document a corporate aging phenomenon in the US. With increasing age, US firms struggle to maintain their initial level of success. Tobin’s Q and return on assets (ROA) decline, sales growth slows, market shares shrink, capital expenditures are cut, and investments in R&D are reduced over the lifetime of a firm. LSW suggest that this phenomenon is the result of time-constrained managers who focus on the firm’s efficient operation and neglect innovation. However, not only internal structures seem to influence corporate aging. LSW show that the negative age dependence of Q is mediated by the institutional environment that firms operate in. Legislation regulating the competitiveness of the product market, the labor market, and the market for corporate control seem to have an impact on the age-Tobin’s Q relation. Given that, relative to other countries, the US have numerous distinctive features with respect to labor markets, product markets, and the market for corporate control, the corporate aging phenomenon documented by LSW is potentially a US-specific effect. However, whether corporate aging occurs internationally is an empirical question. This paper examines whether the corporate aging phenomenon, documented by LSW, subsists in non-US countries, whether there are cross-country differences in the strengths of the effect, and, if so, whether these differences are related to country-level institutional settings relevant for the competitiveness in the labor market, the product market, and the market for corporate control.

In a large international panel which covers more than 32’000 firms in 19 countries and a period between January 1985 and December 2010, I document a robust, monotonic, and economically significant decrease in Tobin’s q over the average firm’s lifetime. The effect is present in a sample containing all observations, a subsample excluding the US, and in each of the 19 countries measured individually. I measure age as years since the firm's incorporation as well as years since IPO and I use binary variables indicating whether the firm is older than the sample median in any given country and year. Results are robust, irrespective of the age measure and also hold for different sub-periods. In addition to Tobin's Q, operating profitability measured by ROA, sales growth, and market shares, decrease over a firm's lifetime in most of the countries. Moreover, firms reduce their capital expenditures and R&D outlays and instead distribute part of the proceeds to the shareholders. Overall, it seems that corporate aging is not confined to the US but is a genuine phenomenon affecting listed firms worldwide.

Comparing the magnitude of this age effect internationally reveals considerable cross-country differences. Therefore, I investigate whether part of this cross-country variation is driven by international institutional differences with respect to legislation regulating the competitiveness of labor markets, product markets, and the market for corporate control. To correctly identify the effect of institutional settings on the age-Tobin's Q relation, I exploit the natural experiment created by the staggered passage of changes in legislations across countries. Since these changes occurred at different times in different countries, I can identify the impact of institutional changes using a difference-in-differences test design (Imbens and Wooldrige (2009)). Specifically, I estimate the before-after difference of the corporate age effect in countries where institutions changed vis-à-vis the difference in countries where institutions did not change. To estimate the difference-in-differences, I employ panel regressions with an interaction term of proxies for institutions and firm age, and control for country, year, and industry fixed-effects. The results suggest that especially labor market aspects play a significant role in moderating the age-Tobin's Q relation. However, the results of these tests are only tentative and need to be buttressed further.

The paper proceeds as follows. Section 2 presents the data and the investigative approach. Section 3 studies the relation between firm age and firm performance in my 19 sample-countries. Section 4 asks how institutions impact the age-Tobin's Q relation and section 5 concludes.

2. Data and Method

2.1. Sample Description

The limited availability and cross-country comparability of firm-level data is a challenge for any international empirical analysis. In my investigation, I require reliable data on firm age and financial characteristics. Because only listed firms comprehensively report such data, I start the sample construction by selecting countries with the world's most important stock exchanges according to the World Federation of Exchanges. I restrict my sample to countries with stock exchanges of more than USD 500 billion market capitalization as of December 2010. For those countries, the sample starts with all available firms in the *Thomson Financial's WorldScope* database in fiscal years 1985 through 2010. The *WorldScope* database provides fundamental information on the world's leading public firms, such as annual balance sheets, income statements, cash flows, and general firm information.[1] Due to poor data availability, I exclude several emerging markets.[2] The final sample therefore contains 19 countries (see column 1 of Table 1). Following Desai, Foley, and Forbes (2008), firms are identified as local based on the country in which they are incorporated. As indicated in Table 2, the overall sample contains more than 48'000 firms and more than 492'000 firm-years. Table 2 lists the restrictions that apply to the sample. Specifically, I exclude all financial firms (SIC 6000–6999) and regulated utilities (SIC 4900–4949).[3] In order to have similar length of accounting periods in every firm-year, I ignore all firm-year observations which do not last between 361 and 371 days. I also exclude all firm-year observations with missing or negative assets, sales, market value of equity, and book

[1] Alternatively, *Compustat* offers financial data on listed firms internationally. Ulbricht and Weiner (2005), however, document that *WorldScope* covers considerably more firms for time periods after 1997, making it the first choice for cross-country studies concerned with recent periods.

[2] Specifically, I exclude firms listed on the Shanghai SE, BSE India, National SE India, BM&FBOVESPA, Shenzhen SE, MICEX, Johannesburg SE, and Taiwan SE.

[3] This omission does not change the conclusions of the analysis. The tables including the omitted industries are available from the author upon request.

value of equity. Finally, following LSW, I ignore all firms younger than 5 years.[4] Due to the imposed restrictions, approximately 16 percent of the firms leave the sample. The final sample contains 32’330 firms and 293’468 firm-years.

Columns 4 to 7 of Table 1 show how the firms and firm-years are distributed across the 19 sample-countries. For an appropriate interpretation of the relative importance of the country-specific results, it is essential to note that cumulatively the US and Japan account for more than half and the ten largest sample-countries for more than 90 percent of the observations, as indicated by column 8 of Table 1. Over time, the coverage increases from 3’795 firms in 1985 to 16’215 firms in 2010. Sample growth is not uniform over time. The number of firms covered increases sharply prior to 1995 by an annual 14 percent, on average. Between 1995 and 2004, the increase is 12 percent and thereafter only 3 percent annually. Splitting the sample into these sub-periods, however, yields consistent results over time, suggesting, that the findings are not driven by the expansion of *WorldScope*’s sample-coverage.[5]

There are several caveats to using *WorldScope* data. As Pinkowitz, Stulz, and Williamson (2006) point out, the data have a bias toward large firms, they suffer from backfilling, and the accounting conventions used in producing the data are not the same across countries. In addition to what *WorldScope* already does to make the data more comparable across countries and time, the analysis below addresses these issues by including industry, year, and country fixed-effects in the cross-country regressions or, alternatively, by estimating separate regressions for each country. Moreover, to reduce the influence of outliers, I winsorize all firm-level variables (except the binary and age variables) at the 1st and the 99th percentile of their pooled distribution at the country-level.

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4 This omission does not change the conclusions of the analysis. The tables including firms younger than 5 years are available from the author upon request.

5 See 3.3 for the empirical results.

2.2. Method

To test whether the corporate age effect exists also outside the US, I methodologically borrow from LSW by modifying their econometric approach to reflect the cross-country features of my dataset and the differences in data sources. In what I refer to as my standard regression, I regress various measures of firm performance on firm age and a set of variables that should help to control for potential confounding effects:

Performance = f(*firm age*, *return on assets*, *capital expenditures*, *R&D outlays*, *cross-listings*, *the degree of specialization*, *financial flexibility*, *leverage*, *firm size*, *volatility, industry, year*). (1)

The following three sections describe in detail, how my econometric approach and the measurement of the variables is distinct from the approach of LSW.

2.2.1. Firm Age

To measure firm age, I closely follow LSW using the number of years (plus one) that the firm has been listed on a stock exchange (Age_{ipo}) and, alternatively, the number of years (plus one) elapsed since the firm's incorporation (Age_{inc}). In line Shumway (2001), I argue that also in an international context listing age is the economically most meaningful measure of firm age. In every sample-country, listing is a defining moment in a firm's life because it affects ownership and capital structure, growth opportunities, media exposure, and corporate governance structure. However, cross-country studies not only use listing age (Dahya, Dimitrov, and McConnell (2008)) but also incorporation age (Bena and Ortiz-Molina (2013), Holderness (2011), Masulis, Pham, and Zein (2011), Gianetti (2003) or Claessens et al. (2002)) as a proxy for firm age.

One of the main challenges of this paper is to comprehensively collect firm age data because *WorldScope* only contains incomplete information on this variable. Several approaches have been used in the literature. For listing age Dahya, Dimitrov, and McConnell (2008) complement *WorldScope* data with information from *SDC Platinum*. For listing age, Holderness (2011) uses *WorldScope* as a main source and complements his sample with information from company websites. Other databases used in the cross-country literature are *Amadeus* from Bureau Van Dijk (Bena and Ortiz-Molina (2013) and Gianetti (2003)), *Osiris* from Bureau Van Dijk (Masulis, Pham, and Zein (2011)). To compile the most complete data set possible, I collect the two age proxies from various sources combining the approaches above. I start with age data obtained from LSW, which contains the two proxies for the US, and add information on firm age for non-US countries obtained from *WorldScope*, *Compustat*, *Osiris*, *SDC Platinum*, *Zephyr*, *CRSP*, stock exchange websites, IR-managers, *Amadeus*, commercial registers, corporate websites, *Reuters*, encyclopedias and a web search, in this order. This pecking order has a somewhat arbitrary component because the ranking according to quality and reliability of a database is difficult to determine objectively. However, the ranking should not introduce any bias because consistency across different data sources is very high. The firm age distribution for subsamples of firms with simultaneous entries in two databases is almost identical for any pair of database. I can verify this consistency because my collection process is designed in a way that for any database I collect all available and assignable observations and not only the residual missing observations.[6]

Panel A of Table 3 reports descriptive statistics for the two age proxies. In terms of incorporation age, the average firm is 39 years old and the median incorporation age is 28 years. For IPO age the respective numbers are 21 and 15 years. Noticeably, the standard deviation of incorporation

[6] As an alternative to the pecking order age proxies, I also employ a measure which uses the earliest appearance across all data sources as the birth date of a firm. Using these age proxies in untabulated regressions does not change the conclusion of the analysis. The tables are available from the author upon request.

age is higher than for IPO age for any sample-country. Coverage indicates percentages of firm-year observations for which data on firm age is available. For both age proxies the coverage is on a high level, which makes sample selection bias unlikely to be a problem. Additionally, a subsample comparison of firms where age data is missing with firms where age data is available does not reveal any significant differences in terms of size, leverage and volatility.

2.2.2. Firm Performance

As in LSW, my main measure for growth opportunities is *Tobin's Q*. Alternatively, I use *ROA*, *Gross margin*, the *Probability of decline in market share*, the *Probability of negative sales growth*, and *Sales growth* as measures of current profitability. Panel B of Table 3 reports descriptive statistics for the six firm profitability measures.

2.2.3. Control Variables

The control variables are, in principle, identical to those in the model of LSW. However, they are measured based on the approaches of Ferreira and Matos (2008), Durnev and Kim (2005), Doidge, Karolyi, and Stulz (2004), Doidge et al. (2009), and Mitton (2002). These studies all estimate firm performance regressions in an international context and employ data from the *WorldScope* database. The purpose of the alternative measurement is, on one hand, to find the best proxies in a setting of limited data availability and, on the other hand, to address problems of limited international comparability. For instance, the measures try to avoid accounting data which is prone to managerial discretion. Variable definitions are in Table 13.

The three main differences with regard to variable measurement concern the degree of specialization (*bFocus*), financial flexibility (*FF-index*), and volatility (*Volatility*). LSW use a

Herfindahl index based on segment sales to measure the degree of specialization. Due to the low availability of segment sales in *WorldScope*, I follow Mitton (2002) and measure the degree of specialization with an indicator that is set to one if the number of two-digit SIC level industries in which a firm operates is below the median in a given country and year. Alternatively, I measure the degree of specialization using the number of industries in which the firm operates and the results do not change (not shown). To measure firm-level financial constraints, LSW use the index of Kaplan and Zingales (1997). However, this index is only available for US firms. Following Doidge et al. (2009), I calculate a simple index of financial flexibility (*FF-index*). The *FF-index* is constructed as a count variable by adding one point for a firm with above median cash and liquid assets, one point for above median dividends, and one more point for below median capital expenditures. *Volatility* of the firm's monthly stock return is calculated over a two-year window as opposed to five years in LSW because my sample period is considerably shorter. A five year window at the start of the sample period constrains too many observations. A problem with *WorldScope*'s stock return data is that returns are carried forward to every consequent month for inactive firms. I follow Ince and Porter (2006) and delete all monthly zero returns from the end of the sample period to the first nonzero return to address this issue.

Finally, as indicated in the standard regression model (1) above, I add an indicator variable for cross-listings (*bADR*) to the model of LSW because Doidge, Karolyi, and Stulz (2004) find that the decision to cross-list in the US is value enhancing. This higher valuation seems to be driven by the firms' commitment to improved disclosure and invest in good corporate governance.

3. International corporate age effect

In this section I examine whether the corporate aging phenomenon documented by LSW in the US subsists in other countries and whether the effect varies in strength across countries.

3.1. Worldwide decline in Tobin's Q ratios

To investigate the relation between firm age and Tobin's Q, I start with estimating OLS panel regressions with robust standard errors clustered at the country-level. Table 4 shows a very robust decrease of Tobin's q with firm age for a set of different specifications. The results are robust to different age proxies. As age proxy, I alternatively use incorporation age or IPO age and natural logs of age (panel A) or binary variables indicating if the firm is older than the sample median in any given country and year (panel B). The negative relation also holds irrespective of whether I only include the age proxy as a control variable in regressions 1 and 2, add the control variables except volatility in regressions 3 and 4, include the full set of control variables in regressions 5 and 6, or, finally, include country fixed-effects in regressions 7 and 8. Regression 3 to 6 include industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects, and regressions 7 and 8 add country fixed-effects. Further, the results obtain for the full sample containing all countries (*World*) and a subsample containing only *non-US countries*. R-squared values are reasonably high, explaining 26 to 29 percent of variation across all specifications.

The coefficients of the control variables in my standard regressions (7 and 8) are mostly in line with LSW. Consistent with their findings, R&D outlays, focus, size, and volatility are associated with larger Tobin's q ratios. Financial frictions seem to be immaterial. Financial leverage and ROA have a negative coefficient. The only difference to LSW's results is that capital expenditures are insignificant (but still positive) in my regressions. The additional control variable for cross-listings also produces an insignificant coefficient, possibly because the variable not only involves cross-listings in the US but dual-listings with any other country. Note that non-disclosed R&D outlays are set to zero and indicated with a dummy variable. The coefficient of this dummy is insignificant in most of the regressions and therefore not shown. However, the coefficients of R&D outlays should be interpreted cautiously.

To find out more about the functional form of the relation between firm age and Tobin's Q, I also estimate non-parametric kernel-weighted local polynomial regressions using an Epanechnikov kernel function with at rule-of-thumb bandwidth estimator and local-mean smoothing. Panel A of Figure 1 shows the unconditional relation. The white area identifies the interquartile range with the median indicated by the vertical black reference line. The age-Tobin's Q relation is negative regardless of whether I measure firm age from the date of IPO or from that of incorporation and whether the estimation relates to the full sample or only to non-US countries. In panel B, I examine whether the documented unconditional relation also holds if I use the full set of control variables of my standard regressions. To obtain these conditional results, I first estimate an OLS regression of *Tobin's Q* on *ROA*, *Capex*, *R&D outlays*, *bADR*, *bFocus*, *FF-index*, *Leverage*, *Size*, and *Volatility* and include industry, year, and country fixed-effects and robust standard errors clustered at the country-level. I then regress the residuals of this OLS regression on incorporation and IPO age, respectively. The resulting graphical illustration of this conditional estimation corroborates the negative age-Tobin's Q relation, regardless of whether I measure firm age from the date of IPO or from that of incorporation and whether the estimation relates to the full sample or only to non-US countries. However, strikingly, Tobin's Q seems to pick up 30 years after IPO. This could either be a random result because the upward-bending occurs at the tail of the distribution or it could also be driven by some countries with distinctive age-Tobin's Q patterns in older age. Therefore, I explore the age-Tobin's Q relation for each country separately in the next section.

However, the overall non-parametric results suggest that a linear estimation is a suitable approximation for the Tobin's q regressions. For reading convenience, I switch back to the linear age measure for the remaining analysis.

3.2. Decline in Tobin's Q ratios across countries

To examine whether the aging phenomenon subsists internationally, I estimate the standard regressions for each of the 19 sample-countries separately. The regression specifications are the same as in regressions 7 and 8 of Table 4, except that, since subsamples are country-specific, I do not include country fixed-effects and cluster standard errors at the firm- instead of the country-level. Table 5 shows the results. To conserve space, I only report the coefficient of ln(*Age*) and the attributed significance level. For reading convenience, the two top rows reproduce the age coefficients of Table 4, regression 7 and 8 for the full and the non-US sample. The age coefficients of the separate country regressions are almost all negative and statistically significant. If I measure age from the date of incorporation, the reported age-Tobin's Q relation is negative for all 19 countries and negative and statistically significant for 15 out of the 19 countries. For IPO age the respective numbers are 18 negative and 17 negative and statistically significant coefficients. The two bottom rows show percentages of negative and significantly negative age coefficients with equal weighting (columns 1 and 6) and firm-year observation weighting (columns 4 and 9). The results of Table 5 suggest that the age effect documented in LSW is very robust across the countries under investigation. The results are also robust to a specification using ln(*Tobin's Q*) instead of *Tobin's Q* as dependent variable (not shown).

In order to make the coefficients more comparable across different countries, I estimate sensitivities. Columns 5 and 10 show the sensitivity of Tobin's Q (in percent) to an increase in age of one standard deviation of the pooled age-distribution in the country. The impact is measured relative to the average Tobin's Q in the country, and is shown only for statistically significant age coefficients. The magnitude of the sensitivities exhibits much less variation than the coefficients in columns 1 and 6, suggesting that the age effect is more similar in magnitude across countries once the age distribution is taken into account. For incorporation age, the sensitivities range from 2.7 percent (Australia) to 7.5 percent (South Korea) and for IPO age from 2.5 percent (Australia) to 12.5 percent (Sweden).

Analogously to the non-parametric analysis for the full sample, I also estimate non-parametric kernel-weighted local polynomial regressions for each country separately. For brevity, I skip the unconditional approach and only estimate the conditional regressions following the same approach as in Figure 1, panel B. The only difference is that I do not include country fixed-effects and cluster standard errors at the firm- instead of the country-level. Figure 2 shows the results. Most of the graphs are characterized by a general pattern of a negative age-Tobin's q relation. However there seem to be differences across countries since the shapes of the graphs are not uniform. To facilitate interpretation across countries, all graphs display the interquartile range (white area) and the median (vertical black reference line) of the pooled age distribution in the country.

Overall, the country specific results reveal a very robust international age effect. There is almost no country exempted from the deterioration of Tobin's Q over the lifetime of a firm. Since there are cross-country differences in the magnitude of the age coefficients and the sensitivities and also the graphical patterns are not uniform, the next section examines whether the US is significantly different from other countries with respect to the strength of the age effect.

3.3. International variation and persistence of the decline in Tobin's Q ratios

LSW document that the speed of corporate aging is driven by competitiveness of labor markets, product markets, and the market for corporate control. Since the competitiveness of these markets is not identical across countries and given that LSW's results also hold internationally, I should be able to detect cross-country differences in the speed of corporate aging. The fact that in Table 4, all adjusted R-squared values are slightly higher in the specifications using country fixed-effects can be interpreted as evidence that country characteristics matter for corporate aging. More importantly, I estimate specifications including interactions of all countries with age (not shown) and test for joint significance of these interactions (Wald test). The F-values are all significant, suggesting that country characteristics explain variation in the cross-country differences of the age effect.

A more straightforward approach to find out whether the speed of corporate aging varies across countries is to estimate separate regressions (as in Table 5) and then compare their age coefficients. Table 6 shows the results of the ln(*Age*) coefficient comparison of the separate country regressions with the US. For reading convenience, columns 1 and 5 in the first row repeat the ln(*Age*) coefficients of the US from Table 5 as the benchmark for the comparison. The remaining rows in these columns show the difference between the US coefficient and the respective country coefficient along with its significance level in columns 2 and 6. For instance, Japan has an ln(*Age*) coefficient of –0.192 + 0.070 = –0.122 and the difference of 0.070 is statistically significant at the 99 percent level. The significance levels are estimated with a two-sample two-sided t-test with unequal variances. This simple coefficient comparison shows that for incorporation age, the ln(*Age*) coefficient of 12 out of 18 countries is significantly different from the US. For IPO age the count is even higher with 14 out of 18 countries. However, as Table 5 has shown, taking the age distributions of the countries into account considerably reduces the variation of the age effect across countries. Therefore I estimate standardized regression in columns 3 and 7. In these regressions all variables are standardized by industry (Fama and French's (1997) 48 industry grouping), year, and country. Using this standardized regression approach, 9 out of 18 incorporation age coefficients and 11 out of 18 IPO age coefficients are significantly different from the respective US coefficient.

Overall, the results shown in Table 6 suggest that corporate aging is significantly different in magnitude compared to the US, even if I estimate standardized regressions. In section 4, I explore whether differences in country-level institutional settings drive the cross-country differences in the strength of the corporate age effect.

In addition to the variation across countries, I also explore whether the results hold across different time periods. Table 7 shows the ln(*Age*) coefficients if I replicate the standard regressions for the three subperiods 1985–1994, 1995–2004, and 2005–2010. This approach helps alleviating potential concerns about backfilling bias, changes in the size bias of the sample, and the dotcom era which could possibly spur the results. I cut the sample in 1994 because prior to 1994 the data suffer from a backfilling bias. 1994 is therefore a common cutoff date in many cross-country studies using *WorldScope* data. The second decade contains the run-up to and crash of the dotcom bubble and simultaneously the coverage of tracked firms in the *WorldScope* sample considerably increased in most of the countries which reduces the size bias because an increasing number of smaller firms were added to the database.

The results suggest that the age effect persist across different time periods for the majority of the countries. Most coefficients also retain their statistical significance and only 3 out of a total of 114 ln(*Age*) coefficients are positive and significant.

3.4. *Decline in current profitability*

In their model, LSW predict that with increasing firm age management's attention is focused on managing assets in place as opposed to developing new growth opportunities. Consequently, current profitability could initially increase but eventually will also decline because the supply of innovations ceases.

Table 8 investigates the relation between firm age and current profitability based on ROA, measures of changes in sales, and gross margin. Panel A starts with *ROA* as dependent variable. Regressions 1 to 4 relate to the full sample and regressions 5 to 8 exclude US firms. I include incorporation age and IPO age as age proxies, alternatively. Regressions 1, 3, 5, and 7 are estimated without country fixed-effects. The evidence shows that ROA significantly decreases with firm age. All eight age coefficients in panel A are negative and 7 out of 8 are negative and significant.

Analogously to the standard regressions with Tobin's Q, panel B replicates the multivariate analysis with ROA as dependent variable for each country separately. The left-hand side of the panel relates to the full sample and the right-hand side repeats the analysis with the subsample of firms older than the median firm in each country, industry, and year. To conserve space, I only report the ln(*Age*) coefficient of each regression in this and the remaining panels and only use IPO age for the remainder of the analysis. However, the results obtain when I use incorporation age. The evidence of the 19 country-specific regressions with ROA is not as robust as with Tobin's Q. While still 16 out of 19 age coefficients are negative, the fraction of significant coefficients is considerably lower with 9 out of 19 countries. The less robust results are consistent with the model of LSW. It is possible that ROA increases in the early life of a firm. By focusing on managing the assets in place, firms become more and more efficient producers until they reach a maximum level of efficiency. If, meanwhile, they neglect to innovate, they cannot replace their antiquating products with new innovative ones. In older firms ROA then starts decreasing. The right-hand side of panel B provides support for this story. ROA decreases more in relatively older firms. Compared to the full sample, 15 of 19 age coefficients have a larger magnitude in the sub-sample of older firms.

Panel C and the left-hand side of panel D in Table 8 show that in 18 out of 19 countries sales growth is negatively related to firm age (in 16 significantly), in all countries sales growth in older firms is more likely to be negative (in 17 significantly), and in 18 out of 19 countries the market share shrinks over the lifetime of a firm (11 significantly). This is consistent with LSW who document for US firms, that the eventual decline in ROA is not compensated by bigger sales volume.

Finally, also gross margins seem to deteriorate, although the results are less clear. Panel D shows that in 13 out of 19 countries the ln(*Age*) coefficient is negative (in 7 significantly).

In sum, the evidence in Table 8 suggests that the overall firm profitability decreases as firms grow older. ROA decreases along with sales, market shares and gross margin.

3.5. Investment activities, payout, and technical efficiency

As managers tend to focus on efficient management of assets in place at the expense of creating growth opportunities, they are also expected to invest less to develop these growth opportunities. The international data support this conjecture. Table 9 documents that capital expenditures standardized by the firm's market value of assets decrease in 18 out of 19 countries (in 11 significantly). The results obtain if I standardize by sales. Also R&D outlays decrease over the lifetime of a firm. The ln(*Age*) coefficient is negative in 15 and significantly negative in 10 out of 19 countries. Note that none of the few positive coefficients is statistically significant, neither in the regressions with capital expenditures nor with R&D outlays as dependent variable. The results for R&D, however, should be interpreted cautiously, since disclosure varies considerably across countries from 8 percent in Spain to 68 percent in the US. Moreover, conditional on firms disclosing R&D, the median R&D spending goes from 1.6 percent of sales in Spain to 37 percent in Canada. Both, the coverage and the median values suggest that the reliability of R&D data in *WorldScope* substantially differs across countries.

As firms reduce their capital expenditures and R&D outlays the question turns up on what else firm spend their profits. Table 10 shows that the firms in most countries seem to return at least part of the cash to shareholders. Accordingly, their cash balances get smaller in 15 and significantly smaller in 8 sample-countries with none of the four positive coefficients being significant. They also increase their payout ratio in 15 and significantly increase it in 7 sample-countries with only one negative coefficient being weakly statistically significant (Canada).

While most results from the international sample in this paper are consistent with the US results from LSW, there seems to be one exception. As Table 11 reveals, technical efficiency measured with the *Sales-to-assets* ratio only increases with firm age in the US. For all remaining countries the ln(*Age*) coefficient is either insignificant or significantly negative. Especially firms in the Asian sample-countries have lower asset turnover with increasing firm age. One reason for why the US stands out against the rest of the world could be related to corporate governance standards. Ang, Cole, and Lin (2000) use *Sales-to-assets* to measure agency costs. Given that the installment of entrenchment in a firm takes time, firms in countries with comparatively low corporate governance standards should encounter increased agency costs when they get older. US firms could be profiting from one of the strictest corporate governance systems in the world (La Porta et al. (2000)). However, this explanation is non-exclusive and needs further corroboration.[7]

[7] Another explanation could be related to depreciation practices. The US was one of the first countries worldwide to introduce accelerated depreciation allowance. If US firms depreciate their assets in young years more aggressively than firms in other countries, this could cause *Sales-to-assets* to increase initially.

4. Institutional differences

In this section I address the question whether the competitiveness of the product market, the labor market, and the market for corporate control has an impact on the age dependence of Tobin's Q. The cross-sectional variation with respect to these institutions is much more pronounced in an international setting than within one country. Therefore, LSW only have limited possibilities to analyze the effects of these institutional settings on the age-Tobin's Q relation. My cross-country dataset allows me to test whether competition in these three market dimensions drives the speed of corporate aging internationally. The evidence of these tests, however, is tentative and needs to be buttressed further.[8]

4.1. Method

To identify the impact of institutions on the speed of corporate aging, the most promising approach is to examine institutional changes and their impact on the magnitude of the age effect in a given country. To find out whether institutional changes cause a change in the magnitude of corporate aging, the method of choice is a panel regression with interaction terms of institutional proxies with firm age, using a difference-in-differences test design in a multiple treatment groups, multiple time periods setting as explained by Imbens and Wooldrige (2009). I estimate country-level changes of the corporate age effect in countries where institutions changed in contrast to contemporaneous changes of the age effect in countries where institutions did not change. This treatment-control contrast identifies the average causal effect of institutional changes on the speed of corporate aging under the assumption that corporate aging would have otherwise evolved similarly in changing and non-changing countries.

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8 See for example Loderer, Wälchli, and Zeller (2014) for an analysis of the impact of employment protection on the speed of corporate aging.

In the spirit of Subramanian and Megginson (2012), all panel regressions include country, year, and industry fixed-effects. The country fixed-effects control for all time-invariant unobserved factors at the country-level. The year fixed-effects control for common global trends and the industry fixed-effects control for time-invariant unobserved factors at the industry-level.

To measure product market competition internationally, a commonly used proxy is trade-liberalization. As argued by Subramanian and Megginson (2012), trade liberalization in a country results in an increase of competition. I employ the aggregate level of imports into and exports from a country (*Trade openness*) as a proxy for trade liberalization, since trade liberalization should result in an increase in imports and exports (Subramanian and Megginson (2012)).

My proxy for competition in the market for corporate control is the size of the stock market relative to the gross domestic product per capita in a given year and country (*Stock market in % GDP*). Shleifer and Vishny (2003) argue that a substantial portion of merger activity is driven by stock market valuations. This might be because, as Harford (2005) suggests, there must be sufficient capital liquidity to accommodate the asset reallocation. Given that *Stock market in % GDP* is a valid proxy for competition in the market for corporate control, I expect that an increase in stock market size triggers an increase in the speed of corporate aging because firms are forced to do a good job in efficiently managing their assets in place in order to avoid a hostile takeover (see LSW).

The effect of labor market competition on the magnitude of corporate aging is not a priori clear. On one hand, LSW argue that laws imposing frictions on the mobility of human capital help younger firms to retain an innovative and competitive labor force. In contrast, it will make it difficult for older firms to find creative employees. Hence, firms headquartered in countries that increase restrictions on the mobility of human capital should experience a quicker decline in Tobin's q ratios over time. On the other hand, Acharya, Baghai, and Subramanian (2012) and

(2014) show that laws restricting labor mobility by protecting employees against unjust dismissal can motivate employees to engage in innovative activities. Hence, such laws should slow down the decline in Tobin's q ratios over time.

I use four different time-varying proxies for the competition in the labor market. The first proxy is a change in the political leaning of governments. As documented by Botero et al. (2004), left-leaning governments tend to have more stringent labor laws. I use the index from Armingeon et al. (2012), which captures *Government orientation*, the balance of power between left and right-leaning parties in a given country's parliament. The second proxy is unemployment insurance benefits. Acharya, Baghai, and Subramanian (2014) argue that employees in firms that are located in states with generous unemployment insurance benefit laws may be more willing to take more risk when choosing innovative projects. This could potentially have an impact on the choice of managers to focus on assets in place versus focusing their attention on innovation. I measure unemployment insurance benefit using the annual expenditures for *Labor market programs* in a country. Third, in more unionized countries, employees exert considerable political pressure to install employment protection. At the same time Atanassov and Kim (2009) document that poorly performing managers, associated with lower firm performance, are more likely to retain their jobs when unions are strong. Therefore, unionization measured with the annual *Fraction of union members* in a country could potentially have an impact on the choice of managers between managing assets in place and creating growth opportunities and therefore influence the speed of corporate aging. Finally, Acharya, Baghai, and Subramanian (2012) document that the introduction of labor laws that prevent employers from arbitrarily dismissing their employees spurs firm-level innovation. Therefore, I argue that strong employment protection should slow down the decrease in Tobin's Q. Employment protection is measured with the *EPL index* of OECD.

Since economic growth is possibly correlated with the size of the stock market, as well as with the competition in the labor market, I include the real *Per-capita GDP growth* in the analysis to correctly identify the impact of institutional changes on the magnitude of the corporate age effect.[9]

4.2. Results

Table 12 shows the results of the difference-in-differences regressions. Specifications 1 and 3 of the table include the proxies for institutional changes and an interaction term of the demeaned proxies with demeaned *ln(Age)* along with the full set of standard control variables and the industry, year, and country fixed-effects. Specifications 2 and 4 add the country-level variables.

For the market of corporate control, Panel A of Table 12 documents that the larger the stock market is relative to GDP, the quicker the Tobin's Q ratios decline over time. The coefficients of the interaction term are, however, only significant on a 10 percent level.

With respect to product market competition the evidence in panel B of Table 12 is mixed. When firm age is measured from the date of incorporation, an increase in competition seems to make the Tobin's Q-age relation flatter. However, with firm age measured since IPO, the effect is insignificant.

For labor market competition the evidence suggests that laws and institutions which provide protection for employees slow down the corporate aging process. All coefficients of the interaction terms of my labor market proxies with firm age are positive. For incorporation age 7 out of 8 coefficients are statistically significant and for IPO age two out of 8. Consistent with Acharya, Baghai, and Subramanian (2014), especially changes in employment protection seem to have a significant impact. For all four specifications the coefficients are statistically significant

9 See for instance Acharya, Baghai, and Subramanian (2012) for an argument for the impact of economic growth on one of my proxies for labor market competition.

on the 1 percent level and the economic significance is also relatively large. The speed of corporate aging decreases for about one third when the index of employment protection increases by one standard deviation. An index change of one standard deviation corresponds to a comprehensive but not uncommon reform of employment protection legislation.

Overall, this section documents that country-level institutional changes can have an impact on the strength of the corporate age effect. The exact channels through which the effects work are left to be determined. However, the preliminary evidence suggests that this is a fruitful area for future research.

5. Conclusion

This paper documents that, in an extensive panel of listed firms with headquarters in the 19 countries with the most developed capital markets, older firms have comparatively lower Tobin's Q ratios and lower operating performance. Tobin's Q ratios decline by approximately 5 percent for every standard deviation increase in firm age. This result is very robust with respect to different estimation techniques, regression specifications, sub-periods, and the way I measure firm age. Not only Tobin's Q ratios decline, but also ROA, sales growth, market shares, and gross margins. Moreover, older firms are less actively investing in R&D and reduce their capital expenditures. There is evidence that firms instead return the cash to shareholders since they have lower cash ratios and slightly higher payout ratios.

Overall, these results are consistent with the model of LSW postulating that after listing, managers tend to focus their limited attention on efficiently managing the assets already in place. This comes at the cost of generating new growth opportunities which eventually causes Tobin's Q ratios and operating performance to decline with firm age.

Comparing the magnitude of this age effect internationally reveals considerable cross-country differences. Since LSW document that the speed of corporate aging depends on the competition in the market for corporate control and product and labor market competition, I investigate whether part of this cross-country variation is driven by international institutional difference with respect to these three dimensions. The results suggest that especially labor market aspects play a significant role in moderating the age-Tobin's Q relation. However, the results of these tests are only tentative and need to be buttressed further.

Taken at face value, the results of the paper suggest that the corporate age effect is not limited to the US but constitutes a worldwide economic reality and that there is a chance for policy makers to influence the aging speed via labor market policies.

Table 1: Sample

The table shows information about the sample selection. Column (1) indicates the country under investigation. To be part of the sample, a country has to have one of the world's 25 largest stock exchanges with a market capitalization above USD 500 billion as of December 2010 (Source: http://www.world-exchanges.org.). Column (2) shows the stock exchanges' market capitalization as of December 2010. For reasons of data availability, I exclude several emerging markets: Shanghai SE, BSE India, National SE India, BM&FBOVESPA, Shenzhen SE, MICEX, Johannesburg SE, and Taiwan SE. The remaining columns show information about the sample composition. The sample period is 1985 – 2010.

Country	Stock Exchange	Domestic Market Capitalization USD billion, 2010	Firms	% of Firms in Sample	Firm-Years	% of Firm-Years in Sample	Cumulative % of Firm-Years
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US	NYSE Euronext (US)	13'394	11'170	34.6	89'531	30.5	30.5
Japan	Tokyo SE	3'828	4'389	13.6	62'609	21.3	51.8
UK	London SE	3'613	3'023	9.4	26'517	9.0	60.9
Canada	Toronto SE	2'170	3'060	9.5	19'712	6.7	67.6
Australia	Australian SE	1'454	2'038	6.3	14'492	4.9	72.5
Korea (South)	Korea Exchange	1'092	1'781	5.5	14'277	4.9	77.4
France	NYSE Euronext (Europe)	2'930	1'335	4.1	12'751	4.3	81.7
Germany	Deutsche Börse	1'430	1'064	3.3	10'967	3.7	85.5
Hong Kong	Hong Kong Exchanges	2'711	975	3.0	8'782	3.0	88.5
Singapore	Singapore Exchange	647	690	2.1	6'140	2.1	90.6
Sweden	OMX Nordic Exchange	1'042	652	2.0	5'084	1.7	92.3
Switzerland	SIX Swiss Exchange	1'229	303	0.9	3'700	1.3	93.6
Netherlands	NYSE Euronext (Europe)	2'930	336	1.0	3'670	1.3	94.8
Italy	London SE	3'613	364	1.1	3'556	1.2	96.0
Norway	OMX Nordic Exchange	1'042	347	1.1	2'649	0.9	96.9
Denmark	OMX Nordic Exchange	1'042	230	0.7	2'644	0.9	97.8
Spain	BME Spanish Exchanges	1'172	198	0.6	2'321	0.8	98.6
Finland	OMX Nordic Exchange	1'042	195	0.6	2'142	0.7	99.3
Belgium	NYSE Euronext (Europe)	2'930	180	0.6	1'924	0.7	100.0
Total			32'330	100.0	293'468	100.0	

Table 2: Sample restrictions

The table shows the restrictions that apply to my sample. The sample starts with all available firms in fiscal years 1985 through 2010 in the *Thomson Financial's WorldScope* database (row 1). I exclude all financial firms and regulated utilities (row 2). In order to have similar length of accounting periods in every firm-year, I ignore all firm-year observations which do not last between 361 and 371 days (row 3). I also exclude all firm-year observations with missing or negative assets, sales, market value of equity, and book value of equity (rows 4 to 7). Finally, I ignore all firms younger than 5 years (row 8). Row 9 shows the final sample size.

		Firms (1)	% of orig. sample (2)	Firm-Years (3)	% of orig. sample (4)
(1)	All firms available in fiscal year 1985 through 2010	48'718		492'320	
(2)	Sample, excluding financial firms (SIC 6) and regulated utilities (SIC 49)	38'379	100.0	383'421	100.0
	Less:				
(3)	Firms with accounting period not between 361 and 371 days	–13	0.0	–3'860	1.0
(4)	Firms with total assets missing or negative	–37	0.1	–1'918	0.5
(5)	Firms with sales missing or negative	–42	0.1	–993	0.3
(6)	Firms with market value of equity missing or negative	–1'765	4.6	–33'819	8.8
(7)	Firms with book value of equity missing or negative	–1'556	4.1	–24'166	6.3
(8)	Firms younger than 5 years	–2'636	6.9	–25'197	6.6
(9)	Final sample	32'330	84.2	293'468	76.6

Table 3: Descriptive statistics

The table shows the descriptive statistics of the proxies for firm age and firm performance for each country separately. Variable definitions are in Table 13 at the end of the paper. The sorting of the countries is according to the relative size in the sample (see Table 1). All variables (except the binary variables and age proxies) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The descriptive statistics are calculated over the pooled distribution at the country-level. Panel A shows the firm age proxies and panel B shows the proxies for firm performance. The sample period is 1985 – 2010.

Panel A: Firm age

	Incorporation age				IPO age			
	Median	Mean	SD	Coverage	Median	Mean	SD	Coverage
US	22.0	32.0	27.3	0.95	15.0	19.4	15.4	0.94
Japan	48.0	50.0	30.6	0.98	29.0	28.4	17.7	0.96
UK	24.0	37.7	32.2	0.94	13.0	20.0	15.9	0.76
Canada	18.0	23.7	21.4	0.99	12.0	16.0	12.5	0.86
Australia	18.0	24.8	22.0	0.92	14.0	16.7	11.7	0.89
Korea (South)	27.0	28.4	14.9	0.99	13.0	15.6	9.7	0.95
France	31.0	48.3	49.6	0.91	10.0	17.7	19.5	0.70
Germany	54.0	67.7	57.3	0.96	10.0	19.8	20.0	0.76
Hong Kong	12.0	17.2	17.0	0.89	12.0	15.6	13.8	0.88
Singapore	19.0	22.5	16.2	0.97	10.0	13.3	8.7	0.95
Sweden	22.0	42.6	46.4	0.93	10.0	13.7	13.3	0.80
Switzerland	77.0	82.6	70.8	0.95	9.0	13.5	15.8	0.64
Netherlands	67.0	67.3	54.6	0.86	14.0	23.7	21.5	0.61
Italy	40.0	49.0	35.5	0.88	10.0	19.3	22.6	0.67
Norway	22.0	48.3	53.9	0.89	10.0	18.4	20.5	0.77
Denmark	55.0	58.4	38.9	0.97	16.0	24.2	23.7	0.74
Spain	39.0	46.8	28.6	0.96	10.0	11.6	7.2	0.58
Finland	46.0	58.5	53.1	0.93	12.0	17.6	16.1	0.91
Belgium	63.0	63.0	45.8	0.94	15.0	34.7	33.7	0.75
Total	28.0	39.0	35.0	0.95	15.0	20.8	16.6	0.88

Panel B: Performance measures

	Median Tobin's Q	Median ROA (%)	Median Sales growth (%)	Probability of negative sales growth	Median Gross margin (%)	Probability of decline in market share
US	1.47	12.38	6.03	0.35	38.17	0.41
Japan	1.08	7.12	1.85	0.42	24.96	0.50
UK	1.35	13.34	5.33	0.36	32.55	0.41
Canada	1.40	6.12	6.31	0.38	31.80	0.28
Australia	1.41	5.96	5.15	0.40	21.05	0.31
Korea (South)	0.96	10.25	5.80	0.37	19.43	0.49
France	1.20	12.34	4.89	0.35	14.89	0.40
Germany	1.28	12.55	3.40	0.40	26.77	0.41
Hong Kong	0.99	7.99	6.24	0.40	26.35	0.49
Singapore	1.05	9.25	5.22	0.40	23.12	0.43
Sweden	1.38	11.86	7.18	0.35	17.22	0.36
Switzerland	1.21	12.32	3.29	0.39	29.47	0.34
Netherlands	1.27	15.40	4.34	0.37	25.40	0.36
Italy	1.13	11.06	3.21	0.41	39.59	0.37
Norway	1.23	12.50	7.59	0.34	27.06	0.33
Denmark	1.13	13.34	4.39	0.38	24.14	0.28
Spain	1.20	12.37	4.43	0.36	26.51	0.32
Finland	1.20	13.46	4.83	0.37	27.19	0.31
Belgium	1.16	13.05	4.28	0.37	14.08	0.25
Total	1.24	10.19	4.23	0.38	28.91	0.41

Table 4: Firm age and Tobin's Q

The table investigates the relation between firm age and Tobin's Q. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The dependent variable is *Tobin's Q*. The age proxy in panel A is the natural logarithm of the firm's age. Panel B repeats the analysis with a dummy equal to 1 if the firm is older than the median firm in the same country, industry, and year, and zero otherwise. Regression 3 to 6 include industry (I) (Fama and French's (1997) 48 industry grouping) and year (Y) fixed-effects (FE) regressions 7 and 8 additionally country (C) FE. All regressions include robust standard errors clustered at the country-level, which are given in parentheses. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

Panel A: Age proxy = ln(Age)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				World				
ln(Age_{inc})	–0.459***		–0.204***		–0.151***		–0.148***	
	(0.102)		(0.037)		(0.028)		(0.018)	
ln(Age_{ipo})		–0.323***		–0.172***		–0.145***		–0.143***
		(0.065)		(0.019)		(0.013)		(0.019)
ROA			–0.015***	–0.015***	–0.013***	–0.013***	–0.013***	–0.013***
			(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Capex			–0.002	–0.002	0.001	0.000	0.003	0.002
			(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
R&D outlays			0.002**	0.002**	0.002**	0.002**	0.002***	0.002***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
bADR			–0.139	–0.138	–0.157	–0.161	–0.041	–0.047
			(0.102)	(0.109)	(0.104)	(0.104)	(0.034)	(0.033)
bFocus			0.058	0.041	0.048*	0.032	0.061***	0.049***
			(0.039)	(0.037)	(0.029)	(0.029)	(0.016)	(0.016)
FF-index			–0.062***	–0.062**	–0.035**	–0.033	–0.012	–0.010
			(0.022)	(0.025)	(0.018)	(0.020)	(0.014)	(0.016)
Leverage			–2.812***	–2.785***	–2.813***	–2.794***	–2.659***	–2.631***
			(0.600)	(0.604)	(0.608)	(0.617)	(0.662)	(0.669)
Size			0.098***	0.105***	0.132***	0.140***	0.126***	0.135***
			(0.016)	(0.018)	(0.024)	(0.023)	(0.017)	(0.016)
Volatility					0.827***	0.831***	0.740***	0.722***
					(0.111)	(0.110)	(0.078)	(0.072)
Constant	3.310***	2.565***	1.556***	2.195***	1.498***	0.274	1.404***	0.084
	(0.480)	(0.332)	(0.227)	(0.221)	(0.191)	(0.253)	(0.230)	(0.147)
I FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Y FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
C FE	No	No	No	No	No	No	Yes	Yes
Observations	277'867	257'866	230'554	214'583	219'329	206'002	219'329	206'002
Adjusted R-squared	0.042	0.030	0.244	0.238	0.256	0.252	0.266	0.262
				Non-US countries				
ln(Age_{inc})	–0.316***		–0.160***		–0.125***		–0.122***	
	(0.059)		(0.033)		(0.029)		(0.018)	
ln(Age_{ipo})		–0.232***		–0.155***		–0.137***		–0.119***
		(0.022)		(0.015)		(0.012)		(0.011)
Controls	–	–	Included	Included	Included	Included	Included	Included
I, Y, and C FE	N, N, N	N, N, N	Y, Y, N	Y, Y, N	Y, Y, N	Y, Y, N	Y, Y, Y	Y, Y, Y
Observations	193'414	173'605	157'689	141'978	150'749	137'508	150'749	137'508
Adjusted R-squared	0.037	0.028	0.231	0.234	0.241	0.245	0.255	0.258

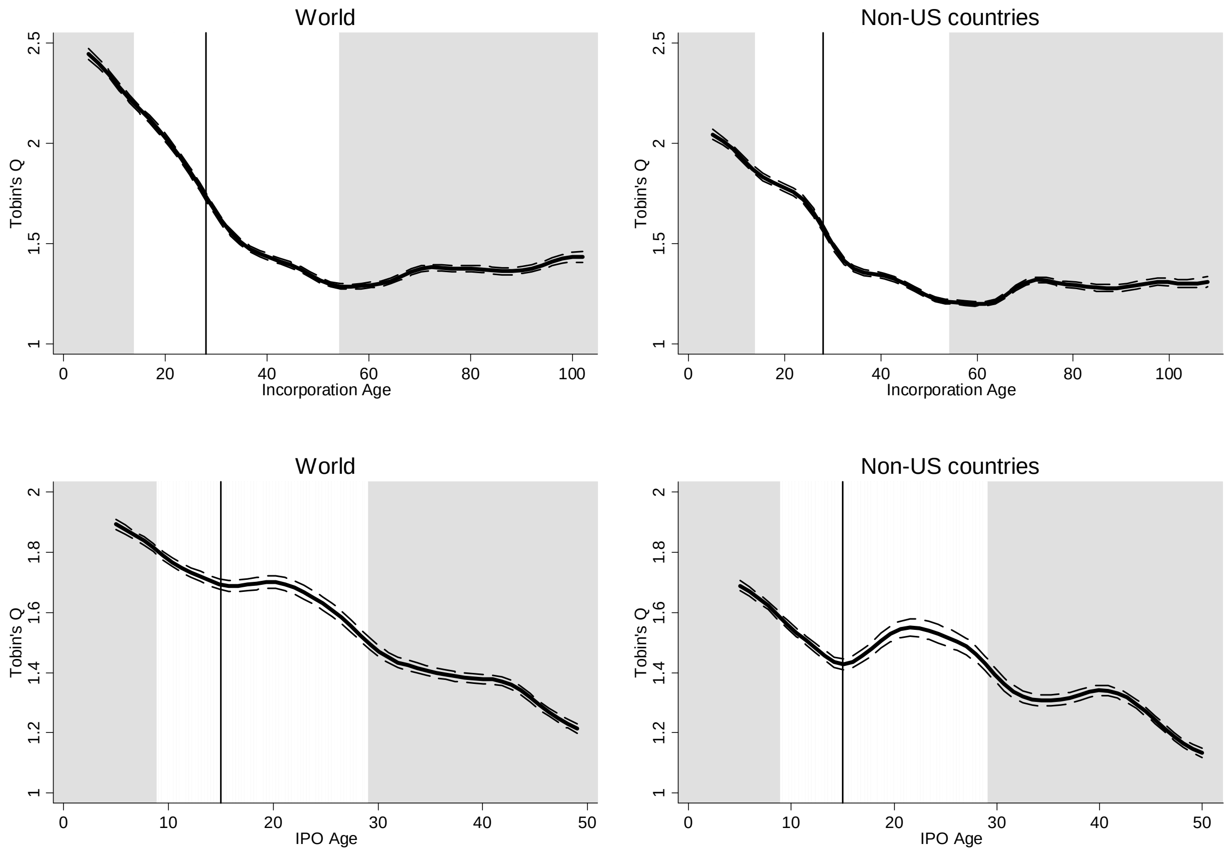
Panel B: Age proxy = bOldfirm

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				World				
$bOldfirm_{inc}$	–0.486***		–0.199***		–0.149***		–0.187***	
	(0.146)		(0.039)		(0.031)		(0.026)	
$bOldfirm_{ipo}$		–0.382***		–0.163***		–0.125***		–0.154***
		(0.092)		(0.027)		(0.023)		(0.016)
Controls	–	–	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.
Observations	277'867	257'866	230'554	214'583	219'329	206'002	219'329	206'002
Adjusted R-squared	0.016	0.010	0.239	0.233	0.254	0.248	0.265	0.259
				Non-US countries				
$bOldfirm_{inc}$	–0.301***		–0.157***		–0.125***		–0.149***	
	(0.035)		(0.020)		(0.020)		(0.022)	
$bOldfirm_{ipo}$		–0.268***		–0.147***		–0.119***		–0.140***
		(0.034)		(0.018)		(0.018)		(0.018)
Controls	–	–	Incl.	Incl.	Incl.	Incl.	Incl.	Incl.
Observations	193'414	173'605	157'689	141'978	150'749	137'508	150'749	137'508
Adjusted R-squared	0.011	0.009	0.225	0.227	0.238	0.239	0.253	0.255

Figure 1: Functional form of the firm age and Tobin's Q relation

The figure shows the relation between firm age and Tobin's Q implied by kernel-weighted local polynomial regressions using an Epanechnikov kernel function with at rule-of-thumb bandwidth estimator and local-mean smoothing. The dashed lines plot the 95-percent confidence band. The white area displays the interquartile range and the black reference line indicates the median. The figures in panel A show the unconditional relation between firm age and Tobin's q. To obtain conditional the figures in panel B, I first estimate an OLS regression with industry (Fama and French's (1997) 48 industry grouping), year, and country fixed-effects and robust standard errors clustered at the country-level of *Tobin's Q* on *ROA*, *Capex*, *R&D outlays*, *bADR*, *bFocus*, *FF-index*, *Leverage*, *Size*, and *Volatility*. I then regress these residuals on incorporation and IPO age, respectively. The sample period is 1985 – 2010.

Panel A: Unconditional



Panel B: Conditional

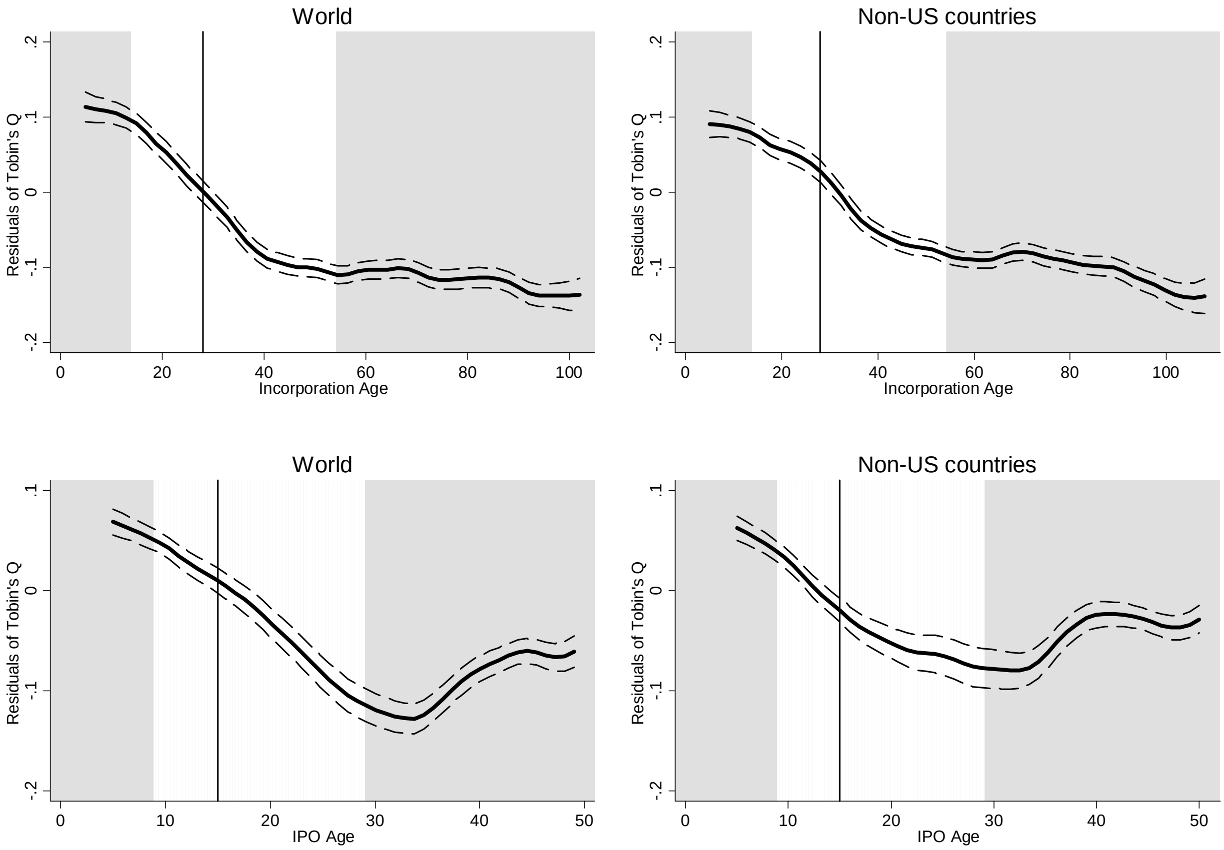


Table 5: Country-specific relation of firm age and Tobin's Q

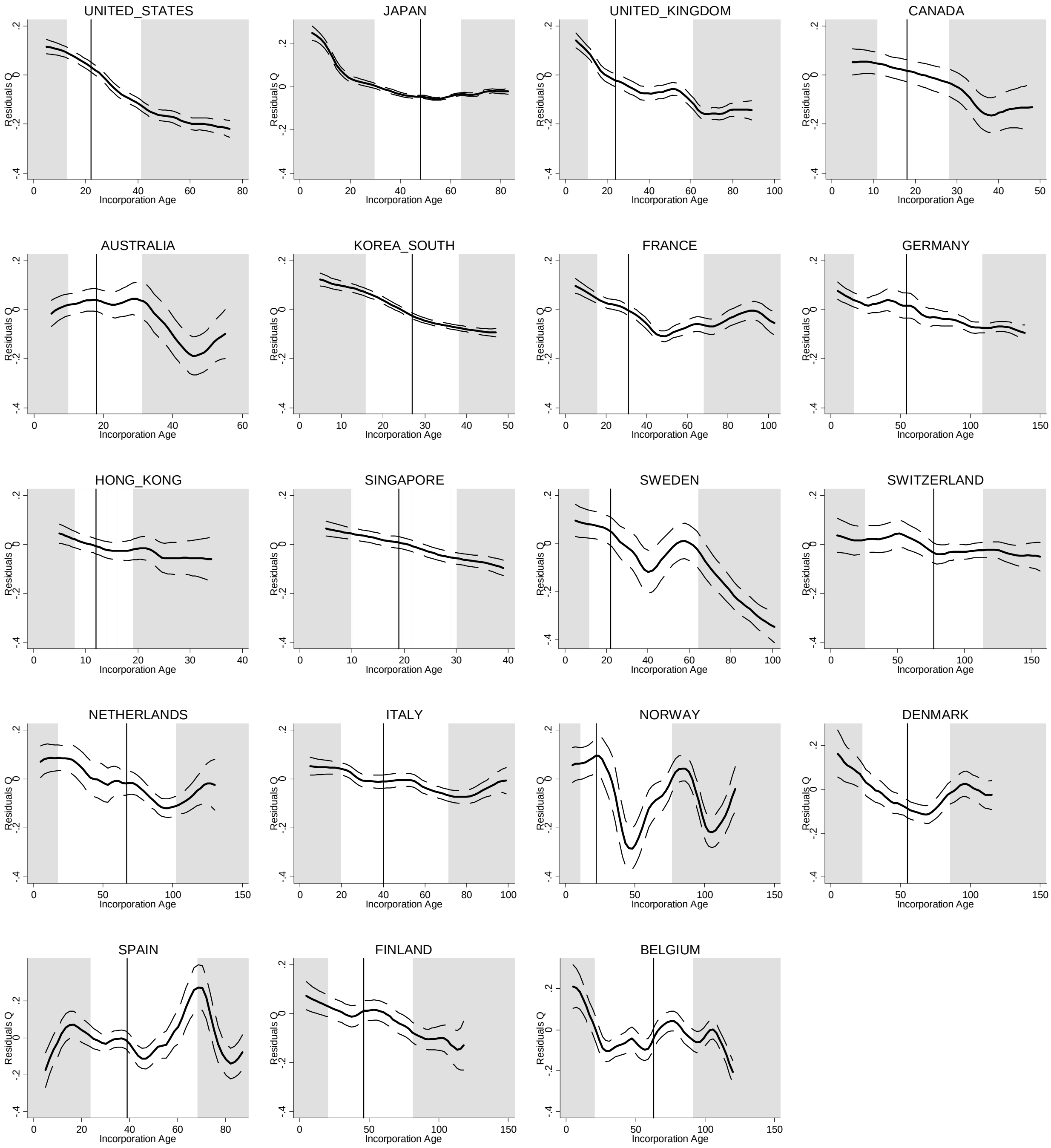
The table investigates the relation between firm age and Tobin's Q at a country-level. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The dependent variable is *Tobin's Q*. Control variables are the same as in Table 4: *ROA*, *Capex*, *R&D outlays*, *bADR*, *bFocus*, *FF-index*, *Leverage*, *Size*, and *Volatility*. All estimations use industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level. To conserve space, I only report the *ln(Age)* coefficient of each regression (columns 1 and 6). Columns 5 and 10 show the sensitivity of *Tobin's Q* (in percent) to an increase in age of one standard deviation. The two bottom rows show the percentage of negative and significantly negative coefficients, respectively. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	Incorporation age					IPO age				
	Coefficient	SE	N	Adj. R^2	Sensitivity	Coefficient	SE	N	Adj. R^2	Sensitivity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
World	–0.148***	(0.008)	219'329	0.27	–5.53	–0.143***	(0.007)	206'002	0.26	–5.53
Non-US	–0.122***	(0.008)	150'749	0.26	–5.25	–0.119***	(0.007)	137'508	0.26	–5.31
US	–0.192***	(0.020)	68'580	0.27	–5.36	–0.194***	(0.017)	68'494	0.26	–5.83
Japan	–0.122***	(0.010)	41'778	0.41	–5.06	–0.073***	(0.007)	41'643	0.40	–3.39
UK	–0.152***	(0.017)	21'867	0.27	–5.55	–0.174***	(0.017)	18'015	0.27	–6.84
Canada	–0.132***	(0.034)	14'437	0.29	–3.95	–0.108***	(0.036)	12'985	0.29	–3.17
Australia	–0.089**	(0.039)	11'076	0.25	–2.71	–0.093**	(0.041)	10'830	0.25	–2.54
Korea (South)	–0.200***	(0.020)	11'583	0.36	–7.51	–0.132***	(0.013)	11'185	0.35	–6.28
France	–0.100***	(0.019)	8'933	0.39	–4.84	–0.112***	(0.018)	7'120	0.42	–6.55
Germany	–0.094***	(0.019)	8'523	0.22	–3.77	–0.060**	(0.026)	6'950	0.23	–3.28
Hong Kong	–0.108***	(0.037)	7'153	0.25	–5.23	–0.121***	(0.036)	7'121	0.25	–5.60
Singapore	–0.093***	(0.029)	5'320	0.31	–4.01	–0.131***	(0.025)	5'253	0.31	–5.86
Sweden	–0.173***	(0.048)	3'740	0.30	–6.64	–0.306***	(0.073)	3'372	0.30	–12.54
Switzerland	–0.048	(0.047)	2'728	0.47	–	–0.036	(0.046)	2'009	0.47	–
Netherlands	–0.091***	(0.030)	2'686	0.41	–3.38	–0.122***	(0.039)	1'959	0.43	–5.49
Italy	–0.042	(0.029)	2'616	0.41	–	–0.095***	(0.021)	2'018	0.47	–6.59
Norway	–0.075*	(0.039)	1'902	0.42	–3.38	–0.126***	(0.044)	1'693	0.42	–6.76
Denmark	–0.151**	(0.059)	1'939	0.41	–5.38	–0.152***	(0.054)	1'638	0.42	–7.53
Spain	–0.006	(0.062)	1'647	0.51	–	0.029	(0.095)	1'102	0.58	–
Finland	–0.049	(0.042)	1'475	0.52	–	–0.105**	(0.049)	1'469	0.53	–4.56
Belgium	–0.145***	(0.045)	1'346	0.59	–5.46	–0.086***	(0.028)	1'146	0.60	–4.76
% negative	100		100			95		99		
% neg. and sig.	79		96			89		98		

Figure 2: Functional form of the country-specific relation of firm age and Tobin's Q

The figure shows the relation between firm age and Tobin's Q implied by kernel-weighted local polynomial regressions using an Epanechnikov kernel function with at rule-of-thumb bandwidth estimator and local-mean smoothing. Each country is estimated separately. The dashed lines plot the 90-percent confidence band. The white area displays the interquartile range and the black reference line indicates the median. To obtain the figures, I first estimate an OLS regression with industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level of *Tobin's Q* on *ROA*, *Capex*, *R&D outlays*, *bADR*, *bFocus*, *FF-index*, *Leverage*, *Size*, and *Volatility*. I then regress these residuals on incorporation (panel a) and IPO age (panel B), respectively. The sample period is 1985 – 2010.

Panel A: Incorporation age



Panel B: IPO age

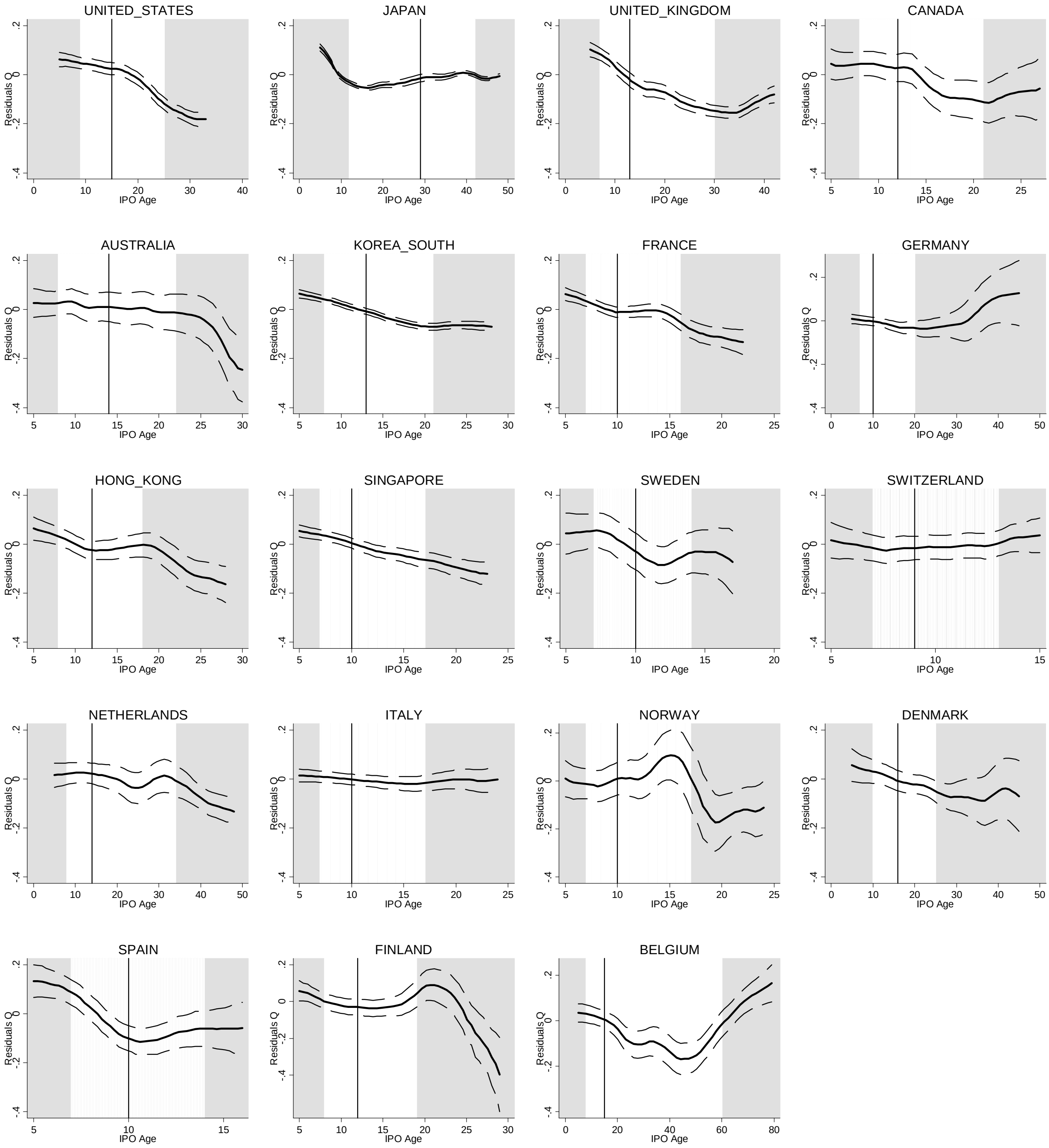


Table 6: Differences of age coefficients in Tobin's Q regressions

The table examines the differences in the coefficients of the country-specific regressions of Table 5. Differences in coefficients are tested for significance with a two-sample two-sided t-test with unequal variances. Regressions 1 and 5 estimate the same model as Table 5 and, for convenience, reproduce the US *ln(Age)* coefficient in the first row. Regressions 3 and 7 estimate panel regressions using standardized variables. Standardization is by industry (Fama and French's (1997) 48 industry grouping), year, and country. Control variables are otherwise identical to the model in Table 5. The symbols ***, **, and * indicate statistical significance with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	Incorporation age				IPO age			
	Coefficient (1)	p-value (2)	Coefficient (3)	p-value (4)	Coefficient (5)	p-value (6)	Coefficient (7)	p-value (8)
US	–0.192***		–0.065***		–0.194***		–0.084***	
Δ Japan	0.070***	0.002	–0.008	0.110	0.121***	0.000	0.031***	0.000
Δ UK	0.041	0.117	–0.037***	0.000	0.020	0.404	–0.044***	0.000
Δ Canada	0.061	0.120	0.015**	0.030	0.085**	0.031	0.050***	0.000
Δ Australia	0.103**	0.019	0.007	0.408	0.101**	0.024	0.032***	0.001
Δ Korea(South)	–0.007	0.793	–0.139***	0.000	0.062***	0.004	–0.117***	0.000
Δ France	0.092***	0.001	–0.074***	0.000	0.081***	0.001	–0.030***	0.000
Δ Germany	0.098***	0.000	–0.006	0.519	0.134***	0.000	0.043***	0.002
Δ Hong Kong	0.084**	0.043	–0.005	0.632	0.073*	0.069	–0.007	0.548
Δ Singapore	0.100***	0.005	–0.035**	0.028	0.062**	0.040	–0.078***	0.000
Δ Sweden	0.020	0.702	–0.008	0.555	–0.112	0.134	–0.095***	0.000
Δ Switzerland	0.145***	0.004	0.029	0.116	0.158***	0.001	0.086***	0.000
Δ Netherlands	0.101***	0.005	–0.056***	0.002	0.072*	0.091	–0.020	0.465
Δ Italy	0.150***	0.000	0.027	0.234	0.098***	0.000	0.024	0.393
Δ Norway	0.117***	0.007	0.032	0.225	0.067	0.151	–0.007	0.790
Δ Denmark	0.041	0.507	0.016	0.624	0.041	0.467	0.046	0.230
Δ Spain	0.187***	0.004	0.069**	0.039	0.223**	0.020	0.132***	0.005
Δ Finland	0.143***	0.002	0.060**	0.034	0.089*	0.085	0.010	0.722
Δ Belgium	0.048	0.331	–0.106***	0.001	0.107***	0.001	0.025	0.491

Table 7: Firm age and Tobin's Q in different sub-periods

The table replicates the regressions of Table 5 in different sub-periods over the sample-years. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The dependent variable is *Tobin's Q*. Control variables are the same as in Table 5: *ROA*, *Capex*, *R&D outlays*, *bFocus*, *FF-index*, *Leverage*, *Size*, and *Volatility*. All estimations use industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level. To conserve space, I only report the *ln(Age)* coefficient and its associated significance level. The sub-periods are 1985–1994, 1995–2004, and 2005–2010. The two bottom rows show the percentage of negative and significantly negative coefficients, respectively. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively.

	Incorporation age			IPO age		
	1985–1994	1995–2004	2005–2010	1985–1994	1995–2004	2005–2010
World	–0.136***	–0.151***	–0.128***	–0.139***	–0.137***	–0.131***
Non-US	–0.083***	–0.131***	–0.110***	–0.080***	–0.125***	–0.105***
US	–0.219***	–0.176***	–0.171***	–0.203***	–0.154***	–0.205***
Japan	–0.017	–0.131***	–0.122***	–0.046	–0.071***	–0.074***
UK	–0.113***	–0.166***	–0.118***	–0.116***	–0.188***	–0.119***
Canada	–0.136***	–0.143***	–0.083*	–0.132**	–0.127**	–0.065
Australia	–0.018	–0.166***	–0.032	–0.126*	–0.159***	–0.038
Korea (South)	–0.158**	–0.194***	–0.205***	–0.157***	–0.107***	–0.151***
France	–0.037*	–0.118***	–0.102***	–0.078***	–0.128***	–0.107***
Germany	–0.119***	–0.072***	–0.113***	0.011	–0.046	–0.079**
Hong Kong	0.033	–0.029	–0.171***	0.073	–0.045	–0.165***
Singapore	0.050	–0.137***	–0.074**	–0.078	–0.127***	–0.188***
Sweden	–0.067*	–0.138**	–0.148**	–0.174***	–0.341***	–0.260***
Switzerland	–0.002	0.001	–0.104	–0.025	–0.020	–0.037
Netherlands	–0.012	–0.123***	–0.085*	–0.021	–0.207***	0.001
Italy	0.016	–0.040	–0.068**	0.043*	–0.096***	–0.107***
Norway	0.072*	–0.075	–0.081*	0.074**	–0.134*	–0.107*
Denmark	–0.136***	–0.115*	–0.230*	–0.134***	–0.216***	–0.091
Spain	0.030	–0.027	0.049	0.177	–0.070	0.126
Finland	–0.152**	–0.063	–0.020	0.029	–0.128*	–0.149**
Belgium	–0.050	–0.187***	–0.136*	–0.117***	–0.128***	–0.068
% negative	74	95	95	68	100	89
% neg. and sig.	47	68	79	47	84	63

Table 8: Firm age and operating performance

The table investigates the relation between firm age and operating performance. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. In panel A, the dependent variable is *ROA*. Regressions 1 to 4 relate to the full sample of firms. Regressions 5 to 8 exclude US firms. Panel B repeats the multivariate analysis for each country separately. The left-hand side relates to the full sample of firms and the right-hand side repeats the analysis with the subsample of firms older than the median firm in each country, industry, and year. To conserve space, I only report the *ln(Age$_{ipo}$)* coefficient of each regression in this and the remaining panels. The left-hand side of panel C repeats the analysis with *Sales growth* as dependent variable and the right-hand side estimates logistic regressions with *Probability of negative sales growth* as dependent variable, defined as a binary variable equal to 1 if the firm's change in net sales in relation to the previous year is negative, and 0 otherwise. In Panel D on the left-hand side, I repeat the analysis with *Gross margin* as dependent and on the right-hand side, I estimate logistic regressions with *Probability of decline in market share* as dependent variable, defined as a binary variable equal to 1 if the firm's ratio of sales to total sales of all sample firms in the same three-digit SIC level industry, country, and year decreases in relation to the previous year, and 0 otherwise. All estimations use industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level. The two bottom rows in each panel (except panel A) show the percentage of negative (positive) and significantly negative (positive) coefficients, respectively. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

Panel A: ROA

	World				Non-US countries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Age$_{inc}$)	–1.183*	–0.637			–1.700***	–1.174**		
	(0.639)	(0.527)			(0.632)	(0.492)		
ln(Age$_{ipo}$)			–2.102***	–1.701***			–2.908***	–2.359***
			(0.774)	(0.625)			(0.569)	(0.499)
Capex	–0.019	–0.030	–0.033	–0.043	–0.062	–0.073	–0.077	–0.091
	(0.146)	(0.138)	(0.146)	(0.139)	(0.157)	(0.153)	(0.158)	(0.152)
R&D outlays	–0.143***	–0.142***	–0.142***	–0.140***	–0.155***	–0.149***	–0.154***	–0.150***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.026)	(0.024)	(0.026)	(0.023)
bADR	–3.788***	–4.612***	–3.679***	–4.380***	–2.842**	–4.076**	–2.516*	–3.995**
	(1.250)	(1.104)	(1.334)	(1.100)	(1.438)	(1.632)	(1.448)	(1.606)
bFocus	0.674	0.796	0.499	0.601	1.265	1.338*	0.921	1.043
	(0.670)	(0.614)	(0.572)	(0.500)	(0.811)	(0.784)	(0.702)	(0.660)
FF-index	–0.115	–0.102	–0.142	–0.130	0.076	0.084	0.113	0.091
	(0.509)	(0.469)	(0.524)	(0.475)	(0.640)	(0.593)	(0.656)	(0.600)
Leverage	–8.204***	–7.570***	–8.149***	–7.563***	–9.263***	–8.784***	–8.689***	–8.380***
	(1.924)	(1.537)	(1.615)	(1.312)	(1.472)	(1.259)	(1.458)	(1.385)
MTB-equity	–1.132***	–1.138***	–1.093***	–1.100***	–1.173*	–1.187*	–1.242*	–1.248*
	(0.176)	(0.172)	(0.182)	(0.179)	(0.679)	(0.668)	(0.665)	(0.655)
Size, 1 year lag	2.479***	2.528***	2.680***	2.708***	2.453***	2.585***	2.777***	2.914***
	(0.412)	(0.397)	(0.407)	(0.411)	(0.732)	(0.741)	(0.707)	(0.742)
Volatility	–27.662***	–28.790***	–26.984***	–28.547***	–23.640***	–24.744***	–23.144***	–24.765***
	(3.972)	(3.486)	(4.095)	(3.445)	(5.509)	(5.358)	(5.515)	(5.372)
Constant	13.344***	13.478***	5.787	2.723	1.482	–0.062	–7.853	–4.503
	(4.006)	(3.832)	(4.392)	(4.683)	(7.276)	(7.697)	(5'095.558)	(9'082.101)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	219'320	219'320	205'993	205'993	150'745	150'745	137'504	137'504
Adjusted R-squared	0.275	0.283	0.275	0.283	0.240	0.253	0.246	0.258

Panel B: ROA – Country-specific regressions

	ROA				*ROA* if $bOldfirm_{ipo} = 1$			
	Coefficient	SE	N	adj. R^2	Coefficient	SE	N	adj. R^2
World	–1.701***	(0.122)	205'993	0.28	–2.740***	(0.235)	104'140	0.26
Non-US	–2.359***	(0.138)	137'504	0.26	–2.456***	(0.282)	69'074	0.26
US	–0.049	(0.264)	68'489	0.32	–3.182***	(0.448)	35'066	0.29
Japan	–1.629***	(0.083)	41'643	0.26	–0.807***	(0.238)	21'906	0.28
UK	–1.553***	(0.221)	18'015	0.36	–1.888***	(0.424)	8'846	0.32
Canada	–2.318***	(0.812)	12'985	0.30	–6.144***	(1.832)	6'394	0.32
Australia	–0.464	(0.888)	10'830	0.30	–3.674	(2.270)	5'380	0.34
Korea (South)	–2.409***	(0.305)	11'185	0.27	–3.214***	(0.708)	5'686	0.26
France	–0.115	(0.249)	7'120	0.21	0.104	(0.368)	3'594	0.26
Germany	–0.603*	(0.323)	6'946	0.22	–0.981**	(0.492)	3'246	0.20
Hong Kong	–1.789***	(0.451)	7'121	0.22	–1.731**	(0.778)	3'421	0.20
Singapore	–2.078***	(0.333)	5'253	0.22	–2.363***	(0.652)	2'571	0.20
Sweden	0.417	(0.781)	3'372	0.37	–1.157	(1.214)	1'723	0.42
Switzerland	–0.679	(0.440)	2'009	0.38	–1.090	(0.828)	936	0.38
Netherlands	–0.859*	(0.516)	1'959	0.34	–1.716	(1.402)	1'020	0.41
Italy	–1.278***	(0.385)	2'018	0.36	–1.357	(0.820)	967	0.41
Norway	0.402	(0.769)	1'693	0.32	–0.631	(1.512)	848	0.29
Denmark	–0.429	(0.624)	1'638	0.39	–0.125	(0.829)	764	0.42
Spain	0.014	(0.798)	1'102	0.42	–4.272*	(2.341)	529	0.58
Finland	–0.870	(0.765)	1'469	0.39	–1.254	(0.914)	683	0.41
Belgium	–0.429	(0.528)	1'146	0.44	–0.656	(0.888)	560	0.47
% negative	84		97		95		97	
% neg. and sig.	47		52		47		84	

Panel C: Sales growth

	Sales growth				*Probability of negative sales growth*			
	Coefficient	SE	N	adj. R^2	Coefficient	SE	N	pseud. R^2
World	–5.870***	(0.259)	202'695	0.05	0.285***	(0.008)	202'695	0.08
Non-US	–3.897***	(0.335)	132'485	0.05	0.257***	(0.009)	132'485	0.08
US	–9.410***	(0.399)	70'210	0.08	0.322***	(0.014)	70'210	0.10
Japan	–1.952***	(0.112)	42'480	0.18	0.310***	(0.018)	42'480	0.15
UK	–6.759***	(0.550)	17'562	0.07	0.264***	(0.026)	17'562	0.10
Canada	–11.709***	(2.251)	9'847	0.05	0.249***	(0.032)	9'845	0.08
Australia	–22.271***	(4.808)	8'173	0.04	0.269***	(0.040)	8'173	0.06
Korea (South)	–2.992***	(0.581)	11'242	0.06	0.188***	(0.036)	11'240	0.07
France	–3.227***	(0.526)	7'310	0.13	0.209***	(0.044)	7'310	0.14
Germany	–4.397***	(0.726)	6'991	0.07	0.208***	(0.038)	6'991	0.10
Hong Kong	2.377	(1.777)	7'157	0.05	0.258***	(0.047)	7'157	0.09
Singapore	–2.544**	(0.991)	5'263	0.06	0.288***	(0.052)	5'262	0.08
Sweden	–3.804	(2.762)	3'355	0.10	0.208***	(0.064)	3'354	0.12
Switzerland	–3.216***	(1.213)	2'034	0.12	0.176**	(0.070)	1'999	0.16
Netherlands	–3.471***	(0.922)	1'991	0.16	0.253***	(0.079)	1'982	0.21
Italy	–2.498***	(0.820)	2'022	0.12	0.406***	(0.079)	2'016	0.14
Norway	–3.515	(2.771)	1'696	0.12	0.301***	(0.068)	1'685	0.11
Denmark	–3.564**	(1.464)	1'635	0.13	0.322**	(0.126)	1'632	0.14
Spain	–3.352**	(1.407)	1'104	0.24	0.261	(0.166)	1'100	0.17
Finland	–2.451*	(1.339)	1'470	0.24	0.171*	(0.098)	1'469	0.21
Belgium	–2.899*	(1.657)	1'153	0.14	0.070	(0.082)	1'149	0.12
% negative	95		96	% positive	100		100	
% neg. and sig.	84		94	% pos. and sig.	89		99	

Panel D: Market share and gross margin

	Probability of decline in market share				*Gross margin*			
	Coefficient	SE	N	adj. R^2	Coefficient	SE	N	pseud. R^2
World	0.209***	(0.008)	211'135	0.04	–2.839***	(0.498)	197'983	0.06
Non-US	0.155***	(0.009)	139'541	0.05	–3.827***	(0.727)	128'736	0.08
US	0.324***	(0.013)	71'594	0.04	–1.476***	(0.281)	69'247	0.15
Japan	0.215***	(0.016)	42'471	0.04	–2.386***	(0.214)	42'009	0.43
UK	0.186***	(0.023)	18'069	0.04	–1.471***	(0.405)	17'033	0.22
Canada	0.184***	(0.035)	13'489	0.09	–2.214	(2.936)	9'555	0.10
Australia	0.211***	(0.040)	10'958	0.08	20.477	(12.537)	7'851	0.12
Korea (South)	0.176***	(0.034)	11'238	0.03	–1.015**	(0.404)	10'887	0.35
France	0.092**	(0.043)	7'269	0.04	–0.546	(0.552)	6'872	0.39
Germany	0.162***	(0.034)	6'981	0.03	–1.524***	(0.513)	6'570	0.28
Hong Kong	0.179***	(0.054)	7'166	0.04	0.384	(0.881)	7'084	0.21
Singapore	0.093	(0.058)	5'222	0.05	0.058	(0.765)	5'235	0.31
Sweden	0.095	(0.083)	3'362	0.05	17.434	(10.933)	3'101	0.15
Switzerland	0.227***	(0.085)	1'901	0.09	–0.869	(1.024)	1'991	0.46
Netherlands	0.144	(0.100)	1'954	0.08	–1.317	(1.100)	1'937	0.44
Italy	0.051	(0.109)	1'939	0.08	0.660	(1.111)	1'971	0.41
Norway	0.215***	(0.075)	1'629	0.09	0.154	(4.124)	1'545	0.17
Denmark	0.069	(0.145)	1'515	0.10	–3.885**	(1.511)	1'537	0.48
Spain	0.178	(0.167)	931	0.12	–1.209	(2.330)	1'078	0.30
Finland	–0.097	(0.127)	1'327	0.12	–0.643	(1.011)	1'393	0.48
Belgium	0.082	(0.101)	1'022	0.15	–1.906*	(1.144)	1'087	0.55
% positive	95		99	% negative	68		86	
% pos. and sig.	58		92	% neg. and sig.	37		75	

Table 9: Firm age and investment activities

The table investigates the relation between firm age and investment activities considering capital expenditures and R&D expenses. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. Panel A shows the medians of the pooled distributions of the proxies for investment activities, *Capex* and *R&D outlays*. Panel B shows the results of the multivariate analysis for each country separately. On the left-hand side of the panel I regress *Capex* on *R&D outlays*, *bFocus*, *FF-index*, *Leverage*, *MTB-Equity*, *Size (1 year lag)*, and *Volatility*. On the right-hand side *R&D outlays* is the dependent variable and control variables are *Capex*, *bFocus*, *FF-index*, *Leverage*, *MTB-Equity*, *Size (1 year lag)*, and *Volatility*. To conserve space I only report the *ln(Age)* coefficient of each regression. All estimations use industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level. The two bottom rows show the percentage of negative and significantly negative coefficients, respectively. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

Panel A: Descriptive statistics

	Capex	*R&D outlays*	*R&D Coverage*		*Capex*	*R&D outlays*	*R&D Coverage*
US	0.57	22.08	0.68	Sweden	0.25	19.51	0.32
Japan	0.31	2.36	0.51	Switzerland	0.49	6.72	0.44
UK	1.41	11.64	0.33	Netherlands	0.90	4.91	0.26
Canada	5.23	37.37	0.30	Italy	0.40	3.49	0.26
Australia	3.64	36.88	0.29	Norway	4.13	9.35	0.26
Korea (South)	2.09	1.64	0.67	Denmark	1.56	19.02	0.22
France	0.34	5.89	0.24	Spain	1.00	1.61	0.08
Germany	0.20	6.48	0.33	Finland	1.46	4.06	0.54
Hong Kong	1.54	2.05	0.19	Belgium	1.00	7.41	0.24
Singapore	1.71	1.70	0.13	Total	1.23	14.67	0.47

Panel B: Multivariate analysis

	Capex				*R&D outlays*			
	Coefficient	SE	N	adj. R^2	Coefficient	SE	N	adj. R^2
World	–0.341***	(0.024)	211'229	0.23	–2.153***	(0.196)	211'229	0.14
Non-US	–0.387***	(0.030)	139'629	0.22	–0.560***	(0.132)	139'629	0.10
US	–0.204***	(0.034)	71'600	0.28	–5.759***	(0.536)	71'600	0.17
Japan	–0.260***	(0.026)	42'482	0.22	–0.085***	(0.029)	42'482	0.47
UK	–0.257***	(0.060)	18'086	0.30	–0.630**	(0.253)	18'086	0.22
Canada	–0.375**	(0.172)	13'503	0.29	–2.595***	(0.988)	13'503	0.21
Australia	–1.180***	(0.168)	11'005	0.28	–3.568***	(1.170)	11'005	0.14
Korea (South)	–0.868***	(0.123)	11'243	0.16	–0.357***	(0.056)	11'243	0.22
France	–0.292***	(0.090)	7'315	0.21	–0.214**	(0.100)	7'315	0.40
Germany	–0.279***	(0.093)	7'013	0.26	–0.238**	(0.095)	7'013	0.37
Hong Kong	–0.318**	(0.146)	7'167	0.14	0.018	(0.040)	7'167	0.31
Singapore	–0.868***	(0.168)	5'269	0.19	–0.024	(0.027)	5'269	0.35
Sweden	–0.177	(0.165)	3'399	0.28	–0.008	(2.430)	3'399	0.19
Switzerland	–0.134	(0.154)	2'037	0.25	–0.422*	(0.246)	2'037	0.48
Netherlands	–0.328**	(0.159)	1'995	0.22	0.042	(0.120)	1'995	0.56
Italy	–0.015	(0.144)	2'025	0.30	0.031	(0.066)	2'025	0.63
Norway	–0.227	(0.416)	1'707	0.24	–0.350	(0.278)	1'707	0.51
Denmark	0.084	(0.267)	1'653	0.23	–1.535	(1.436)	1'653	0.32
Spain	–0.389	(0.304)	1'104	0.27	–0.023	(0.075)	1'104	0.48
Finland	–0.084	(0.281)	1'473	0.23	0.118	(0.221)	1'473	0.50
Belgium	–0.272	(0.240)	1'153	0.27	–0.753*	(0.428)	1'153	0.41
% negative	95		99		79		94	
% neg. and sig.	58		93		47		88	

Table 10: Firm age and cash payouts

The table investigates the relation between firm age and cash payouts considering cash balances and payout ratios. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. Panel A shows descriptive statistics of the pooled distributions of the proxies for cash payouts, *Cash* and *Payout ratio*. Panel B shows the results of the multivariate analysis for each country separately. On the left-hand side of the panel, I regress *Cash* on *ROA*, *Capex*, *R&D outlays*, *bFocus*, *FF-index*, *Leverage*, *MTB-Equity*, *Size (1 year lag)*, and *Volatility*. On the right-hand side, I exchange *Cash* for *Payout ratio* as the dependent variable. To conserve space, I only report the *ln(Age)* coefficient of each regression. All estimations use industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level. The two bottom rows show the percentage of negative and significantly negative coefficients, respectively. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

Panel A: Descriptive statistics

	Median *Cash*	Median *Payout ratio*		Median *Cash*	Median *Payout ratio*
US	9.96	0.05	Sweden	10.74	0.12
Japan	14.85	0.09	Switzerland	12.35	0.11
UK	7.56	0.14	Netherlands	6.11	0.11
Canada	9.53	0.06	Italy	8.59	0.10
Australia	10.91	0.10	Norway	11.78	0.09
Korea (South)	9.85	0.06	Denmark	9.96	0.10
France	9.86	0.09	Spain	5.75	0.13
Germany	7.74	0.09	Finland	8.32	0.18
Hong Kong	15.07	0.18	Belgium	8.22	0.12
Singapore	13.01	0.17	Total	11.26	0.09

Panel B: Multivariate analysis

	Cash				*Payout ratio*			
	Coefficient	SE	N	adj. R^2	Coefficient	SE	N	pseud. R^2
World	–1.631***	(0.081)	205'852	0.41	0.006***	(0.001)	204'545	0.19
Non-US	–1.050***	(0.088)	137'414	0.37	0.003***	(0.001)	136'174	0.18
US	–3.566***	(0.164)	68'438	0.50	0.015***	(0.001)	68'371	0.24
Japan	–1.284***	(0.135)	41'642	0.46	0.001	(0.001)	41'275	0.15
UK	–0.718***	(0.208)	18'014	0.41	0.011***	(0.003)	17'998	0.19
Canada	–1.583***	(0.343)	12'914	0.42	–0.005*	(0.003)	12'811	0.23
Australia	–1.594***	(0.416)	10'829	0.45	0.007**	(0.003)	10'808	0.38
Korea (South)	–1.909***	(0.250)	11'179	0.43	–0.003	(0.002)	11'124	0.22
France	–0.501	(0.367)	7'120	0.41	0.004	(0.004)	7'003	0.20
Germany	–0.364	(0.337)	6'946	0.44	–0.001	(0.003)	6'708	0.21
Hong Kong	–0.623	(0.494)	7'120	0.37	0.015	(0.012)	7'087	0.22
Singapore	0.596	(0.483)	5'253	0.40	0.013	(0.009)	5'242	0.18
Sweden	–1.487**	(0.648)	3'372	0.44	0.006	(0.006)	3'272	0.26
Switzerland	–0.407	(0.583)	2'009	0.43	0.005	(0.005)	1'989	0.24
Netherlands	0.399	(0.693)	1'957	0.45	0.010*	(0.006)	1'940	0.30
Italy	–0.961**	(0.433)	2'018	0.37	–0.003	(0.005)	1'995	0.25
Norway	–0.836	(0.545)	1'693	0.55	0.013	(0.009)	1'661	0.21
Denmark	–0.842	(0.994)	1'632	0.49	0.011	(0.007)	1'617	0.21
Spain	0.373	(0.838)	1'101	0.38	0.019*	(0.012)	1'066	0.38
Finland	–0.254	(0.702)	1'469	0.51	0.016*	(0.009)	1'463	0.24
Belgium	1.022	(0.705)	1'146	0.51	0.019***	(0.007)	1'115	0.25
% negative	79		95	% positive	79		84	
% neg. and sig.	42		82	% pos. and sig.	37		50	

Table 11: Firm age and technical efficiency

The table investigates the relation between firm age and technical efficiency. Variable definitions are in Table 13 at the end of the paper. All variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. Panel A shows the medians of the pooled distributions of the proxy for technical efficiency, *Sales-to-assets*. Panel B shows the results of the multivariate analysis for each country separately. I regress *Sales-to-assets* on *Capex*, *R&D outlays*, *bFocus*, *FF-index*, *Leverage*, *MTB-Equity*, *Size (1 year lag)*, and *Volatility*. The left-hand side relates to the full sample of firms and the right-hand side repeats the analysis with the subsample of firms older than the median firm in each country, industry, and year. To conserve space, I only report the *ln(Age)* coefficient of each regression. All estimations use industry (Fama and French's (1997) 48 industry grouping) and year fixed-effects and robust standard errors clustered at the firm-level. The two bottom rows show the percentage of negative and significantly negative coefficients, respectively. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

Panel A: Descriptive statistics

	Sales-to-assets		*Sales-to-assets*
US	1.13	Sweden	1.18
Japan	1.03	Switzerland	1.02
UK	1.23	Netherlands	1.42
Canada	0.40	Italy	0.82
Australia	0.47	Norway	0.98
Korea (South)	0.96	Denmark	1.16
France	1.18	Spain	0.88
Germany	1.25	Finland	1.16
Hong Kong	0.69	Belgium	1.13
Singapore	0.83	Total	1.03

Panel B: Multivariate analysis

	Sales-to-assets				*Sales-to-assets* if $bOldfirm_{ipo} = 1$			
	Coefficient	SE	N	adj. R^2	Coefficient	SE	N	adj. R^2
World	–0.037***	(0.005)	211'174	0.28	–0.063***	(0.013)	105'740	0.30
Non-US	–0.061***	(0.006)	139'620	0.29	–0.069***	(0.015)	69'764	0.31
US	0.037***	(0.010)	71'554	0.29	0.014	(0.025)	35'976	0.28
Japan	–0.082***	(0.009)	42'482	0.32	–0.016	(0.028)	22'138	0.34
UK	–0.054***	(0.017)	18'086	0.30	–0.076*	(0.040)	8'864	0.28
Canada	0.015	(0.014)	13'497	0.48	–0.029	(0.037)	6'595	0.53
Australia	–0.006	(0.022)	11'002	0.34	0.099	(0.063)	5'459	0.37
Korea (South)	–0.085***	(0.019)	11'243	0.17	–0.162***	(0.048)	5'709	0.16
France	0.009	(0.020)	7'315	0.28	–0.033	(0.037)	3'659	0.24
Germany	0.025	(0.031)	7'013	0.24	0.012	(0.050)	3'259	0.28
Hong Kong	–0.202***	(0.030)	7'167	0.26	–0.383***	(0.058)	3'437	0.35
Singapore	–0.181***	(0.034)	5'269	0.27	–0.146**	(0.071)	2'579	0.34
Sweden	0.033	(0.037)	3'399	0.29	0.061	(0.066)	1'728	0.44
Switzerland	–0.034	(0.044)	2'037	0.28	–0.297***	(0.099)	941	0.40
Netherlands	0.051	(0.080)	1'995	0.50	–0.026	(0.201)	1'024	0.58
Italy	–0.081***	(0.021)	2'025	0.37	–0.133***	(0.037)	974	0.45
Norway	–0.088**	(0.043)	1'707	0.40	–0.138**	(0.057)	850	0.54
Denmark	0.052	(0.058)	1'653	0.32	0.028	(0.139)	770	0.46
Spain	–0.002	(0.045)	1'104	0.53	–0.013	(0.130)	530	0.61
Finland	0.015	(0.040)	1'473	0.43	0.121	(0.105)	683	0.48
Belgium	0.012	(0.057)	1'153	0.45	0.123	(0.077)	565	0.58
% negative	53		48		63		54	
% neg. and sig.	37		42		37		22	

Table 12: Corporate aging and institutional differences

The table investigates the relation between corporate aging and international institutional differences. Variable definitions are in Table 13 at the end of the paper. All firm-level variables (except the binary and age variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The dependent variable is *Tobin's Q*. Panel A includes demeaned *Stock market in % GDP* and an interaction term of this variable with firm age. Panel B replicates the analysis of panel A by individually replacing the interaction term of *Stock market in % GDP* and firm age with interaction terms of *Trade openness*, *Government orientation*, *Labor market programs (LMP)*, *Fraction union members (FUM)*, and *Employment protection legislation (EPL index)* and (demeaned) firm age. All estimations include industry (I) (Fama and French's (1997) 48 industry grouping), year (Y), and country (C) fixed-effects (FE) and robust standard errors clustered at the country-level, which are given in parentheses. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

Panel A: Stock market in % GDP

	Incorporation age		IPO age	
	(1)	(2)	(3)	(4)
ln(Age)	–0.155***	–0.153***	–0.149***	–0.150***
	(0.015)	(0.015)	(0.011)	(0.012)
Stock market * ln(Age)	–0.075*	–0.083*	–0.083*	–0.084*
	(0.042)	(0.045)	(0.043)	(0.049)
Stock market in % GDP	0.173*	0.121	0.157*	0.085
	(0.101)	(0.128)	(0.086)	(0.111)
ROA	–0.014***	–0.014***	–0.014***	–0.014***
	(0.002)	(0.002)	(0.001)	(0.001)
Capex	0.002	0.001	0.001	0.000
	(0.007)	(0.007)	(0.007)	(0.007)
bADR	–0.042	–0.037	–0.048	–0.040
	(0.055)	(0.056)	(0.054)	(0.055)
bFocus	0.061***	0.062***	0.050***	0.050***
	(0.018)	(0.019)	(0.018)	(0.019)
FF-index	–0.009	–0.009	–0.006	–0.005
	(0.016)	(0.018)	(0.018)	(0.021)
Leverage	–2.672***	–2.827***	–2.649***	–2.794***
	(0.728)	(0.784)	(0.737)	(0.797)
Size, 1 year lag	0.127***	0.128***	0.135***	0.137***
	(0.019)	(0.020)	(0.018)	(0.019)
Volatility	0.711***	0.732***	0.689***	0.708***
	(0.085)	(0.090)	(0.072)	(0.078)
EPL index		–0.218		–0.219
		(0.150)		(0.172)
Per-capita GDP growth		1.500		1.516
		(1.354)		(1.268)
Trade openness		–0.111		–0.176
		(0.348)		(0.352)
Government orientation		–0.021		–0.020
		(0.015)		(0.015)
Labor market programs		–0.040		–0.049
		(0.050)		(0.063)
Fraction union members		–0.003		–0.009
		(0.014)		(0.016)
Constant	0.053	2.327	–0.090	0.835
	(0.145)	(2.072)	(0.204)	(1.289)
I, Y, and C FE	Yes	Yes	Yes	Yes
Observations	199'277	184'233	187'330	173'153
Adjusted R-squared	0.267	0.265	0.262	0.260

Panel B: Government orientation, Trade openness, Labor market programs, Fraction union members

	Incorporation age		IPO age	
	(1)	(2)	(3)	(4)
		Trade openness		
ln(Age)	–0.162***	–0.162***	–0.148***	–0.149***
	(0.008)	(0.009)	(0.020)	(0.020)
Trade openness * ln(Age)	0.081***	0.083***	0.020	0.019
	(0.027)	(0.026)	(0.044)	(0.041)
Trade openness	0.089	–0.133	0.081	–0.142
	(0.197)	(0.316)	(0.172)	(0.317)
Observations	195'273	191'098	182'443	178'810
		Government orientation		
ln(Age)	–0.161***	–0.161***	–0.149***	–0.149***
	(0.012)	(0.012)	(0.020)	(0.020)
Gov. orient. * ln(Age)	0.032***	0.032**	0.014	0.013
	(0.011)	(0.013)	(0.013)	(0.013)
Government orientation	–0.020*	–0.023*	–0.017	–0.020
	(0.010)	(0.013)	(0.011)	(0.015)
Observations	195'197	191'098	182'406	178'810
		Labor market programs (LMP)		
ln(Age)	–0.163***	–0.161***	–0.150***	–0.150***
	(0.010)	(0.009)	(0.018)	(0.019)
LMP * ln(Age)	0.040***	0.044***	0.018	0.019
	(0.013)	(0.012)	(0.016)	(0.016)
LMP	–0.081**	–0.073*	–0.091***	–0.071
	(0.032)	(0.042)	(0.029)	(0.054)
Observations	201'334	191'098	188'890	178'810
		Fraction union members (FUM)		
ln(Age)	–0.158***	–0.156***	–0.148***	–0.150***
	(0.016)	(0.016)	(0.019)	(0.020)
FUM * ln(Age)	0.001	0.002*	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
FUM	–0.003	0.003	–0.008	–0.000
	(0.010)	(0.012)	(0.010)	(0.015)
Observations	206'856	191'098	193'628	178'810
		Employment protection legislation (EPL)		
ln(Age)	–0.159***	–0.159***	–0.150***	–0.152***
	(0.013)	(0.010)	(0.008)	(0.010)
EPL index * ln(Age)	0.062***	0.062***	0.055***	0.049***
	(0.014)	(0.016)	(0.016)	(0.017)
EPL index	–0.128	–0.207*	–0.102	–0.191
	(0.092)	(0.122)	(0.087)	(0.146)
Observations	206'803	191'098	193'587	178'810
Controls (panel A)	Included	Included	Included	Included
I, Y, and C FE	Yes	Yes	Yes	Yes
Adjusted R-squared	0.26	0.26	0.26	0.26

Table 13: Variable definitions

Variable	Definition
	Panel A: Firm age
Age_{inc}	Incorporation age, computed as one plus the difference between the year under investigation and the firm's incorporation year. The incorporation age is from (a) Jay Ritter's Website and Mergent Webreports, (b) WorldScope item 18273: "Date of Incorporation represents the date the company was incorporated", (c) Osiris from Bureau van Djik, (d) SDC Platinum, (e) Zephyr from Bureau van Djik, (f) official websites from stock exchanges, (g) personal email to Investor Relations Manager, (h) Amadeus from Bureau van Djik, (i) official websites from trade registers, (j) corporate websites, and (k) online encyclopedias, filled up in this order
Age_{ipo}	IPO age, computed as one plus the difference between the year under investigation and the firm's IPO year. The IPO year is computed as (a), for the US, the minimum value of: (1) the first year the firm appears on the CRSP tapes; (2) the first year the firm appears on the COMPUSTAT tapes; and (3) the first year for which I find a link between the CRSP and the COMPUSTAT tapes, (b) WorldScope item 00000; the footnote contains information about "the date when the company became publicly held", (c) Compustat, (d) Osiris from Bureau van Djik, (e) SDC Platinum, (f) Zephyr from Bureau van Djik, (f) CRSP, (g) official websites from stock exchanges, (h) personal email to Investor Relations Manager, (i) corporate websites, (j) Thomson Reuters, and (k) online encyclopedias, filled up in this order
$bOldfirm_{inc}$ (95.45)	Binary variable equal to 1 if the firm's incorporation age (Age_{inc}) is above the sample median in any given country and year, and equal to 0 otherwise
$bOldfirm_{ipo}$ (88.10)	Binary variable equal to 1 if the firm's IPO age (Age_{ipo}) is above the sample median in a given country and year, and equal to 0 otherwise
	Panel B: Firm performance
Gross margin	The gross profit margin, defined as net sales (WorldScope item 01001) minus cost of goods sold (WorldScope item 01051) divided by net sales, multiplied by 100.
Probability of decline in market share	Binary variable equal to 1 if the firm' ratio of sales (WorldScope item 01001) divided by the total of sales of all sample firms in the same three-digit SIC level industry, country, and year decreases in relation to the previous year, and 0 otherwise
Probability of negative sales growth	Binary variable equal to 1 if the firm's change in net sales (WorldScope item 01001, expressed in USD) in relation to the previous year is negative, and 0 otherwise
ROA	The firm's return on assets, calculated as the ratio of the firm's earnings before interest, taxes, depreciation and amortization (WorldScope item 18198) divided by the lagged book value of the firm's assets (WorldScope item 02999) multiplied by 100
Sales growth	The firm's change in net sales (WorldScope item 01001, expressed in USD) in relation to the previous year, multiplied by 100
Tobin's Q	Tobin's Q, computed as the market value of the firm's assets (*Size*) divided by the book value of the firm's assets (WorldScope item 02999)
	Panel D: Firm-level variables
bADR	Binary variable equal to 1 if the firm's shares are listed on stock exchange in a country different from the country in which the firm is incorporated as indicated by WorldScope items 11496 and 06100, and is zero otherwise
bFocus	Borrowing from Mitton (2002), a binary variable equal to 1 if the number of two-digit SIC level industries in which a firm operates is less than the median in a given country and year, using the higher number of reported industries in WorldScope items 07021 to 07028 and 19506 to 19596, respectively, and 0 otherwise
Capex	The firm's capital expenditures (WorldScope item 04601) net of depreciation and amortization (WorldScope item 01151), divided by the lagged market value of the firm's assets (*Size*)

Variable	Definition
Cash-to-assets	The firm's cash balance (WorldScope item 02001) divided by the book value of the firm's assets (WorldScope item 02999)
FF-index	Borrowing from Doidge et al. (2009), a financial flexibility index constructed as a count variable by adding one point for a firm with above median cash (WorldScope item 02001), one point for above median dividend payments (WorldScope item 04551 divided by WorldScope item 18198), and one point for below median capital expenditures (*Capex*) in a given country, industry (Fama and French's (1997) 48 industry grouping), and year
Leverage	The firm's leverage, calculated as the firm's total debt (WorldScope item 03255) divided by the market value of the firm's assets (*Size*)
MTB-equity	The firm's market-to-book ratio, calculated as the market value of the firm's equity (WorldScope item 08001) divided by the book value of the firm's equity (WorldScope item 03501)
Payout ratio	The firm' ratio of dividends (WorldScope item 04551) devided by the firm's earnings before interest, taxes, depreciation and amortization (WorldScope item 18198)
ROA	The firm's return on assets, calculated as the ratio of the firm's earnings before interest, taxes, depreciation and amortization (WorldScope item 18198) divided by the lagged book value of the firm's assets (WorldScope item 02999) multiplied by 100
R&D outlays	The firm's R&D expenditures (WorldScope item 01201) divided by the firm's net sales (WorldScope item 01001). Undisclosed values are set to zero and I use non-disclosure indicators to control for the undisclosed values.
Sales-to-assets	The firm's net sales (WorldScope item 01001) divided by the lagged book value of the firm's assets (WorldScope item 02999).
Size	The firm's size is the log of the market value of the firm's assets, calculated as the book value of the firm's assets (WorldScope item 02999) minus the book value of the firm's equity (WorldScope item 03501) plus the market value of the firm's equity (WorldScope item 08001) minus deferred taxes (WorldScope item 03263)
Volatility	The volatility of the firm's monthly stock return, calculated over a two-year window and including all firm-years with at least 12 monthly returns. The returns are continuously compounded and all padded zero-return records at the end of each stock's time series are removed, as defined in Ince and Porter (2006)
	Panel E: Country-level variables
EPL index	OECD indicators of employment protection for 34 OECD countries and 9 emerging economies. We use version 1 of the employment protection summary indicator as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
Fraction union members	Net union membership as a proportion of wage and salary earners in employment. The data is from Comparative political data set I 1960-2010 (item ud) from Armingeon et al. (2012). Source: *http://www.ipw.unibe.ch*
Government orientation	Cabinet composition index ranging from 1 (hegemony of right-wing (and center) parties) to 5 (hegemony of social-democratic and other left parties). The data is from Comparative political data set I 1960-2010 (item govparty) from Armingeon et al. (2012). Source: *http://www.ipw.unibe.ch*
Labor market programs	Grubb and Puymoyen's (2008) annual public expenditure on labor market programs as a percentage of GDP. Source: *http://stats.oecd.org*
Per-capita GDP growth	The country's change in per-capita gross domestic product (GDP) relative to the previous year. GDP is expressed in constant national currency per person. Data are derived by dividing constant price GDP by total population. The data is from World Economic Outlook database. Source: *http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/download.aspx*

Variable	Definition
Stock market in % GDP	The country's ratio of stock market capitalization to gross domestic product in percent. The data is from Financial Development and Structure Dataset (item stmktcap) from Beck, Demirgüç-Kunt, and Levine (2010). Source: *http://econ.worldbank.org*
Trade openness (94.87)	Openness of the economy, measured as total trade (sum of import and export) as a percentage of GDP. The data is from Comparative political data set I 1960-2010 (item openc) from Armingeon et al. (2012). Source: *http://www.ipw.unibe.ch*

Is employment protection the fountain of corporate youth?

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Acharya, Baghai, and Subramanian (2012, 2013) find that employment protection legislation (EPL) encourages innovation. We argue that this effect should be particularly strong in mature firms. We would therefore also expect EPL to boost growth opportunities. Using the natural experiment created by the staggered passage of changes in EPL across seventeen countries, we find evidence that employment protection legislation does indeed stimulate innovation efforts, especially in mature firms. The effect is stronger in countries in which patents are owned by the firm and in the context of regular contracts. Consistent with that, EPL encourages risk taking. Overall, however, there is little evidence that the effect of EPL on innovation effort translates into higher firm value, not even in mature firms. EPL does motivate employees in those firms to put in a greater effort, as evidenced by stronger sales growth. Yet it also increases costs, reduces profitability, and depresses Tobin's Q ratios in all firms, especially the mature ones, possibly because of the rigidities that characterize these firms [Loderer, Stulz, and Waelchli (2014)].

Keywords: company age, firm performance, employment protection, innovation.

JEL codes: G30, L20

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1. Introduction

As they age, firms progressively run out of growth opportunities (Loderer, Stulz, and Waelchli, 2014). At the same time, the evidence shows that employment protection legislation (EPL) encourages firms and employees to engage in innovation (Acharya, Baghai, and Subramanian, 2012 and 2013; henceforth ABS (2012) and (2013)). Arguably, the effect of EPL should be more pronounced in mature firms than in young ones. On the one hand, younger firms are busy exercising the growth options that induced them to list, as documented by the dramatic increase in book assets that follows the IPO (Mikkelson, Partch, and Shah, 1997). Hence, the generation of new innovative projects is not a priority of younger firms. On the other hand, older firms have a more urgent innovation problems, since the growth options they had when they went public are partially exhausted. If so, EPL should have a comparatively stronger effect on mature firms than on young ones. This paper tests this proposition. We also test whether, as predicted by ABS (2013), EPL increases firm value, and whether that effect, as we just argued, is more pronounced in mature organizations. Moreover, we want to know whether the effect on firm value is mediated by the effect on innovation effort.

According to Acharya, Baghai, and Subramanian (2012 and 2013), laws that protect employees against unjust dismissal help reduce the underinvestment problem brought about by incomplete employment contracts and the ability of firms to hold up innovating employees. A similar prediction follows from theoretical arguments that tolerance for failure in employment contracts fosters innovation and economic growth (Manso, 2011, Ederer and Manso, 2012), or that job security encourages workers to invest in firm-specific human capital (Suedekum and Ruehmann, 2003, and Wasmer, 2006). Consistent with these predictions, ABS (2013) find evidence that employment protection spurs innovation in the US. Similarly, ABS (2012) uncover cross-country evidence that more stringent employment protection leads to more innovation internationally. We test whether this effect is stronger in mature firms, based on the argument that mature firms are more likely to face the choice of routine versus innovation projects depicted in ABS (2013) than young firms are. Young firms list to fund the exploitation of growth opportunities. Hence, given limited managerial attention (Loderer, Stulz, and Wälchli, 2014), their focus will be on production, marketing, and distribution rather than on innovation (Holmstrom, 1989). As firms grow older, innovation becomes an issue. Stricter EPL will encourage innovation at the margin in these firms.

We test this proposition using an international panel, which covers more than 30,000 firms in 17 countries between January 1985 and December 2010. To examine the impact of employment protection, we exploit the variation in the composite index of EPL compiled by the Organization for Economic Cooperation and Development (OECD), which measures the evolution of EPL across countries and over time. The annual index varies considerably across countries and displays substantial time-series variation within countries.

Since these changes occur in different countries at different points in time, we can identify the impact of changes in EPL using a difference-in-differences test design with industry, year, and country fixed effects. The results show that EPL does indeed encourage innovation effort, as measured by R&D expenses. The results hold also when examining the number of patent applications. The effect is significant both statistically as well as economically. For a firm of average age, a change in the EPL index by one unit leads to an increase in R&D expenditures of 2.3 percent of sales. Compared with the unconditional sample-wide average of R&D to sales of 7.3 percent, this is an increase of approximately 30 percent.

As predicted, however, the innovation boost occurs mostly in mature firms, and especially in innovation-intensive industries. We obtain similar results when measuring employment protection legislation with the alternative index proposed by Deakin, Lele, and Siems (2007). We also find that the EPL effect we uncover is much stronger in countries in which patents are owned by the firm, consistent with ABS's (2012) argument that EPL limits the employers' ability to hold up innovating employees. Moreover, the effect we find is particularly pronounced in the context of regular contracts as opposed to temporary contracts. Consistent with increased innovation activities, EPL also stimulates corporate risk taking. This is in line with ABS (2012), who find that EPL increases the standard deviation of patent citations, their measure of riskiness of innovation projects. The evidence also shows that, possibly to hedge this increased risk, firms hold larger cash balances.

To address endogeneity concerns, we incorporate variables into our analysis that could be a determinant of innovation efforts and correlate with EPL. The literature has identified a number of such time-varying country-level factors, such as economic growth or trade liberalization.[1] When we extend the specification of our regression models with these variables, however, the statistical significance and the economic magnitude of the impact of EPL on innovation remains the same.

More intensive innovation effort would not be economically very relevant if it didn't affect firm value. We therefore investigate whether, as predicted by ABS, EPL also contributes to higher firm value. Because of the preceding results, this effect should be limited to mature firms.

We find that EPL tends to depress Tobin's Q ratios, but less so in mature firms. The more moderate effect on mature firms is especially pronounced in the countries in which patents are owned by the firm, and in the context of regular (as opposed to temporary) contracts. These results are empirically robust to different measures of firm age, the exclusion of the US from the sample, and various error clustering procedures at the country- and firm-level. Employment

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[1] See Acharya, Baghai, and Subramanian (2013), Acharya, Baghai, and Subramanian (2012), Atanassov and Kim (2009), Saint-Paul (2002), and Subramanian and Megginson (2012).

protection legislation is highly correlated with product market legislation. There is no evidence, however, that EPL is a proxy for product market legislation in our tests.

We also find, however, that the differential effect of EPL on Q in mature firms is not mediated by higher R&D expenditures. In other words, although EPL does affect R&D, higher R&D expenditures have no tangible effect on Q. EPL influences Q through other channels than R&D. One possibility that is fully in line with the logic and the predictions of the ABS model is that stricter EPL encourages investment in firm-specific human capital (Belot, Boone, van Ours, 2007). This could increase the productivity of labor. Consistent with this interpretation, the evidence shows that EPL boosts growth. This effect, however, is swamped by the higher costs EPL brings about as well as the lower profitability, particularly in mature firms. On net, however, EPL reduces firm value, even in mature firms. In these firms, EPL seems to encourage greater effort in the form of R&D expenditures and sales, but it also imposes restrictions that mature firms, because of their rigidities [Loderer, Stulz, and Waelchli (2014)], are less able to cope with.

This paper makes four main contributions to the literature. First, we show that the effect of EPL on innovation efforts documented in ABS (2012 and 2013) is limited to mature firms. Second, we find that EPL encourages risk taking in those firms, which they seem to hedge by increasing their cash balances. Third, we illustrate that EPL adversely affects firm value, although less so in mature firms. Fourth, the higher innovation effort that EPL sparks does not translate into higher firm value. Fifth, EPL boosts sales in mature firms, possibly by encouraging higher investments in firm-specific human capital, but it also increases costs that especially mature firms have more problems dealing with. Overall, stricter EPL reduces firm value, especially in mature firms.

The paper proceeds as follows. Section 2 discusses the data and provides summary statistics. Section 3 estimates the relation between EPL and innovation. Section 4 does the same for the relation between EPL and Q. Section 5 investigates whether innovation intermediates the association between EPL and Q. Section 6 interprets the relation between EPL and Q. Finally, Section 7 concludes.

2. Data and summary statistics

2.1. Employment protection legislation

Employment protection generally refers to the rules governing the hiring and firing of employees. As outlined by Bassanini, Nunziata, and Venn (2009), for open-ended regular contracts, these rules typically define under what conditions the termination of employment is fair or unfair, what procedures should be followed in the case of individual layoffs, and how the dismissed employee can legally challenge the layoff decision. Usually, the regulations also specify the monetary compensation that employees are entitled to after dismissal. Employment protection typically also regulates collective dismissal procedures and fixed-term contracts. Employment protection is normally specified in legislation, collective agreements, or individual contracts. It also depends on judicial interpretation as well as on law enforcement procedures.

To analyze the impact of employment protection on innovation and firm value, we exploit the time-series variation of changes in these laws. To measure how restrictive employment protection is, we use the OECD's overall EPL index. The index covers the years 1985 to 2013 and is constructed by surveying existing laws and regulations in the OECD member countries with the help of labor law experts from the International Labor Organization. Most of the information used to calculate the EPL index refers to national and regional legislation. However, the index also takes into account national, regional and industry-level collective agreements as well as, where relevant, court rulings. In the US, employment protection is mostly not statutory but rather based on court decisions. OECD (2013) gives a detailed overview of the method and the data collection procedures of the EPL index. The academic literature considers the OECD EPL index as the best summary of EPL across countries (see, among many others, Pagano and Volpin (2005), Bassanini and Garnero (2013), and Bassanini, Nunziata, and Venn (2009)).

The OECD index is compiled from eighteen aspects of EPL, grouped into three sub-indices: (a) Individual dismissal of employees with regular contracts; (b) Regulation of temporary contracts; and (c) Costs for collective dismissals. Table 1 describes the index components and the weights used to aggregate them into the overall index.

There are different versions of the index, depending on the weights used to combine its components. We rely on Version 1 of that index because it provides the longest time series. This version does not include the subindex for collective dismissals. As indicated in the table, it has two equally weighted components (Level 2 in the table): one for regular (*EPLR*) and one for temporary contracts (*EPLT*).

The two components themselves are composed of three and two elements, respectively (Level 3 in the table). The first element of the sub-index for regular contracts captures the procedural hurdles that employers have to take when they want to dismiss an employee based on fair grounds. These hurdles include whether the notification of individual dismissal must be oral or written, whether a third party, such as work councils or the competent labor authority, must authorize the notification, and whether there is a delay before notice can start. Generally, the notification must be in writing. The exception is the US with no specific notification requirement. The delay before the start of notice exhibits substantial cross-country variation. In some countries, such as Switzerland and Norway, notice can only start at month-end, which adds an average 15 days to the standard notice period. If administrative authorization or preliminary court judgment is required, the associated delays are typically between two and four weeks.

The second element of the sub-index for regular contracts measures notice period and severance pay. The notice period is quantified in months and the mandatory severance payment is the equally-weighted average of the number of monthly wages at three levels of job tenure (9 months, 4 years, and 20 years). All countries except the US enforce minimum notice periods but only two thirds provide for ordinary severance pay.

The third element of the sub-index for regular contracts assesses the difficulty of dismissal, which involves a classification of fair or unfair dismissal, the compensation and the possibility of reinstatement after unfair dismissal, and the length of the trial period. Most countries have laws governing fair and unfair dismissal. For example, Australia, France, Germany, Italy, Norway, and Sweden consider dismissal in the case of redundancy as unfair if the employee could have been given another job within the same company. Unfair dismissal can require compensation above ordinary severance pay. The OECD average is six months of former pay, but Sweden typically mandates payment of 32 months, and Italy and France 21 and 16 months, respectively. The possibility of reinstatement and the length of the trial period also vary substantially across countries.

A substantial fraction of employer-employee agreements takes the form of temporary contracts. The second component of the OECD EPL index we use has two elements, one for fixed-term contracts and the other for temporary work agencies, respectively. Both elements classify the conditions for valid use, the restrictions on renewals, and the maximum cumulated duration of these contracts. Some countries have no restrictions on the use of temporary contracts, whereas others permit these contracts only on the basis of an objective or material situation, for example to perform a task which in itself is of limited duration.[2]

Figure 1 shows the evolution of Version 1 of the EPL index in the seventeen sample countries for the period between 1985 and 2010.[3] The index exhibits considerable cross-sectional variation and, with the exception of Canada, Switzerland, and the US, substantial time-series variation as well. Table 2 provides a comprehensive description of all the changes in EPL during the sample period.[4] The last column of Table 2 reports the associated index changes. The majority of these changes are negative, indicating a deregulation trend. Approximately half of the index changes concern regular contracts, and some are substantial whereas others are not. The substantial changes include those that Spain enacted in 1994, namely: 1) a significant transfer of regulatory powers regarding pay and conditions from the law to collective agreements; 2) the decentralization of collective bargaining, especially in the form of enterprise agreements; 3) a lifting of the public monopoly of job placement to allow private employment agencies and temporary employment agencies ; 4) the facilitation of internal labor mobility within the enterprise; 5) the reduction of the costs of individual dismissal; and 6) a relaxation of the rules governing collective dismissal and redundancy.[5] The legal reform led to a decrease in the EPL index from 3.65 to 2.80. An example of a less sizeable legal change is the 2008 adjustment of the severance pay in the Netherlands. That change decreased the EPL index from 1.91 to 1.88.

There are several alternatives to the EPL index. First, there is the index compiled by Botero, Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2004) that measures labor protection in 85 countries. This index, however, is available only for 1997. Second, there is the labor law index calculated by Deakin, Lele, and Siems (2007), which reflects the evolution of EPL across

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[2] This paragraph is based on OECD (2013).

[3] We exclude the years 2011-2013 for lack of data.

[4] The list is derived from Bertola, Boeri, and Cazes (1999), OECD (2004) and (2013), Subramanian and Megginson (2012), and Venn (2009).

[5] From: www.eurofound.europa.eu

countries from 1970 to 2005. This *Deakin index* decomposes labor laws into the following five components: alternative employment contracts, work time regulation, dismissal regulation, employee representation, and industrial action. Moreover, it "takes into account not just the formal or positive law but also the self-regulatory mechanisms that play a functionally similar role to laws in certain countries" (ABS, 2012). We work with this index of EPL as well. The index is available for only five countries: the US, the UK, France, Germany, and India. These countries, however, account for 70% of the patents filed with the United States Patent and Trademark Office during 1970-2006. Since reliable age data for India are difficult to obtain, we limit our attention to the other four countries. All the variables related to employment protection are defined in panel A of Table 16.

2.2. Performance, innovation measures, and control variables

We use four alternative performance measures: *Tobin's Q*, *Sales growth*, *ROA*, and *SGA-to-sales*. Most performance tests involve *Tobin's Q*. Innovation is measured with *Number of patents* (actually, patent applications) and *Number of patents per million population* at the country-level, and *R&D expenditures* at the firm-level. Since we want to investigate the impact of EPL on innovation effort, R&D expenditures is probably the more appropriate innovation variable. Patent filings do not necessarily capture changes in innovation effort. Moreover, not all innovations are patented. In some cases, firms might be unable to or might prefer not to file for patent protection. All these variables are defined in panel C of Table 16.

The control variables in the regression analysis we perform include return on assets, capital expenditures, cross-listings, the degree of specialization, financial flexibility, leverage, firm size, and volatility. These firm-level variables are defined in panel D of Table 16. The data source is *Worldscope*. In the analysis of firm performance, we also include a number of time-varying country-level control variables that could simultaneously affect Tobin's Q ratios and the changes in EPL. First, as suggested by ABS (2012) and Saint-Paul (2002), low economic growth compromises growth opportunities and increases the political support for employment protection. To control for this possibility, we include real *Per-capita GDP growth* in the analysis. Second, as suggested by Subramanian and Megginson (2012), trade liberalization may boost Tobin's Q and at the same time induce governments to enact stringent EPL following trade liberalization to offset the associated job losses. To control for this effect, we include the country-level aggregate of imports and exports (*Trade openness*) as a proxy for trade reforms. A third concern is that changes in EPL as well as growth opportunities could be correlated with government changes. As documented by Botero et al. (2004), left-leaning governments tend to have more stringent labor laws. At the same time, the laws likely affect a given country's growth opportunities. We therefore include the *Government orientation* index from Armingeon et al. (2012), which captures the balance of power between left and right-leaning parties in a given country's parliament. Fourth, increases in unemployment insurance benefits could correlate with changes in EPL and at the same time affect the growth opportunities of firms in the economy. Since this effect could also bias the results, we control for the annual expenditures for *Labor market programs* in a given country. Finally, in more unionized countries, employees exert considerable political pressure to legislate employment protection. At the same time, poorly performing managers are more likely to retain their jobs when unions are strong (Atanassov and Kim, 2009). Therefore, the regression arguments include the degree of unionization in a given country, as measured by the annual *Fraction of union members* among wage and salary earners. Finally, for robustness tests, we also use measures of bankruptcy codes (*Creditor rights),* financial development (*Stock market in % of GDP*), and education data (*Tertiary enrolment*). All country-level variables are defined in panel E of Table 16 along with their data sources.

2.3. Sample composition and descriptive statistics

The sample contains all the countries included in the OECD EPL indicators in 1985-2010 that host one of the 30 largest stock markets in the world according to the World Federation of Exchanges (December 2010). As an exception, we also include South Korea, even though it is present in the EPL indicators only from 1993 onward. For the resulting set of 17 countries, we gather firm-specific data from *Worldscope*. To ensure comparable fiscal years, we ignore all firm-years which do not last between 361 and 371 days. We disregard all financial firms (SIC 6) and regulated utilities (SIC 49). We also exclude all firm-years with missing or negative assets, sales, market values of equity, and book values of equity. Finally, we ignore all firms younger than 5 years, since these firms might have special characteristics and therefore not be representative (LSW, 2014). This omission, however, does not alter our conclusions.

Across all years, the final sample contains 30,665 firms and 278,546 firm-years. During the sample period the coverage increases from 3,741 firms in 1985 to 14,934 firms in 2010. This increase is not uniform over time. The number of firms covered increases sharply by an annual 10 percent prior to 1995, on average. Thereafter, the annual increase is only 3 percent. Leaving out the first ten sample years in the analysis, however, yields consistent results.

To reduce the influence of outliers, we winsorize all firm-level variables at the 1st and the 99th percentile of their pooled distribution at the country-level. To limit skewness, we take the log of firm age, firm size, tertiary enrolment, and trade openness. Panel A of Table 3 shows descriptive statistics about the listing age of firms in the overall sample and across countries. Overall, the median listing age is 15 years. The variation is substantial. The oldest companies are in Japan, with a median value of 29, and the youngest are in Switzerland, with a median age of 9. For comparison, the panel also reports data about incorporation age. The median incorporation age in the overall sample is 29 years. Incorporation and listing age are positively correlated, but not perfectly so. For example, Switzerland has the oldest firms in terms of incorporation age (77 years) but the youngest ones, as we have seen, in terms of listing age. In the analysis, age is measured with listing age. The results, however, are very similar when using incorporation age. Panel B reports median values for the variables used as dependent variables in the subsequent regression analysis.

3. Employment protection and innovation

3.1. General findings

This section asks how employment protection affects innovation. ABS (2012) and (2013) report that employment protection spurs innovation, as measured by number of patents filed and number of patent citations. ABS (2012) investigate the U.S., the U.K., France, and Germany. Table 4 performs panel regressions of innovation against determining factors in the 17 countries included in our sample. Innovation is measured alternatively with number of patents filed in column (1), number of patents per million population in column (2), and R&D-to-sales in columns (3) and (4). Employment protection is measured with the binary variable *bHigh EPL,* which equals 1 if the EPL index is above the cross-sectional median value of the EPL index in any given year, and zero otherwise.

The staggered passage of changes in EPL across countries enables us to identify the effect of changes in EPL using a difference-in-differences approach. To that end, we estimate panel regressions with year and country fixed-effects. The country fixed-effects control for all time-invariant unobserved factors at the country-level, such as other laws and institutions, the country's legal origin (Botero, et al. (2004)), rule of law, anti-director rights index, efficiency of the judicial system, days to enforce a contract, and estimated cost of insolvency proceedings, (La

Porta, et al., (1997) and (1998)). The year fixed-effects control for time-related unobserved variables. All regressions are estimated with robust standard errors.

Columns (1) and (2) show that higher EPL values correlate with a larger number of patents at a country level, a finding that is consistent with ABS (2012 and 2013). The availability of firm-level *R&D expenditures* data enables us a finer granularity of innovation at the firm level in columns (3) and (4). There, the regression specification contains the set of control variables mentioned in the data section, including firm age, which we measure with the demeaned natural logarithm of the firm's listing age (*Age*). These regressions include industry fixed effects based on Fama and French's (1997) 48 industry grouping, and an indicator variable for R&D non-disclosure. Robust standard errors are clustered at the firm-level. According to the results in column (3), the relation between EPL and innovation is statistically essentially zero. The same results obtain when we add a squared term of EPL to assess possible nonlinearities in the relation (not shown). Note that the coefficient of the demeaned value of company age is negative and significant. Older firms tend to engage less in R&D activities, a result that Loderer, Stulz, and Waelchli (2014) observe in the U.S. When we add an interaction variable of *bHigh EPL* with the demeaned value of firm age, the EPL-related results change. EPL per se has a negative and significant coefficient, whereas the interaction term has a positive and highly significant coefficient (column 4). This means that EPL tends to depress innovation efforts in young firms. In contrast, in mature firms, the effect is increasingly positive. Age maintains a negative and significant coefficient. Hence, EPL appears to slow down the negative impact of age on innovation efforts. When we repeat the analysis in Table 4 for firms that report R&D data, this result is even stronger (not shown). A formal test shows that higher levels of EPL completely offset the age effect, on average.

3.2. EPL in innovation-intensive and other industries

If EPL has an impact on innovation efforts in mature firms, this phenomenon should be particularly pronounced in high innovation industries. In ABS (2013), the benefits from undertaking an innovative project in reaction to stricter legal employment protection is larger than that from undertaking a routine project. Consistent with this prediction, they find that the impact of changes in EPL on innovation is in fact stronger in innovative industries than in traditional industries. We perform a similar test and split the sample into a high and low innovation subsample. Table 5 replicates the analysis of column (4) of the preceding table, our standard regression specification, for these two subsamples. To sort industries into high vs. low innovation environments, we use information from the U.S., the largest economy in the world.[6] Since industries worldwide share technological commonalities, the relative distribution of innovation intensity across U.S. industries should be representative for other countries as well. We therefore compute the mean R&D-to-sales ratio in each 3-digit SIC industry over the full sample period in the U.S. Using Fama and French's (1997) 48 industry classification yields similar results. High innovation industries are those with an above median R&D-to-sales ratio in the U.S., and low innovation industries are those with a below median R&D-to-sales ratio in that country. For example, a German firm operating in the textiles industry is classified into the low innovation subsample because the U.S. textiles industry's mean R&D-to-sales ratio is below the typical R&D-to-sales ratio across all U.S. industries.

The results show that employment protection per se has little if any effect on R&D effort. As before, the effect can only be observed in combination with age. The coefficient of the interaction term between demeaned ln(*Age*) and demeaned *EPL index* is always positive and

[6] Klapper, Laeven, and Rajan (2006), Acharya and Subramanian (2009), Acharya, Baghai, and Subramanian (2012), and Alimov (2013), among others, also create industry-level innovation intensity measures in cross-country settings using U.S. data.

statistically significant with confidence of at least 0.9. As predicted, the effect is more than ten times stronger in innovation intensive industries. As noted in Table 4 before, age per se seems to discourage innovation efforts. This effect is also much stronger in innovation intensive industries. However, unlike what we noted in Table 4, EPL is unable to completely offset this aging effect. Older firms engage in significantly less R&D activities even in countries with high legal protection of employees.

3.3. The relevance of ownership of intellectual property

To further assess the influence of EPL on innovation efforts, we distinguish between countries that grant ownership of intellectual property to the employer vs. countries that grant it to the inventor instead. If EPL encourages innovation because it reduces the potential for holdup by employers, this effect should be stronger in countries in which the employer is entitled to the results of innovation effort. In these countries, the employer can credibly threaten holdup to appropriate the rents from the employee's effort. In countries where that is not the case, the employee can simply walk away and take the intellectual property with him. We therefore test the proposition that EPL has a stronger impact on innovation efforts in countries in which the employer owns the intellectual property produced in the firm, particularly if the latter is more mature and consequently more attentive to innovation.

OECD (2008) provides information about the ultimate ownership of intellectual property at the country-level. It classifies patent ownership into five categories, distinguishing between private businesses, individuals, governments, universities, and hospitals or private non-profit organizations. The data show that, in 2005, 80 percent of patents were owned by private businesses, on average. The cross-country variation in that percentage during the period in question is considerable. It ranges from 52 percent in Spain to 93 percent in Finland.

To test our proposition, we partition the sample into two subsamples according to the median country-level fraction of employer-ownership of patents in 2005 and then re-run the difference-in-differences regressions for each subsample, using our standard regression specification. The results are in Table 6. For space limitations, the table reports only the coefficients associated with firm age, the value of the *EPL index*, and the product of the two. For ease of interpretation, we measure company age with the binary variable *bOldfirm*. The results go through, however, also when measuring it with *ln(Age)*. Firms that operate in countries where employers own an above (below) median fraction of patents are classified into the Employer (Inventor) ownership subsample.

We find that in countries where relatively more employers own the intellectual property of their innovating employees (subsample *Employer*), the impact of changes in EPL is significantly stronger than in the subsample where employers enjoy weaker intellectual property rights (subsample *Inventor*). This effect, however, is confined to mature firms. Specifically, the coefficient of EPL is statistically zero, while that of the interaction between *EPL index* and the demeaned value of *bOldfirm* is positive and statistically significant. Moreover, and as predicted, that coefficient has a larger magnitude and higher levels of significance in the *Employer* subsample. As an alternative to the OECD patent measure, we also used the classification in Wolk (2008) to attribute countries to a subsample of patent ownership (not shown). The results were similar.

3.4. Alternative EPL indices and index components

As mentioned above, the EPL index is not the only measure of international labor protection. An alternative index is the one compiled by Deakin, Lele, and Siems (2007) for the US, the UK, France, Germany, and India for the years 1970-2005. We therefore reestimate our standard regression specification with this index, leaving out, for lack of data, India. We expect results similar to those in Table 4. The evidence in column (1) of the first panel of Table 7 is consistent with this prediction. Employment protection has little impact on R&D efforts, except in mature firms. In those firms, the effect is strong enough to more than offset the negative influence of age at high enough levels of EPL.

In columns (2) and (3) of the table, we distinguish between regular (*EPLR*) and temporary contracts (*EPLT*). The effect of employment protection on R&D activities should be felt more significantly in the context of regular contracts, simply because temporary contracts expire and a finite horizon decreases the employees' incentives to be innovative. The evidence is consistent with this prediction. The results show that, in the context of regular contracts, EPL actually has a negative impact on young firms. In contrast, even at the fairly low index levels of 1.1, EPL has the predicted boosting effect in mature firms. In the context of temporary contracts, EPL has little if any effect on innovation efforts in young firms. In mature firms, the effect is positive and significant. As predicted, however, the effect of EPL is significantly more pronounced in the context of regular contracts than in that of temporary contracts.

3.5. Nonlinearities

Bradley, Kim, and Tian (2013) argue that the relation between employee protection and firm innovation is probably inverted U-shaped. According to that argument, increasing labor protection provides job insurance against failure risk from innovative investment projects and therefore spurs innovation, as reported in ABS (2013). Too much employee protection, however, stifles innovation. Their evidence shows that employee protection via unionization does discourage innovation.

Column (4) in Table 7 investigates the existence of an inverted U-shaped relation between EPL and R&D expenditures. The regression specification is the standard one except for the addition of the squared value of *EPL index* and of the interaction of that squared term with *bOldfirm*. According to the estimates, employee protection per se has little impact on R&D expenditures. As observed before, however, that protection has a statistically significant impact in mature firms. To examine the shape of that impact in young vs. mature firms, Panel B of the table uses the estimated regression coefficients to plot the predicted R&D expenditures as a function of EPL. We find little evidence of concavities in that relation. Over the range of EPL observed in the sample, the relation is actually almost linear in mature firms and U-shaped in young firms. Except for comparatively low levels of EPL, stricter employment protection legislation encourages innovation effort. Moreover, as observed before, the effect is much stronger in mature firms regardless of how stringent EPL is.

3.6. Innovation, business risk, and hedging

According to ABS (2012), laws that prevent employers from arbitrarily discharging employees spur firm-level innovation and therefore encourage firms to invest in risky, but potentially mold breaking projects. Consistent with that, they report that dismissal laws increase the standard deviation of patent citations, their proxy for the risk of innovative projects. We investigate the existence of a similar pattern by examining the impact of EPL on the volatility of monthly stock returns. Higher innovation should that volatility.

To test this prediction, we estimate our standard regression specification using *Volatility* as the dependent variable. The results in Table 8 indicate that EPL is in fact associated with higher stock return volatility (column (1)) both in young and in mature firms. Consistent with our preceding findings, the innovation boost from EPL is more pronounced in older firms. Hence, the evidence is consistent with the prediction that, by stimulating innovation, EPL induces firms to take riskier projects–or at least this is what investors believe. Note that age per se has a negative relation with volatility, in line with LSW (2014) and Pastor and Veronesi (2003).

Higher risk brings about random fluctuations that could be detrimental to the firm. We therefore inquired whether EPL is also associated with higher cash holdings for precautionary reasons. The investigation replicates the one of volatility by simply replacing that variable with the firm's cash holdings (as a proportion of total assets) as the dependent variable. Because of space restrictions, the results are not reported in a separate table. They are consistent with the proposition that EPL induces firms to hold higher cash balances, particularly in the case of mature firms. The effect is inverted U-shaped. Within the interquartile range of EPL values observed in the sample, however, higher levels of EPL are always associated with larger cash holdings. At the lower end of that range, the holdings are about 15 percent of total assets, compared with 19 percent at the higher end.

4. Employment protection and growth opportunities

Established firms focus on their core abilities and their assets in place, and optimally dedicate comparatively less attention to growth opportunities. Over time, their profitability, margins, and growth opportunities decline (Loderer, Stulz, and Wälchli, 2014). EPL should change the allocation of managerial capacity at the margin. By making innovation more attractive, it should induce, as we have seen, more active innovation in mature firms. This should slow down the observed decline in Q over time. What follows tests that prediction.

4.1. International evidence of a decline of Tobin's Q ratios as firms get older

We begin by documenting the phenomenon of an age related decline in Tobin's Q ratios across countries. Table 9 computes the association between *Tobin's Q* and company age in the overall sample and in each individual country, separately. For each one of these countries, we regress Tobin's Q ratios against company age and the following control variables: *ln(Age)*, *ROA*, *Capex*, *bADR*, *bFocus*, *FF-index*, *Leverage*, *Size*, and *Volatility*. To conserve space, the table reports only age coefficients. As one can see, all but one coefficient are negative and 31 out of the 36 are statistically significant. Consequently, Tobin's Q ratios decrease as firms grow older, a phenomenon that LSW (2014) document for the U.S. and Zeller (2014) confirms in an international context.[7] Having assessed that EPL seems to boost innovation in older firms, we test whether it also tempers the negative age dependence of Q.

4.2. Employment protection and Tobin's Q ratios

To measure the impact of changes in EPL on Q, we estimate panel regressions with interaction terms of *EPL index* with firm age, using the same difference-in-differences test design used in the analysis of innovation. All panel regressions therefore include country, year, and industry fixed-effects. We use the standard regression specification. The coefficient of EPL and the coefficient of the interaction between EPL and company age estimate the difference-in-differences effect of employment protection in a generalized multiple treatment groups, multiple time periods setting (see also ABS (2012)).

[7] It could be that countries with high levels of employment protection could have higher average Q ratios for reasons unrelated to the ones investigated here. If so, and assuming that Tobin's Q ratios converge towards 1, on average, it would not be surprising to observe a stronger age-related decline of Q in these countries. The results remain unchanged, however, when we replicate the analysis with standardized Tobin's Q ratios. To standardize, we demean each observation of Tobin's Q with the industry's average and then divide the difference by the industry's standard deviation.

Table 10 shows the results. Column (1) reports the results of a regression of Tobin's Q on *ln(Age)*, *EPL index*, an interaction term of demeaned *EPL index* and demeaned *ln(Age)*, and the control variables of our standard regression specification. Colum (2) computes the same regression but replaces *ln(Age)* with the binary measure of age, *bOldfirm*.

In both regression specifications, the coefficient of *EPL index* is negative but statistically insignificantly different from zero across specifications at customary levels of significance. In contrast, the coefficient of company age is negative and statistically significant with confidence better than 0.99. Moreover, the coefficient of the interaction term between company age and the EPL index is positive and statistically significant, which suggests that an increase in EPL affects mature firms and makes the Tobin's Q-age relation flatter. This result is robust to the age proxy we use (natural logarithm or binary). Moreover, it does not change when we exclude U.S. firms from the sample. Unreported results also show robustness to clustering of the standard errors at the country- rather than the firm-level.

Economically, the magnitude of the coefficient of the interaction term generally amounts to one third of the coefficient of *ln(Age)*. Hence, a change by one unit in the *EPL index* leads to a reduction in the age effect by around one third. The average EPL change equals 0.21, and the standard deviation of those changes is 0.26. Although large, a change by one unit in the index is not uncommon. EPL reforms with that impact occurred in Germany (1985), Spain (1994), Denmark (1995), Belgium (1997), and South Korea (1998).

Despite the fact that all time-invariant unobserved factors at the industry-, year-, and country-level are controlled for by our fixed-effects approach, time-variant unobserved factors that are simultaneously correlated with the changes in EPL present an endogeneity problem. To address this difficulty, we expand the standard regression specification by including the time-varying country-level variables listed in Section 2.2 above. These variables might have an impact on both, Tobin's Q and EPL. Regressions 3 and 4 in Table 10 replicate the specifications in the first two columns with the addition of these time-varying country-level controls. Only *Per-capita GDP growth* has a coefficient that is marginally different from zero, although only at the 0.10 confidence level. More important, a comparison between columns (3) and (1), and (4) and (2), respectively, reveals that the addition of these control variables leaves the coefficients of age and those of the interaction term between EPL and age unaffected.

In separate, unreported tests, we also controlled for financial development, which could boost innovation (Aghion and Howitt (1992)) and correlate with more liberal labor markets. However, when we add the ratio of stock market capitalization to GDP as a proxy for financial development, the results remain the same. We come to the same conclusion when controlling for a country's intellectual resources as measured by the enrollment in institutions of higher education. The level of education could correlate both with the ability to innovate and with employment protection policies.

Overall, we therefore find that EPL encourages R&D in mature firms and that it slows down the age-related decrease in Q. The question we want to pursue in the rest of the paper is whether these two effects are related. Does EPL mitigate the age-related decline in Q ratios because, at the margin, it brings about more innovation? To test this proposition, we examine first whether the situations in which we observe a boost in R&D effort are also situations in which Q ratios go up.

4.3. EPL and Tobin's Q in innovation-intensive vs. innovation-weak industries

In analogy with Table 5, we therefore begin by splitting the sample into two by degree of industry-level innovation intensity. We saw that changes in EPL animate mature firms to make a stronger innovation effort in innovation-intensive industries. We want to test whether these changes also revive the growth opportunities of mature firms. We therefore reestimated the regression specification in Table 10 for each subsample separately. For ease of interpretation, we relied on the binary measure of firm age, *bOldfirm*, and therefore focused on the specification in column (4) of that Table. The conclusions were the same when measuring firm age with *ln(Age).*

The results showed that the age-sensitivity of Q is more than twice as pronounced in innovative industries than in other industries (not shown in a separate table). More important, for our purposes, EPL appeared to slow down that effect in mature firms, as the coefficient of the interaction term between EPL and age was positive and significant (the coefficient of EPL alone was statistically zero). This held regardless of whether we used the Fama-French or the 3-digit SIC industry classification. However, and in contradiction with our prediction and the evidence concerning R&D expenses in Table 5, a formal test was unable to reject equality of the interaction coefficients across industries.

4.4. The relevance of ownership of intellectual property

In the second test of whether increased R&D effort is responsible for the impact of changes in EPL on the age-sensitivity of Tobin's Q ratios, we sort firms by ownership of intellectual property as we did in Table 6. There, we saw that EPL has a stronger impact on innovation efforts in countries in which the employer owns the intellectual property produced in the firm—at least in mature firms. Consequently, it should follow that EPL has a stronger effect on Q in the mature firms of those countries.

We partition the sample into two according to the median country-level fraction of employer-ownership of patents in 2005 and then re-run the difference-in-differences regressions for each subsample, separately. The regression specification is again the one in column (4) of Table 10.

According to Table 11, the coefficient of EPL alone is statistically marginal at best. However, in countries where patents tend to belong to the employer (subsample *Employer*), the coefficient of the interaction term of *EPL index* with *bOldfirm* is positive and significant. Hence, as in the case of R&D, the effect of EPL is confined to mature firms. In contrast, in the subsample where patents tend to belong to the inventor (subsample *Inventor*), the coefficient of that interaction term is statistically zero. The difference between the coefficients of the interaction term in the two subsamples is statistically significant in a t-test with unequal variances. We therefore conclude that mature firms in countries in which the employer tends to have the intellectual property rights experience both an increase in innovation activities and a boost to growth opportunities in reaction to EPL.

4.5. Alternative EPL indices and index components

In our third test, we replicate the analysis of Table 7 and inquire into whether the impact of EPL on the age dependence of Q also holds when we use the Deakin index of employment protection, and whether the effect is stronger in the case of regular, as opposed to temporary, employment contracts. The results are in Table 12. Column 1 shows that, when we replace the OECD index of EPL with the Deakin index, the results are similar to what we found in Table 7, but statistically much weaker. In particular, unlike in the case of R&D expenditures, EPL has little marginal effect on the Q of mature firms. If anything, it depresses Q in all firms, regardless of age. Columns 2 and 3 then compare regular and temporary contracts. Here, the evidence is a bit more similar to what we observed for R&D expenses. The effect of EPL on Q is positive, but there is no difference in that respect between regular and temporary contracts.

4.6. Nonlinearities

Finally, we investigate the existence of nonlinearities. In the case of R&D effort, we found that EPL has a positive and almost linear effect in mature firms (Table 7). In contrast, in young firms, the effect is U-shaped and negative except for higher levels of EPL. We would expect the effect of EPL on Q to reproduce that on R&D expenses. Column (4) in Table 12 performs that analysis. To interpret the results, Panel B of the table uses the estimated coefficients to plot the relation between EPL and Q. As one can see, the results are quite different. First, EPL per se has now a negative, U-shaped relation with Q regardless of firm age.[8] The effect flattens out but never reverts to positive for the EPL levels observed in the sample. We will discuss the possible interpretation of this finding further down. Second, when interacted with company age, EPL has a positive and concave impact on Q. Given the values of the EPL index observed in the sample, this marginal effect of age is always positive, but not enough to offset the negative effect of EPL alone. Graphically, this means that the decline in Q as a function of EPL is less extreme in mature firms.

5. Does innovation intermediate the effect of EPL on Q?

The evidence so far shows that EPL encourages R&D in mature firms. At the same time, it seems to slow down the decrease in Q that firms experience over time. The two effects could be related, since the impact of EPL on Q mimics, although only in part, its impact on R&D. For a formal test, we could control for R&D in our standard Q regressions. If R&D mediated the effect of EPL on Q, this should cause the size and significance of the coefficient of the interaction term between EPL and age to disappear. When we estimate this regression specification, the

[8] Using data from 17 OECD countries, Belot, Boone, and van Ours (2007) report an inverse U-shaped relation between EPL and economic growth.

coefficient of *EPL index * ln(Age)* does decline, even though only very imperceptibly, from 0.049 in column 3 of Table 10 to 0.046 in column 1 of Table 13. The problem with this approach of testing whether R&D expenditures intermediate the effect of EPL on Q is endogeneity. R&D affects the firm's future cash flows and therefore, if unexpected, it should have an impact on Q. At the same time, Q is a proxy for the firm's investment opportunities and is therefore a determinant of R&D. To get around this problem of reverse causality, we instrument R&D with the financial flexibility index, *FF*, proposed by Doidge, Karolyi, and Stulz (2009). The rationale is that financial flexibility affects R&D expenditures. Financial flexibility, however, satisfies the exclusion restriction, since it should not affect Q directly. Hence, *FF* affects R&D but does not belong in the Q regression. The results from estimating this regression model are in columns 2 and 3 of Table 13.

The first stage regression shows that the FF-index has indeed a significant effect on R&D expenses: more financial flexibility is associated with larger R&D expenses. The second stage regression shows that the instrumented R&D expenditures have little if any effect on Q, a result that we interpret as showing that annual R&D expenditures, a measure of research effort, provide little information to investors about value creation. A Wu-Hausman test rejects the hypothesis of endogeneity of R&D expenditures. Overall, we find little if any evidence that R&D expenditures mediate the effect of EPL on Q. That effect must work through other channels than R&D. Equally importantly, the second-stage results also show that EPL has a negative and significant relation with Q, while the interaction term of EPL and company age maintains its positive and significant coefficient.

What follows investigates possible reasons why EPL has an adverse impact on Q, and why that impact is more pronounced in young firms than in mature ones.

6. The economics of the impact of EPL on Q

We entertain two possible reasons. First, it could be that EPL is a proxy for product market regulation, and that market regulation is harmful, but less so to mature firms because it shields them from new entrants. Second, EPL could impose costs on all firms but also persuade employees to invest in firm-specific human capital in mature firms. What follows discusses these three interpretations.

6.1. Product market regulation

Under the first hypothesis, EPL is a proxy for other government regulation. As it turns out, EPL is highly correlated with product market regulation (PMR) across OECD countries (Nicoletti, Haffner, Nickell, Scarpetta, and Zoega (2001)). This positive correlation could come about because, according to Koeniger and Vindigni (2003)), employment protection imposes costs on firms, and product market regulation is designed to help them bear those costs.[9] Product market regulation, however, has an asymmetric impact on firms, because it tends to protect incumbent firms against new entrants. This could explain why EPL per se reduces the Q of young firms much more than that of mature firms. To test this interpretation of the evidence, we use data on indicators of product market regulation that the OECD has published (PMR) in 34 OECD countries in four different years (1998, 2003, 2008, and 2013). These indicators measure the degree to which public policies promote or inhibit product market competition. This regulation includes state controls (public ownership and public involvement in business operations, such as price controls); barriers to entrepreneurship (licenses and permits, and administrative burdens); and barriers to trade and investment (for example, tariffs). We then

[9] Another possibility that Koeniger and Vindigni (2003) offer is that product market regulation decreases employment and makes workers' outside options relatively worse, which could induce them to ask for employment protection.

reestimate the regression specification in column (4) of Table 12 with the addition of the demeaned value of the OECD PMR index. We restrict the regression equation to the years for which PMR data are available. This reduces the sample size from 178,810 to only 29,298 observations. Alternatively, to avoid losing so many observations, we estimate the regression under the assumption that PMR did not change in the years between the four years for which we have OECD data. The sample size in that case goes up to 136,111. The results are in Table 14.

To save space, we report regression coefficients only for company age, EPL and PMR index values, and the interaction term between EPL index and company age. To make sure the four years with PMR data are not special, we first replicate the regression specification of column (3) in Table 10. The results, which we report in column (1) of Table 14, are similar, in the sense that the coefficient of age is negative and significant, that of EPL is statistically zero, and that of the interaction between EPL and company age is positive and significant. Moreover, at least in the case of the age-related variables, the coefficients are numerically similar (in the case of the interaction term, they are almost identical). We reach the same conclusions when we include all sample years (column (3)). Hence, there is little reason to believe that the years investigated in Table 14 are unusual.

We then add the PMR index to the regression specification. When we do so, the age-related coefficients, in particular the one related to the interaction term between firm age and EPL, remain almost identical (columns (2) and (4)), whereas the coefficient of EPL alone becomes negative and marginally significant. PMR has a positive and significant coefficient, especially for the years for which we have data. Product market regulation seems to benefit existing firms. However, it cannot explain why the coefficient of EPL alone is nonpositive and why the interaction term of EPL and company age has a positive coefficient.

6.2. Firm-specific human capital

What could be happening is that EPL imposes higher labor costs on all firms while at the same time encouraging the employees of mature firms to increase their investment in firm-specific human capital. Firm-specific human capital is skills and knowledge that are idiosyncratic to the employing firm (Becker, 1962) or only relevant in a particular composition to the firm (Lazear, 2009). It includes things such as relationships with clients or shop floor staff and knowledge of how the firm operates (Prendergast, 1993), and is not transferable to other firms. The moral hazard logic of the ABS model applies to the investment in firm-specific human capital as well. EPL protects the employee against holdup by the employer who could otherwise threaten dismissal to appropriate the rents generated by the employee’s know-how. EPL raises for the employee the net present value from investing in firm-specific human capital. If we assume that human capital is less firm-specific in younger companies because they are still deciding what they want to do, then the problem of appropriable quasi-rents in these firms will be less extreme. If so, the effect of EPL on this type of investment should be felt more strongly in mature firms.

We cannot measure investments in firm-specific human capital directly. However, if the hypothesis is correct and EPL does encourage investment in firm-specific human capital in mature firms, we would expect stronger growth, lower costs, and improved profitability there.

To test this prediction, we replace Tobin’s Q as the dependent variable in the regression of Column (4) of Table 12 with the variables *Sales growth, Gross margin,* and *SGA-to-Sales*. The results are in Table 15.

As predicted, EPL does affect performance. EPL appears to boost sales, but only in mature firms. This is consistent with the above findings that EPL stimulates R&D effort in mature firms.

In contrast, however, EPL has an adverse effect on profitability and costs. This effect is significant in young firms, but it gets compounded in mature firms.

Consequently, the evidence is consistent with the prediction that EPL sparks effort in both current production and innovation in mature firms. This is consistent with an increased identification with the firm and an increased willingness to invest in firm-specific human capital. At the same time, however, EPL also increases the operating costs of firms, particularly in mature firms. This effect dominates the increased incentives to invest in firm-specific human capital and leads to lower Q across age categories.

The reason why the costs of mature firms are more affected by EPL than young firms are could be the characteristics that make mature firms less flexible to changes in their business environment. As discussed in Loderer, Stulz, and Waelchli (2014), mature firms, because of their optimal focus and specialization on assets in place, have less flexible cost structures, more rigid product portfolios, and more rigid organizations. They are therefore comparatively less able to cope with the business implications of stricter EPL. Their costs increase more and their profitability declines more.

7. Conclusion

The academic literature has shown an increasing interest in the relation between labor market institutions and productivity (e.g. Atanassov and Kim, 2009; Bassanini, et. al., 2009; Wasmer, 2006). These papers generally find that rigid labor market regulations hamper the reallocation of resources, and thus hinder growth (e.g. Lazear, 1990; Botero et al., 2004). Also intergovernmental organizations, such as OECD and the IMF, regularly urge countries in Europe to relax their labor market regulations to stimulate economic growth. Our evidence is consistent with these efforts.

We rely on a large panel of seventeen countries over a period of twenty-five years to study the effect of the staggered passage of changes in employment protection legislation on innovation and firm value. We employ a difference-in-differences identification strategy for multiple treatment groups and multiple time periods. The evidence suggests that employment protection encourages innovative efforts and sales growth, although mainly in mature firms, where the potential conflict about the rents created by employees is more significant. EPL, however, also increases costs in both young and established firms. The net effect is to penalize Q, particularly in young firms.

Figure 1: Evolution of the employment protection legislation index by OECD

The figure shows the evolution of the level of employment protection in a country as measured by the OECD composite index of employment protection legislation (*EPL index*). The level of the *EPL index* is shown on the vertical axis and the horizontal axis displays time, respectively. The sample period is 1985 – 2010.

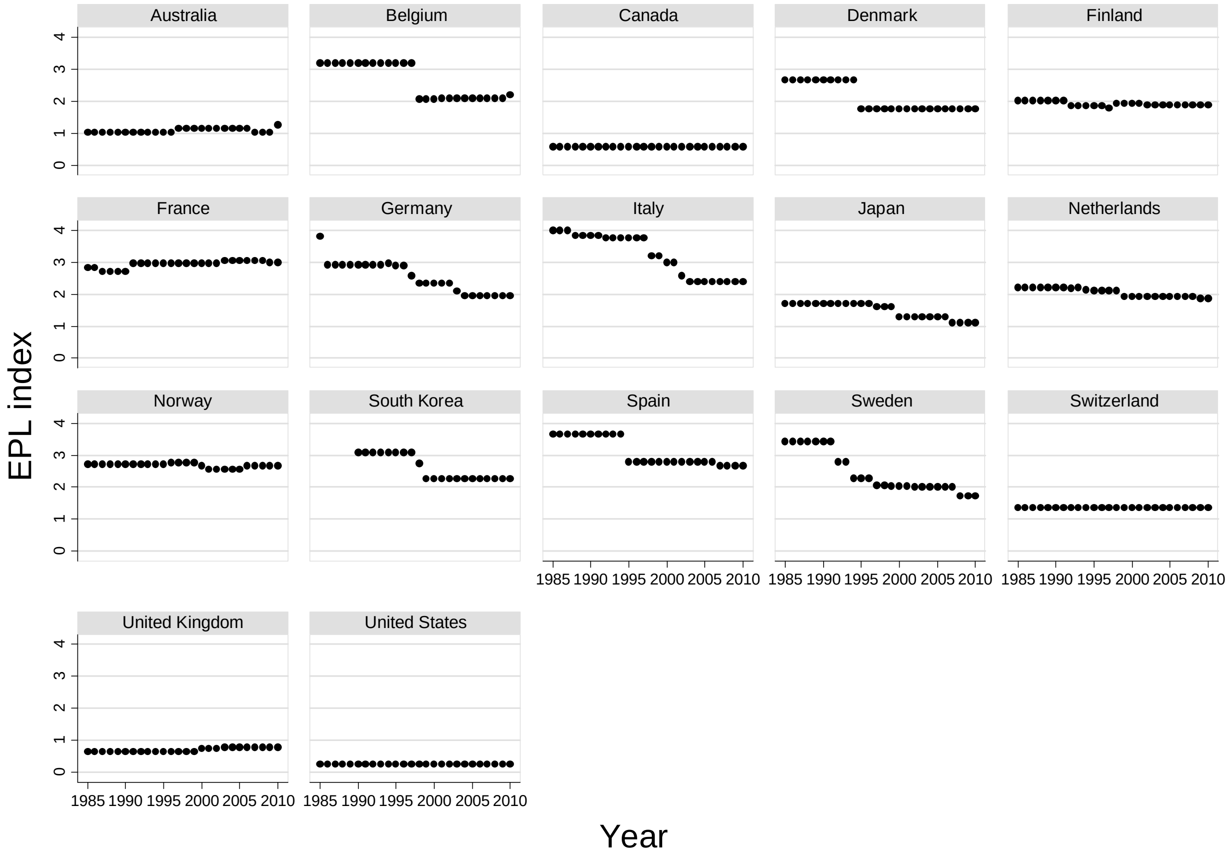

Table 1: Employment protection summary indicator weights

The table shows the composition of the OECD composite index of employment protection legislation (*EPL index*). The scale is between 0 and 6. The grey shaded components of the index are used throughout the analysis. Source: Venn (2009).

<table>
<tr><th>Level 1</th><th>Level 2: sub-indices</th><th>Level 3: components</th><th>Level 4: items</th></tr>
<tr><td rowspan="6">Overall summary indicator</td><td rowspan="3">Regular contracts
Version 1: (1/2)
Version 2: (5/12)</td><td>Procedural inconveniences (1/3)</td><td>1. Notification procedures (1/2)
2. Delay to start a notice (1/2)</td></tr>
<tr><td>Notice and severance pay for no-fault individual dismissals (1/3)</td><td>3. Notice period after: 9 months (1/7); 4 years (1/7); 20 years (1/7)
4. Severance pay after: 9 months (4/21); 4 years (4/21); 20 years (4/21)</td></tr>
<tr><td>Difficulty of dismissal (1/3)</td><td>5. Definition of unfair dismissal (1/4)
6. Trial period (1/4)
7. Compensation (1/4)
8. Reinstatement (1/4)</td></tr>
<tr><td rowspan="2">Temporary contracts
Version 1: (1/2)
Version 2: (5/12)</td><td>Fixed-term contracts (1/2)</td><td>9. Valid cases for use of fixed-term contracts (1/2)
10. Maximum number of successive contracts (1/4)
11. Maximum cumulated duration (1/4)</td></tr>
<tr><td>Temporary work agency employment (1/2)</td><td>12. Types of work for which is legal (1/2)
13. Restrictions on number of renewals (1/4)
14. Maximum cumulated duration (1/4)</td></tr>
<tr><td colspan="2">Collective dismissals
Version 1: (0)
Version 2: (2/12)</td><td>15. Definition of collective dismissal (1/4)
16. Additional notification requirements (1/4)
17. Additional delays involved (1/4)
18. Other special costs to employers (1/4)</td></tr>
</table>

Table 2: Changes in employment protection legislation

The table lists the major changes in employment protection legislation regulation which caused a change in the level of the *EPL index* in the sample countries. The list is derived from the changes described in Bertola, Boeri, and Cazes (1999), OECD (2004) and (2013), Subramanian and Megginson (2012), and Venn (2009). The gray (white) shaded changes in the last column concern the EPL component for regular (temporary) contracts (*EPLR* and *EPLT*). The hatched areas refer to both types of contracts.

Country	Year	*Changes*	EPL
Australia	1996	*Workplace Relations Act 1996 restricted the scope of the unfair dismissals provisions. Employees were encouraged to push out of award regulation into a sphere of single-employer bargaining.*	+ 0.13
	2007	*Work Relations Amendment Act dispensed with unfair dismissal laws for companies under workers and for all companies, where dismissal is for a bona fide reason.*	– 0.13
	2009	*Adoption of the Fair Work Act.46 which introduced a new provision preventing employers from dismissing a worker on the basis of redundancy without first considering opportunities for redeployment within the company or an associated entity of the company. Moreover, the size threshold was reduced from 100 to 15 workers.*	+ 0.25
Belgium	1997	*Restrictions on temporary work agencies were reduced and fixed-term contracts were made renewable.*	– 1.13
	2000	*Tightening of rule concerning notice period and compensation in case of unjustified dismissal for blue-collar workers.*	+ 0.02
	2009	*Severance pay entitlements were increased.*	+ 0.10
Canada		*No changes.*	=
Denmark	1995	*Restrictions on temporary agency contracts were reduced. Introduction of lower compensation rates for employees wishing to take advantage of the leave schemes, restrictions on the use of sabbatical leave, abolishment of the early retirement scheme, reduction of the benefit entitlement period.*	– 0.90
Finland	1991	*The delay before notice can start was shortened from 2 months (as set in the Act on the Dismissal Procedure) to 1-2 weeks (as set in the Act of Employment Contracts).*	– 0.17
	1996	*Notice period was halved for workers with tenure less than 1 year.*	– 0.07
	1997	*Introduction of limiting the circumstances in which the use of temporary agency contracts is permissible. Maximum total duration of temporary agency contracts was reduced.*	+ 0.16
	2001	*The new employment contract act came into force reducing notice periods further.*	– 0.07
France	1986	*Prior administrative authorization for dismissals for economic reasons was abolished.*	– 0.13
	1990	*The list limiting the circumstances in which the use of fixed-term and temporary agency contracts is permissible is restored and the maximum total duration of fixed-term contracts and temporary agency contracts was reduced.*	+ 0.28
	2002	*Severance pay entitlements were increased.*	+ 0.06
	2008	*Introduction of a formalized scheme of termination by mutual agreement and reduction of the length of the trial period.*	– 0.04
Germany	1985	*Fixed-term contracts were allowed without specifying an objective reason.*	– 0.88
	1993	*Notice period for blue collar workers was extended and aligned with that of white-collar workers.*	+ 0.05
	1994	*Temporary work agency legislation was loosened.*	– 0.06
	1996	*The renewal period for fixed-term and temporary agency contracts and admissible frequency of renewals were increased.*	– 0.56
	2002	*Maximum total duration of temporary agency contracts was brought to 24 months.*	– 0.25
	2004	*The limit on the maximum total duration of temporary agency contracts was lifted.*	– 0.15
Italy	1987	*Fixed-term contracts use was widened through collective agreements specifying target groups and employment shares*	– 0.19
	1991	*Fixed-term contracts legislation was eased.*	– 0.06
	1997	*In case of violation of fixed-term contracts legal discipline, a new Act limited the drastic sanction (conversion of the fixed-term contract into an open-ended one) only to serious cases.*	– 0.56
	1999	*Reform of temporary work agencies extended the use of temporary work agencies and removed the restrictions concerning unskilled workers.*	– 0.19
	2001	*Expansion of valid cases for the use of fixed-term contracts.*	– 0.44
	2003	*Reform of temporary work agencies extended further the use of temporary work agencies.*	– 0.19

Table 2: Changes in employment regulation (continued)

Country	Year	Changes	EPL
Japan	1996	The use of temporary work agencies was extended to 26 occupations.	– 0.09
	1999	The use of temporary work agencies was extended to all occupations with some exclusions.	– 0.31
	2006	Introduction of less stricter laws in case of reinstatement.	– 0.17
Netherlands	1993	Inserts a new Section 1637f in the Civil Code establishing that the employer must provide the employee with given written information when concluding a labor contract.	– 0.08
	1999	The flexibility and security law increased the maximum possible number of fixed-term contracts and lengthened the maximum total duration of contracts with temporary agency contracts.	– 0.19
	2008	Introduction of a lower maximum severance pay.	– 0.03
Norway	1995	Temporary work agencies legislation was eased.	– 0.03
	2000	Temporary work agencies legislation was further eased.	– 0.22
	2005	Temporary work agencies and fixed-term legislation was increased.	+ 0.13
South Korea	1998	Temporary work agencies were liberalized. Dismissals for managerial reasons are allowed (i.e. redundancy and economic restructuring). Whereas this new law may be used for dismissing a single person for urgent business needs, it was mainly introduced with collective dismissals in mind.	– 0.83
Spain	1994	Procedural requirements for dismissals for economic reasons were relaxed and notice periods shortened. Rules governing renewals of fixed-term contracts were tightened and temporary work agencies permitted.	– 0.85
	2006	The maximum allowable duration for temporary agency contracts was increased.	– 0.13
Sweden	1991	Temporary work agencies were permitted.	– 0.66
	1993	The maximum allowable duration for temporary agency contracts was increased.	– 0.50
	1996	Fixed-term contracts were made possible without objective reason and notice periods were reduced.	– 0.21
	1998	Notice period was shortened.	– 0.02
	2001	Notice period was shortened.	– 0.02
	2007	The maximum allowable duration for most kinds of fixed-term contracts was increased.	– 0.31
Switzerland		No changes.	=
UK	2000	Trial period was halved.	+ 0.08
	2002	Maximum total duration of fixed-term contracts was reduced to 4 years (from unlimited).	+ 0.06
US		No changes.	=

Table 3: Descriptive statistics

Variable definitions are in Table 16 at the end of the paper. All variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. Panel A describes firm age across countries, and panel B shows the median values of the dependent variables for each country separately. Countries are sorted according to number of observations in decreasing order. The sample period is 1985 – 2010.

Panel A: Company age

	Age since incorporation				Age since listing			
	Median	Mean	SD	Coverage	Median	Mean	SD	Coverage
World	29.0	40.0	35.4	0.95	15.0	21.2	16.8	0.88
US	22.0	32.0	27.3	0.95	15.0	19.4	15.5	0.94
Japan	48.0	50.0	30.6	0.98	29.0	28.4	16.5	0.96
UK	24.0	37.7	32.2	0.94	13.0	20.0	16.1	0.76
Canada	18.0	23.7	21.4	0.99	12.0	16.0	12.6	0.86
Australia	18.0	24.8	22.0	0.92	14.0	16.7	11.5	0.89
Korea (South)	27.0	28.4	14.9	0.99	13.0	15.6	9.2	0.95
France	31.0	48.3	49.6	0.91	10.0	17.7	21.9	0.70
Germany	54.0	67.7	57.3	0.96	10.0	19.8	21.8	0.76
Sweden	22.0	42.6	46.4	0.93	10.0	13.7	14.9	0.80
Switzerland	77.0	82.6	70.8	0.95	9.0	13.5	18.1	0.64
Netherlands	67.0	67.3	54.6	0.86	14.0	23.7	22.2	0.61
Italy	40.0	49.0	35.5	0.88	10.0	19.3	25.5	0.67
Norway	22.0	48.3	53.9	0.89	10.0	18.4	23.4	0.77
Denmark	55.0	58.4	38.9	0.97	16.0	24.2	24.5	0.74
Spain	39.0	46.8	28.6	0.96	10.0	11.6	7.0	0.58
Finland	46.0	58.5	53.1	0.93	12.0	17.6	16.7	0.91
Belgium	63.0	63.0	45.8	0.94	15.0	34.7	35.5	0.75

Panel B: Median values of dependent variables and EPL

	Tobin's Q	R&D-to-sales (%)	Asset volatility	Cash-to-assets	Sales growth (%)	ROA	SGA-to-Sales	EPL index
World	1.25	1.61	0.37	11.10	4.17			1.02
US	1.47	2.34	0.44	9.96	6.03			0.25
Japan	1.08	1.31	0.32	14.85	1.85			1.29
UK	1.35	1.64	0.34	7.56	5.33			0.64
Canada	1.40	0.99	0.57	9.53	6.31			0.59
Australia	1.41	0.13	0.52	10.91	5.15			1.15
Korea (South)	0.96	0.46	0.47	9.85	5.80			2.25
France	1.20	2.39	0.32	9.86	4.89			2.98
Germany	1.28	3.41	0.31	7.74	3.40			2.34
Sweden	1.38	3.02	0.38	10.74	7.18			2.02
Switzerland	1.21	4.11	0.27	12.35	3.29			1.36
Netherlands	1.27	2.59	0.28	6.11	4.34			1.91
Italy	1.13	2.05	0.30	8.59	3.21			3.01
Norway	1.23	2.78	0.37	11.78	7.59			2.67
Denmark	1.13	4.92	0.27	9.96	4.39			1.75
Spain	1.20	0.65	0.30	5.75	4.43			2.80
Finland	1.20	1.91	0.30	8.32	4.83			1.86
Belgium	1.16	1.95	0.26	8.22	4.28			2.09

Table 4: Employment protection and innovation

The table investigates the relation between employment protection and innovation. All variables (except for the binary and country-level variables) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. The dependent variables are *Number of patents* in regression 1, *Number of patents per million population* in regression 2, and *R&D-to-sales* in regressions 3 and 4. *bHigh EPL* is a binary variable equal to 1 if the *EPL index* is above the median value of the *EPL index* in any given year, and zero otherwise. The age proxy in regressions 3 and 4 is the demeaned natural logarithm of the firm's IPO age (*Age*). All estimations include year and country fixed effects (FE) and robust standard errors, which are given in parentheses. Regressions 3 and 4 additionally include industry (Fama and French (1997) 48 industry grouping) FE, an indicator for R&D non-disclosure, and robust standard errors clustered at the firm-level, which are given in parentheses. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. Variable definitions are in Table 16 at the end of the paper. The sample period is 1985 – 2008.

	Patents, country-level		R&D-to-sales, firm-level	
	(1)	(2)	(3)	(4)
bHigh EPL	346.766*	5.095**	2.410	–6.044***
	(179.597)	(2.312)	(1.906)	(2.100)
bHigh EPL * ln(Age)				3.345***
				(0.318)
ln(Age)			–2.650***	–4.216***
			(0.200)	(0.322)
ROA			–0.337***	–0.334***
			(0.016)	(0.016)
Capex			–0.042*	–0.048**
			(0.022)	(0.022)
bADR			1.805	1.458
			(1.272)	(1.276)
bFocus			–0.383	–0.417
			(0.446)	(0.445)
Leverage			–11.213***	–11.526***
			(0.749)	(0.750)
MTB-equity			0.229***	0.226***
			(0.068)	(0.068)
Size, 1 year lag			0.443***	0.445***
			(0.095)	(0.095)
Volatility			3.903***	3.314***
			(0.837)	(0.837)
Constant	–576.230	–3.234	0.601	6.137**
	(561.659)	(5.530)	(2.961)	(3.102)
Industry FE	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	403	403	167'073	167'073
Adjusted / Pseudo R^2	0.949	0.915	0.183	0.184

Table 5: Employment protection and innovation in high vs. low innovation industries

The table investigates the relation between employment protection and R&D-to-sales in high vs. low innovation industries. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. Firms operating in industries whose corresponding US industry has an above (below) median average industry *R&D-to-sales* ratio are classified into the *High innov.* (*Low innov.*) subsample. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). Industry classification is according to Fama and French's (1997) 48 industry grouping and, alternatively, the SIC 3-digit industry classification codes. All estimations include industry (I) (Fama and French (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE). Robust standard errors are clustered at the country level, and are given in parentheses. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. *Difference* indicates the difference between the coefficients of *EPL index* * ln(Age_{ipo}) in the two subsamples. Variable definitions are in Table 16 at the end of the paper. The sample period is 1985 – 2010.

	FF-48		SIC 3-digit	
	High innovation industries	Low innovation industries	High innovation industries	Low innovation industries
	(1)	(2)	(3)	(4)
bOldfirm	–6.423***	–0.747***	–6.713***	–0.506***
	(1.009)	(0.107)	(1.011)	(0.134)
EPL index * bOldfirm	3.688***	0.694***	3.789***	0.275***
	(0.506)	(0.097)	(0.507)	(0.081)
EPL index	3.236	0.615	4.584*	0.830**
	(2.448)	(0.445)	(2.692)	(0.373)
ROA	–0.569***	–0.053**	–0.573***	–0.035***
	(0.040)	(0.023)	(0.052)	(0.007)
Capex	0.441**	–0.041***	0.471**	–0.037**
	(0.180)	(0.013)	(0.230)	(0.016)
bADR	5.562	0.094	5.171	–0.102
	(7.483)	(0.378)	(6.498)	(0.257)
bFocus	–2.248***	0.089	–1.408***	–0.285
	(0.436)	(0.205)	(0.274)	(0.236)
Leverage	3.065**	0.058	3.101*	0.054
	(1.521)	(0.057)	(1.688)	(0.068)
MTB-equity	–15.478***	–3.284***	–18.768***	–2.308***
	(4.387)	(1.071)	(3.611)	(0.701)
Size, 1 year lag	0.140	0.145***	0.154	0.073
	(0.164)	(0.025)	(0.160)	(0.053)
Volatility	0.434	–0.059	0.569	–0.114
	(0.321)	(0.120)	(0.368)	(0.097)
Constant	5.466**	2.092***	5.921**	1.130*
	(2.237)	(0.771)	(2.424)	(0.631)
I, Y, and C FE	Yes	Yes	Yes	Yes
Observations	61'973	101'869	61'848	101'187
Adjusted R^2	0.218	0.034	0.219	0.024

Table 6: Employment protection and innovation by ownership of intellectual property rights

The table investigates the relation between R&D-to-sales and employment protection as a function of who owns the intellectual property rights in the firm. Firms operating in countries whose employers own an above (below) median fraction of patents are classified into the *Employer* (*Inventor*) subsample. Patent ownership fractions are from OECD (2008). The regression specification is that of column (4) in Table 4. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). All estimations include industry (I) (Fama and French (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE) and robust standard errors clustered at the country level, which are given in parentheses. Variable definitions are in Table 16 at the end of the paper. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. *Difference* indicates the difference between the coefficients of the interaction terms *EPL index * bOldfirm* in the two subsamples *Employer* and *Inventor* and statistical significance is indicated using a one-sided t-test. The sample period is 1985 – 2010.

	Patent ownership	
	Employer	Inventor
	(1)	(2)
bOldfirm	–4.705***	–2.690***
	(0.202)	(0.718)
EPL index * bOldfirm	4.605***	1.534***
	(0.269)	(0.457)
EPL index	–1.718	0.411
	(2.579)	(1.344)
Difference	3.070***	
	(0.531)	
Controls	Included	Included
I, Y, and C FE	Yes	Yes
Observations	125'909	52'892
Adjusted R^2	0.207	0.152

Table 7: Employment protection and innovation: alternative indices and nonlinearities

The dependent variable is the *R&D-to-sales* ratio. As proxies for employment protection we use the *Deakin index* in regression 1 and the component of the *EPL index* for regular contracts (*EPLR*) in regression 2 and for temporary contracts (*EPLT*) in regression 3. Regression 4 uses the *EPL index*. All indices are demeaned and we include an interaction term of the index with firm age. In addition, in regression 4, we add the squared *EPL index* and an interaction term of the squared index with firm age. The specification is that of column (4) in Table 4. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). All estimations include industry (I) (Fama and French (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE) and robust standard errors clustered at the country level, which are given in parentheses. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. Variable definitions are in Table 16 at the end of the paper. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. *Difference* indicates the difference between the coefficients of the interaction terms *EPL index* * *bOldfirm* in the two subsamples. Statistical significance there is indicated using a one-sided t-test. Panel B uses the index-related regression coefficients to plot the relation between EPL and *R&D-to-sales*. The sample period is 1985 – 2010.

Panel A: Regression estimates

	Deakin index	EPLR	EPLT	EPL index
	(1)	(2)	(3)	(4)
bOldfirm	–5.577***	–4.291***	–4.314***	–4.298***
	(0.614)	(0.366)	(1.042)	(0.459)
Index * bOldfirm	14.765***	4.038***	2.662***	9.346***
	(4.006)	(0.194)	(0.785)	(1.319)
Index	3.073	–4.312**	1.147	–5.071
	(4.812)	(1.824)	(0.755)	(4.309)
$Index^2$ * bOldfirm				–1.997***
				(0.429)
$Index^2$				2.044**
				(0.938)
Difference		1.075**		
		(0.541)		
Controls	Included	Included	Included	Included
I, Y, and C FE	Yes	Yes	Yes	Yes
Observations	75'045	178'801	178'801	178'801
Adjusted R^2	0.206	0.185	0.184	0.185

Panel B: R&D and employment protection ADD AVERAGE CONTROLS

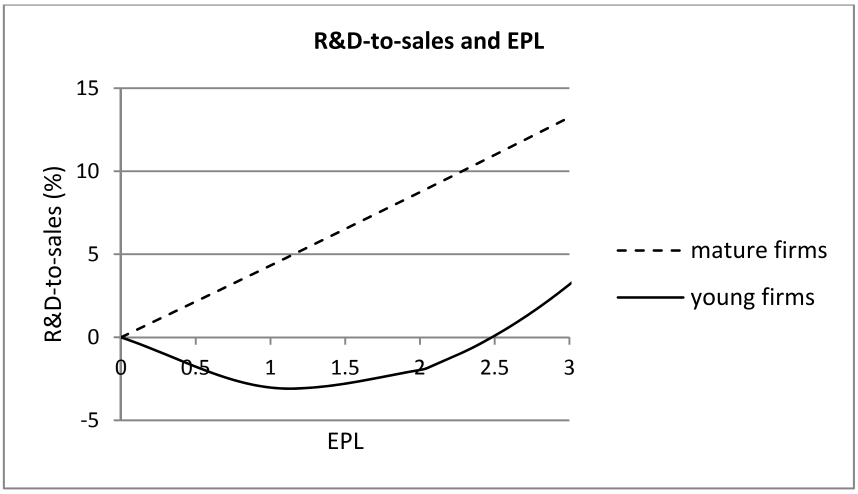

Table 8: Employment protection, firm age, and asset volatility

The table investigates the relation between asset volatility, firm age, and employment protection. The table shows the results of a panel regression. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). All estimations include industry (I) (Fama and French's (1997) 48 industry grouping), year (Y), and country (C) fixed-effects (FE) and robust standard errors clustered at the country-level, which are given in parentheses. Variable definitions are in Table 16 at the end of the paper. All variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	(1)
bOldfirm	–0.049***
	(0.007)
EPL index * bOldfirm	0.028***
	(0.011)
EPL index	0.114**
	(0.046)
ROA	–0.002***
	(0.000)
Capex	–0.001
	(0.001)
Badr	0.075***
	(0.023)
bFocus	0.013**
	(0.006)
Size, 1 year lag	–0.036***
	(0.008)
Constant	0.863***
	(0.060)
I, Y, and C FE	Yes
Observations	193,597
Adjusted R^2	0.444

Table 9: Age dependence of Tobin's Q – country-year level

The table investigates the age dependence of Tobin's Q in the different countries in the sample. For each one of these countries, we regress Tobin's Q ratios against company age and the following control variables: *ln(Age)*, *ROA*, *Capex*, *bADR*, *bFocus*, *Leverage*, *Size*, and *Volatility* across all sample years. All estimations use industry (Fama and French (1997) 48 industry grouping) and year fixed-effects, as well as robust standard errors clustered at the firm level. Variable definitions are in Table 16 at the end of the paper. To conserve space, the table reports only information concerning the coefficient of *ln(Age)*. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	Coefficient of ln(*Age*)	SE	N	Adj. R^2
	(1)	(2)	(3)	(4)
World	–0.148***	(0.008)	193,628	0.260
US	–0.198***	(0.017)	68,494	0.259
Japan	–0.074***	(0.007)	41,643	0.402
UK	–0.183***	(0.017)	18,015	0.259
Canada	–0.117***	(0.035)	12,985	0.282
Australia	–0.096**	(0.041)	10,830	0.247
Korea (South)	–0.140***	(0.013)	11,185	0.347
France	–0.118***	(0.019)	7,120	0.400
Germany	–0.062**	(0.026)	6,950	0.229
Sweden	–0.309***	(0.077)	3,372	0.286
Switzerland	–0.055	(0.048)	2,009	0.448
Netherlands	–0.123***	(0.040)	1,959	0.418
Italy	–0.093***	(0.021)	2,018	0.465
Norway	–0.124***	(0.044)	1,693	0.417
Denmark	–0.153***	(0.054)	1,638	0.420
Spain	0.030	(0.092)	1,102	0.568
Finland	–0.106**	(0.052)	1,469	0.498
Belgium	–0.114***	(0.036)	1,146	0.552

Table 10: Tobin's Q and employment protection

The table investigates the relation between employment protection and Tobin's Q. All estimations include industry (I) (Fama and French's (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE). The age proxy, ln(Age), is demeaned. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). Robust standard errors are clustered at the country-level and reported in parentheses. Variable definitions are in Table 16 at the end of the paper. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	(1)	(2)	(3)	(4)
ln(Age)	–0.150***		–0.152***	
	(0.008)		(0.010)	
bOldfirm		–0.162***		–0.165***
		(0.014)		(0.013)
EPL index	–0.102	–0.119	–0.190	–0.196
	(0.087)	(0.093)	(0.140)	(0.148)
EPL index * ln(Age)	0.055***		0.049***	
	(0.016)		(0.017)	
EPL index * bOldfirm		0.066***		0.068***
		(0.019)		(0.022)
ROA	–0.014***	–0.014***	–0.014***	–0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
Capex	0.001	0.002	0.001	0.001
	(0.007)	(0.007)	(0.007)	(0.007)
bADR	–0.060	–0.068	–0.055	–0.064
	(0.054)	(0.054)	(0.057)	(0.057)
bFocus	0.048***	0.062***	0.049***	0.063***
	(0.017)	(0.018)	(0.018)	(0.018)
Leverage	–2.672***	–2.701***	–2.799***	–2.828***
	(0.710)	(0.712)	(0.776)	(0.777)
Size, 1 year lag	0.136***	0.128***	0.136***	0.128***
	(0.017)	(0.016)	(0.018)	(0.018)
Volatility	0.704***	0.745***	0.713***	0.755***
	(0.073)	(0.082)	(0.074)	(0.081)
Per-capita GDP growth			2.097*	2.190*
			(1.183)	(1.191)
Trade openness			–0.134	–0.117
			(0.316)	(0.315)
Government orientation			–0.021	–0.018
			(0.016)	(0.015)
Labor market programs			–0.065	–0.073
			(0.053)	(0.053)
Fraction union members			–0.001	–0.003
			(0.015)	(0.015)
Constant	0.918***	0.964***	0.211	0.238
	(0.304)	(0.295)	(1.024)	(1.021)
I, Y, and C FE	Yes	Yes	Yes	Yes
Observations	193,587	193,587	178,810	178,810
Adjusted R-squared	0.261	0.258	0.259	0.256

Table 11: Tobin's Q and employment protection by employer friendly vs. inventor friendly regimes

The table investigates the relation between employment protection and Tobin's Q depending on intellectual property rights. Firms operating in countries whose employers own an above (below) median fraction of patents are classified into the *Employer* (*Inventor*) subsample. Patent ownership fractions are from OECD (2008). The regression specification is that of column (4) in Table 10. The age proxy, ln(Age), is demeaned. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). All estimations include industry (I) (Fama and French (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE) and robust standard errors clustered at the country level, which are given in parentheses. Variable definitions are in Table 16 at the end of the paper. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. *Difference* indicates the difference between the coefficients of the interaction terms *EPL index * bOldfirm* in the two subsamples. Statistical significance in that test refers to a one-sided t-test. The sample period is 1985 – 2010.

	Patent ownership	
	Employer	Inventor
	(1)	(2)
bOldfirm	–0.158***	–0.171***
	(0.016)	(0.035)
EPL index * bOldfirm	0.084***	0.048
	(0.023)	(0.033)
EPL index	–0.476	–0.499*
	(0.292)	(0.279)
Difference	0.036	
	(0.040)	
Controls	Included	Included
I, Y, and C FE	Yes	Yes
Observations	125'918	52'892
Adjusted R^2	0.266	0.253

Table 12: Employment protection and Q: alternative indices and nonlinearities

The table investigates the relation between employment protection and Tobin's Q for alternative indices. As proxies for employment protection we use the *Deakin index* in regression 1 and the component of the *EPL index* for regular contracts (*EPLR*) in regression 2 and for temporary contracts (*EPLT*) in regression 3. Regression 4 uses *EPL index*. All indices are demeaned and we include an interaction term of the index with firm age. In addition, in regression 4, we add the squared *EPL index* and an interaction term of the squared index with firm age. The specification is that of column (4) in Table 10. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). All estimations include industry (I) (Fama and French's (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE) and robust standard errors clustered at the country-level, which are given in parentheses. Variable definitions are in Table 16 at the end of the paper. All firm-level variables (except for the binary variables and the indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country-level. Panel A presents regression estimates. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. *Difference* indicates the difference between the interaction terms of age with *EPLR* and age with *EPLT*. Statistical significance in that test refers to a one-sided t-test. Panel B uses the index-related regression coefficients to plot the relation between EPL and Q. The sample period is 1985 – 2010.

Panel A: Regression estimates

	Deakin index	EPLR	EPLT	EPL index
	(1)	(2)	(3)	(4)
bOldfirm	–0.201***	–0.165***	–0.165***	–0.165***
	(0.032)	(0.016)	(0.014)	(0.020)
Index * bOldfirm	0.136	0.071***	0.048**	0.204***
	(0.191)	(0.017)	(0.022)	(0.061)
Index	–1.076*	–0.487**	–0.062	–1.038***
	(0.597)	(0.238)	(0.070)	(0.345)
$Index^2$ * bOldfirm				–0.049***
				(0.018)
$Index^2$				0.202***
				(0.073)
Difference		0.023		
		(0.028)		
Controls	Included	Included	Included	Included
I, Y, and C FE	Yes	Yes	Yes	Yes
Observations	75'050	178'810	178'810	178'810
Adjusted R^2	0.249	0.256	0.256	0.256

Panel B: Q-ratios and employment protection ADD AVERAGE CONTROLS

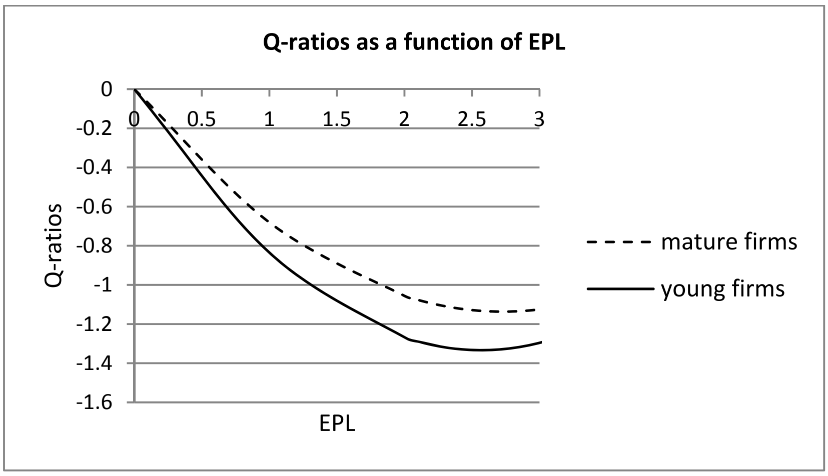

Table 13: Instrumental variable regression

The table uses the financial flexibility index proposed by Doidge, Karolyi, and Stulz (2009) to instrument R&D expenses in our Q regressions. The EPL index is demeaned and we include an interaction term of the index with firm age. All estimations include industry (I) (Fama and French (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE), as well as robust standard errors clustered at the country level, which are given in parentheses. Variable definitions are in Table 16 at the end of the paper. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	Panel regression	2SLS	
		first stage	second stage
	Tobin's Q	R&D-to-sales	Tobin's Q
	(1)	(2)	(3)
R&D-to-sales	0.002**		
	(0.001)		
FF-index (Instrument)		1.271***	
		(0.104)	
R&D-to-sales (Instrumented)			–0.004
			(0.003)
ln(Age)	–0.147***	–2.810***	–0.163***
	(0.010)	(0.126)	(0.011)
EPL index * ln(Age)	0.046***	2.275***	0.059***
	(0.018)	(0.118)	(0.009)
EPL index	–0.202	3.476***	–0.183***
	(0.139)	(0.557)	(0.028)
ROA	–0.013***	–0.311***	–0.015***
	(0.001)	(0.011)	(0.001)
Capex	0.001	–0.013	0.001
	(0.007)	(0.018)	(0.001)
bADR	–0.052	1.237**	–0.045**
	(0.049)	(0.630)	(0.019)
bFocus	0.049***	–0.257	0.048***
	(0.017)	(0.232)	(0.009)
Leverage	–2.776***	–10.865***	–2.846***
	(0.795)	(0.458)	(0.046)
Size, 1 year lag	0.137***	0.360***	0.139***
	(0.018)	(0.056)	(0.003)
Volatility	0.710***	4.091***	0.731***
	(0.081)	(0.642)	(0.031)
Per-capita GDP growth	2.107*	–6.918	2.067***
	(1.160)	(8.554)	(0.349)
Trade openness	–0.136	2.967**	–0.119**
	(0.308)	(1.301)	(0.053)
Government orientation	–0.021	–0.219***	–0.022***
	(0.015)	(0.078)	(0.003)
Labor market programs	–0.066	0.707**	–0.062***
	(0.053)	(0.299)	(0.011)
Fraction union members	–0.002	0.363***	0.000
	(0.014)	(0.051)	(0.002)
Constant	1.027	–7.912*	0.645***
	(2.035)	(4.340)	(0.178)
I, Y, and C FE	Yes	Yes	Yes
Observations	178'810	178'810	178'810
Adjusted R-squared	0.261		
F-test		81.97***	366.95***
Centered R^2		0.187	0.244
Durbin-Wu-Hausman chi-2			2.817*

Table 14: Employment protection, product market regulation, and Q

The table investigates the relation between employment protection, product market regulation, and Q. The specification is that of column (4) in Table 10. All estimations include industry (I) (Fama and French's (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE) and robust standard errors clustered at the country level, which are given in parentheses. Variable definitions are in Table 16 at the end of the paper. All firm-level variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. Statistical significance in that test refers to a one-sided t-test. The sample period is 1985 – 2010.

	(1)	(2)	(3)	(4)
ln(Age)	–0.122***	–0.123***	–0.137***	–0.136***
	(0.009)	(0.009)	(0.007)	(0.007)
Index * ln(Age)	0.046***	0.046***	0.040**	0.040**
	(0.017)	(0.017)	(0.020)	(0.020)
Index	0.409	0.261	–0.698	–0.749*
	(0.519)	(0.558)	(0.429)	(0.405)
Product market regulation		0.678**		0.364*
		(0.325)		(0.203)
Controls	Included	Included	Included	Included
I, Y, and C FE	Yes	Yes	Yes	Yes
Observations	29'298	29'298	136'111	136'111
Adjusted R^2	0.245	0.245	0.267	0.267
Sample years	1998, 2003, 2008	1998, 2003, 2008	1998–2010	1998–2010

Table 15: Employment protection and alternative firm performance measures

The table investigates the relation between employment protection and alternative performance measures. The specification is that of column (4) in Table 10. *bOldfirm* is the binary measure of firm age (equal to 1 if the firm's IPO age is above the sample median in a given country and year, and equal to 0 otherwise). All variables (except for the binary variables and indices) are winsorized at the 1st and the 99th percentile of their pooled distribution at the country level. Variable definitions are in Table 16 at the end of the paper. All estimations include industry (I) (Fama and French's (1997) 48 industry grouping), year (Y), and country (C) fixed effects (FE) and robust standard errors clustered at the country level, which are given in parentheses. The symbols ***, **, and * indicate statistical significance in two-sided tests with confidence 0.99, 0.95, and 0.90, respectively. The sample period is 1985 – 2010.

	Sales Growth	ROA	SGA-to-Sales
bOldfirm	–8.125***	–0.849	–0.092***
	(1.227)	(0.755)	(0.030)
EPL index * bOldfirm	2.718***	–2.235***	0.197***
	(1.053)	(0.715)	(0.045)
EPL index	–3.280	–9.054**	0.616**
	(3.725)	(3.397)	(0.244)
Controls	Included	Included	Included
I, Y, and C FE	Yes	Yes	Yes
Observations	175'464	193'597	159'771
Adjusted R-squared	0.053	0.223	0.078

Table 16: Variable definitions

Variable (Coverage)	Definition
	Panel A: Employment protection
bHigh EPL (99.93)	Binary variable equal to 1 if the country's employment protection (*EPL index*) is above the sample median in any given year, and equal to 0 otherwise.
Deakin index (39.38)	Index composed by Deakin, Lele, and Siems (2007) for France, Germany, United Kingdom, United States, and India. The index contains five sub-indices: alternative employment contracts, work time regulation, dismissal regulation, employee representation, and industrial action. We use the sub-index measuring dismissal regulation. Source: *http://www.cbr.cam.ac.uk*
EPL index (99.93)	OECD indicators of employment protection for 34 OECD countries and 9 emerging economies. We use version 1 of the employment protection summary indicator as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
EPLR (99.93)	OECD indicators of employment protection (*EPL index*) level 2 sub-index for regular contracts as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
EPLT (99.93)	OECD indicators of employment protection (*EPL index*) level 2 sub-index for temporary contracts as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
Procedural inconvenience (99.93)	OECD indicators of employment protection (*EPL index*) level 3 sub-index for procedural inconveniences as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
Notice and severance pay (99.93)	OECD indicators of employment protection (*EPL index*) level 3 sub-index for notice and severance pay for non-fault individual dismissals as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
Difficulty of dismissal (99.93)	OECD indicators of employment protection (*EPL index*) level 3 sub-index for difficulty of dismissal as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
Fixed-term contracts (99.93)	OECD indicators of employment protection (*EPL index*) level 3 sub-index for fixed-term contracts as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
Temporary work agency (99.93)	OECD indicators of employment protection (*EPL index*) level 3 sub-index for temporary work agency employment as described in Venn (2009), Table A2, with the updated data from OECD (2013). Source: *http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm*
	Panel B: Firm age
Age (88.10)	IPO age, computed as one plus the difference between the year under investigation and the firm's IPO year. The IPO year is computed as (a), for the US, the minimum value of: (1) the first year the firm appears on the CRSP tapes; (2) the first year the firm appears on the COMPUSTAT tapes; and (3) the first year for which we find a link between the CRSP and the COMPUSTAT tapes, (b) WorldScope item 00000; the footnote contains information about "the date when the company became publicly held", (c) Compustat, (d) Osiris from Bureau van Djik, (e) SDC Platinum, (f) Zephyr from Bureau van Djik, (f) CRSP, (g) official websites from stock exchanges, (h) personal email to Investor Relations Manager, (i) corporate websites, (j) Thomson Reuters, and (k) online encyclopedias, filled up in this order.
bOldfirm (88.10)	Binary variable equal to 1 if the firm's IPO age (Age) is above the sample median in a given country and year, and equal to 0 otherwise.

Variable (Coverage)	Definition
	Panel C: Performance and innovation measures
Gross margin (91.98)	The gross profit margin, defined as net sales (WorldScope item 01001) minus cost of goods sold (WorldScope item 01051) divided by net sales, multiplied by 100.
Number of patents (91.98)	Country-level annual number of patents. Data are from the OECD Science and Technology Indicators database. We use the triadic patent family: i.e. patents which are simultaneously filed at the European Patent Office (EPO), the Japan Patent Office (JPO) and granted by the US Patent & Trademark Office (USPTO). Source: *http://stats.oecd.org*
Number of patents per million population (89.56)	Number of patents (*Number of patents*) scaled by one million population. Source: *http://stats.oecd.org*
R&D expenditures (100.00)	The firm's R&D expenditures (WorldScope item 01201) divided by the market value of the firm's assets (*Size*), multiplied by 100. Undisclosed values are set to zero and we use non-disclosure indicators to control for the undisclosed values.
Sales growth (89.56)	The firm's change in net sales (WorldScope item 01001, expressed in USD) in relation to the previous year, multiplied by 100.
Tobin's Q (98.73)	Tobin's Q, computed as the market value of the firm's assets (*Size*) divided by the book value of the firm's assets (WorldScope item 02999)
	Panel D: Firm-level control variables
bFocus (100.00)	Borrowing from Mitton (2002), a binary variable equal to 1 if the number of two-digit SIC level industries in which a firm operates is less than the median in a given country and year, using the higher number of reported industries in WorldScope items 07021 to 07028 and 19506 to 19596, respectively, and 0 otherwise
Capex (83.48)	The firm's capital expenditures (WorldScope item 04601) net of depreciation and amortization (WorldScope item 01151), divided by the lagged market value of the firm's assets (*Size*)
FF-index (99.93)	The financial flexibility index proposed by Doidge, Karolyi, and Stulz (2009). It is a count variable that adds one point for a firm with above median cash (WorldScope item 02001), one point for above median dividend payments (WorldScope item 04551 divided by WorldScope item 18198), and one point for below median capital expenditures (*Capex*) in a given country, industry (Fama and French's (1997) 48 industry grouping), and year.
Leverage (98.67)	The firm's leverage, calculated as the firm's total debt (WorldScope item 03255) divided by the market value of the firm's assets (*Size*)
MTB-equity (98.72)	The firm's market-to-book ratio, calculated as the market value of the firm's equity (WorldScope item 08001) divided by the book value of the firm's equity (WorldScope item 03501)
ROA (88.84)	The firm's return on assets, calculated as the ratio of the firm's earnings before interest, taxes, depreciation and amortization (WorldScope item 18198) divided by the lagged book value of the firm's assets (WorldScope item 02999) multiplied by 100
R&D expenditures (100.00)	The firm's R&D expenditures (WorldScope item 01201) divided by the firm's net sales (WorldScope item 01001). Undisclosed values are set to zero and we use non-disclosure indicators to control for the undisclosed values.
Size (89.82)	The firm's size is the log of the market value of the firm's assets, calculated as the book value of the firm's assets (WorldScope item 02999) minus the book value of the firm's equity (WorldScope item 03501) plus the market value of the firm's equity (WorldScope item 08001) minus deferred taxes (WorldScope item 03263)
Equity volatility (88.13)	The volatility of the firm's monthly stock return, calculated over a two-year window and including all firm-years with at least 12 monthly returns. The returns are continuously compounded and all padded zero-return records at the end of each stock's time series are removed, as defined in Ince and Porter (2006)
Asset volatility	Weighted average of debt and equity volatility. Debt volatility is assumed to equal 5% + 0.25 * equity volatility. The weights are given by the book capital structure of the firm.

Variable (Coverage)	Definition
	Panel E: Country-level control variables
Creditor rights *(57.36)*	Djankov, McLiesh, and Shleifer's (2007) index aggregating creditor rights. The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights). Source: *http://scholar.harvard.edu/shleifer/publications?page=1*
Fraction union members (100.00)	Net union membership as a proportion of wage and salary earners in employment. The data is from Comparative political data set we 1960-2010 (item ud) from Armingeon et al. (2012). Source: *http://www.ipw.unibe.ch*
Government orientation (94.83)	Cabinet composition index ranging from 1 (hegemony of right-wing (and center) parties) to 5 (hegemony of social-democratic and other left parties). The data is from Comparative political data set I 1960-2010 (item govparty) from Armingeon et al. (2012). Source: *http://www.ipw.unibe.ch*
Labor market programs (95.80)	Grubb and Puymoyen's (2008) annual public expenditure on labor market programs as a percentage of GDP. Source: *http://stats.oecd.org*
Per-capita GDP growth (100.00)	The country's change in per-capita gross domestic product (GDP) relative to the previous year. GDP is expressed in constant national currency per person. Data are derived by dividing constant price GDP by total population. The data is from World Economic Outlook database. Source: *http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/download.aspx*
Stock market in % GDP (93.21)	The country's ratio of stock market capitalization to gross domestic product in percent. The data is from Financial Development and Structure Dataset (item stmktcap) from Beck, Demirgüç-Kunt, and Levine (2010). Source: *http://econ.worldbank.org*
Tertiary enrolment (87.44)	Total number of students enrolled at public and private tertiary education institutions. Data is from the UNESCO Institute for Statistics. Source: *http://stats.uis.unesco.org*
Trade openness (94.87)	Openness of the economy, measured as total trade (sum of import and export) as a percentage of GDP. The data is from Comparative political data set I 1960-2010 (item openc) from Armingeon et al. (2012). Source: *http://www.ipw.unibe.ch*

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I. Selbständigkeitserklärung

„Ich erkläre hiermit, dass ich diese Arbeit selbstständig verfasst und keine anderen als die angegebenen Quellen benutzt habe. Alle Stellen, die wörtlich oder sinngemäss aus Quellen entnommen wurden, habe ich als solche gekennzeichnet. Mir ist bekannt, dass andernfalls der Senat gemäss Art. 36 Abs. 1 lit. o des Gesetzes über die Universität vom 5. September 1996 zum Entzug des aufgrund dieser Arbeit verliehenen Titels berechtigt ist.“

Bern, 24. November 2014

Jonas Zeller