CEO CONTRACT HORIZON AND INNOVATION[1]

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Abstract

We link the duration of CEO employment contracts to innovation, using hand-collected data on 1,727 contracts from SEC filings. We find that CEOs with more years remaining in their contract invest significantly more, and in more varied and higher quality innovation. A CEO with five years remaining until contract expiration spends 2% more of the firm's assets in R&D and generates patents that receive 2.6 more citations, than a CEO with only one year left in the contract. The results point to the existence of innovation cycles in firms. Taken together, the findings provide empirical support for theoretical work on managerial myopia and on the provision of incentives, especially for innovation. The findings also suggest that recent proposals to reduce entrenchment with legal upper limits on contract length, for example in the UK or Switzerland, can have negative real consequences.

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Fixed-duration employment contracts between public companies and their Chief Executive Officers (CEOs) are prevalent (Gillan et al, 2003) and generally abided (Cziraki and Xu, 2014). In contrast to a large body of work on incentives set by compensation, little is known about the incentives set by the duration of these contracts, partly because the data is not readily available, and has to be extracted from actual agreements. Yet, duration is a crucial component of incentive schemes. Indeed, the theoretical literature describes how myopic incentives can be detrimental to shareholder value (starting with Stein, 1988, 1989). Because innovation incurs immediate costs but only leads to observable benefits in the long-run, and thus is particularly vulnerable to myopia, it is of first-order importance to study the relation between contract-duration and innovation.

In this paper, we link the duration of CEO employment contracts with increases in innovation, using hand-collected data on CEO employment contracts from the Securities and Exchange Commission (SEC) filings' exhibits. Our main finding is that CEOs with more years remaining in their contract invest significantly more, and in more varied and higher quality innovation. This evidence points to the existence of innovation cycles in firms, which match the duration of CEOs' employment contracts. Taken together, our results provide empirical support for theory work on managerial myopia and on the provision of incentives, especially for innovation.

In a frictionless market, contract length or indeed contracts should not matter at all. When there are information asymmetries about the quality of projects and the competence of agents, however, Stein (1988, 1989) shows that managers are likely to avoid uncertain, potentially higher value projects, if their value is only observable in the long-run. Contracts of longer duration can help alleviate this problem (Edmans et al., 2012; Narayanan, 1995; Aghion and Jackson, 2014) in several ways. First, longer contracts can increase the chance that the value of uncertain projects is realized while the CEO is employed, which implicitly

gives CEOs longer planning horizons. Second, longer contracts provide CEOs more years to signal their ability before potential contract renewal, thus allowing them to take up long-term projects at the expense of short-term decreases in earnings. Indeed, long-contracts can potentially insulate agents from the pressure to constantly deliver short-term profits. Manso (2011) explicitly describes this insulating mechanism in the context of innovation, where managers can either exploit already known actions with sure payoffs, or explore untested actions that may have higher returns but are likely to fail. In such a setting, the optimal scheme to motivate exploration should exhibit substantial tolerance for early failure and reward for long-term success, which in practice, can be implemented by firms using long-duration contracts.

Our empirical strategy explores the relation between CEO contract-duration and innovation by comparing changes in innovation for the same firm when the CEO has several and few years remaining in his/her contract. We describe innovation using not only R&D expenditures, but also patenting activity. Patents have several advantages as a measure of innovation: first, they are not based on accounting data, which are prone to manipulation, as Zingales (2000) and Stein (1989) point out; second, they measure an outcome of innovation rather than an input; third, following Hall et al (2001), patent citations can be used to more accurately characterize the quality of innovative investments and capture the *long-term* value of innovations after the initial information asymmetry is resolved.

We find that CEOs with longer contract horizons pursue more influential innovations, as measured by patent citations. Patents receive 0.5 more citations for each additional year remaining in the CEO's contract (before expiration) at the time of application. CEOs with five years to expiration file patents that generate 3.1 more citations (compared to the expiration year), while patents filed in the year before expiration only generate 0.5 additional citations, a difference of 2.6. This pursuit is consistent with the pattern of R&D expenses,

which is also increasing in the number of years remaining in CEO's contracts. CEOs spend 6 basis points of assets more for each year further from expiration. CEOs add 4.4% of assets to their R&D expenditures when they have five years to expiration, compared to 2.4% in the year prior to expiration.

The higher quality is also not explained by long horizon CEOs cutting back unproductive research, as measured by the level of patent filings, or by changes in the "originality" of patents. Instead, the evidence points to long horizon CEOs pursuing more exploratory research, as measured by the diversification across technology-classes of their patent portfolios, the dispersion in citation counts to their patents, and the "generality" of their filings. Long horizon CEOs appear to pursue innovation strategies geared towards technological areas previously unexplored by the firm, as evidenced by the higher likelihood that patents are filed in new technology-classes and the lower likelihood that the new filings are based on the firm's prior work.

A distinctive feature of our empirical strategy is that it allows us to study within-firm changes in innovation due to changes in CEO contract-duration by using firm fixed-effects. This feature is useful as it reduces the need for cross-company comparisons, which confound differences across firms that may also determine the choice of contract-duration. Our empirical strategy also carefully controls for other CEO characteristics that vary along contract life and which are known to correlate with firms' investments such as: CEO-tenure under contract, CEO-tenure in the firm, CEO-age, firm-age and CEO compensation.[2] Our results are robust to controlling for these measures, and to restricting the sample to contract renewals, which is reassuring, as unlike tenure or age, contract horizon re-sets upon renewal. These additional results suggest that the patterns in CEO horizon and innovation are not

[2] There are several papers that explore these relations. Among many others, they include the following: Pan et al. (2013a), Bereskin and Hsu (2013), Yim (2013) and Jenter and Lewellen (2013), Ittner, Lambert, and Larcker (2003); Carter and Lynch (2001); Yanadori and Marler (2006); Lerner and Wulf (2007); Chang et al. (2014); and Baranchuk et al. (2014).

explained by life-cycle effects of CEOs and firms, or by changes in CEO's pay along contract horizon. Taken together, they suggest that the work of Manso (2011) accurately describes the incentives used in practice to motivate innovation by CEOs.

Our results by themselves are not evidence of a causal effect of CEO contract horizon on innovation, as contract length can be set up jointly with innovation plans. Indeed, an alternative explanation of the findings is that innovation opportunities in firms arrive in cycles, and the lengths of these cycles are consistently forecasted by boards to determine the duration of managers' contracts. Note that this explanation of the findings is still consistent with Manso (2011) and myopia theories in general: boards ensure that CEO contracts do not expire while investment opportunities are still strong because they believe that shorter contracts induce myopia.

While there is no exogenous variation to help us identify causal effects, we use several complementary strategies to rule out basic alternative explanations. Specifically, we make sure that the innovation cycles along the span of CEO contracts that we document are not driven by predictable cycles in: the demand of new products, the supply of new technology, the cost of research and development, or in the availability of financing resources.

We start by forecasting various cycles in innovation, demand, and cost using their historical incidence at the company level, and use these forecasted cycles to control in the estimation for changes in investment opportunities that are likely to be anticipated by the company's board (and that are observable to us). In addition, we control for industry- and market-wide trends in technology, supply of researchers, and finance. Our results hold when we control for such cycles and trends. Further, we run a placebo test using a sample of firms without fixed-term CEO contracts. We show that the innovation cycles along the span of

CEO contracts that we document are not present for firms that are in the same position of their predicted investment cycle, but that have no fixed-term contracts with their CEOs.

Second, we exploit the fact that contract cycles are sticky (Shue and Townsend, 2013; Hall 1999) and use information on companies' previous contracts to predict current CEO contract's length. The length of past contracts is predictive of future contract terms, but does not contain information about anticipation of innovation cycles for the *new* contract period. Using past contract terms, while controlling for recurring investment cycles, we find that results continue to hold. These findings suggest that simultaneity in setting contract-duration and innovation plans may not be the only explanation behind our results.

The main alternative explanation that we cannot rule out with our empirical strategy is that firms consistently predict innovation cycles above and beyond those that can be anticipated using historical data and set the duration of CEO contracts to match those predictions. The robustness of our results across firms in very different industries, some of which are not necessarily high-technology-based, suggests that this alternative explanation plays a relatively minor role in our results. Nonetheless, this alternative interpretation of the findings should be kept in mind below.

This paper relates to the literature on CEO employment contracts, which is recent and small (e.g., Schwab and Thomas (2005), Gillan et al. (2009), Cziraki and Xu (2013)). We contribute to this literature by focusing on the relation between contract-duration and real outcomes. Most existing research has focused instead on testing the effect of ex-post measures of CEO compensation (e.g., Ittner, Lambert, and Larcker (2003); Carter and Lynch (2001); Yanadori and Marler (2006); Lerner and Wulf (2007); Chang et al. (2014); and Baranchuk et al. (2014)) and other observable outcomes of employment agreements such as CEO turnover and tenure on innovation and investment (e.g., Pan et al. (2013a), Bereskin and Hsu (2013), Yim (2013), Jenter and Lewellen (2013)). While evidence from these prior

studies helps us better understand the relationship between firms' innovation and CEO incentives, as MacLeod and Malcomson (1998), Nosal (2001), Bandeira (2007) and Gillan et. al (2009) note, CEO incentives are also likely to be affected by the terms of the contracts themselves. Thus, focusing on contract-duration is essential to better understand the role of manager's incentives in corporate innovation.

This paper also relates to the long literature on managerial myopia. In addition to the papers already mentioned other models include Bebchuck and Stole (1993), and Edmans (2009). While there is empirical evidence on CEO short-termism (e.g., Edmans et al. (2014) among others), this paper is the first to empirically demonstrate that long-term ex-ante contractual arrangements can mitigate this issue, as predicted by Edmans et al., 2012, Manso (2011) and Aghion and Jackson (2014). In this analysis we follow Chiappori and Salanie (2003) and Prendergast (1999), and their suggestion to devote more work on assessing whether theory predicts well the contractual forms that are actually observed.

Other papers have documented alternative mechanisms that can mitigate CEO myopia in the context of innovation, particularly through long-term investors, and we view our paper as complementary to this work. Most notably, Aghion et. al (2013) explore the potential positive role of institutional owners, which had been suggested by Edmans (2009) among others, in the governance of innovation. They find that institutional owners have a small and positive impact on R&D, and large positive effect on the productivity of R&D. Relatedly, Lerner et. al (2011) find that firms pursue more influential innovations in the years following private equity investments.

The rest of this paper is organized as follows. Section 1 describes the data used in this project. In Section 2 we describe the empirical approach. Section 3 presents results from our empirical analysis. Section 4 concludes.

1. DATA

1.1. *Contract data*

We hand-collect data on Chief Executive Officer (CEO) contracts from SEC filings exhibits[3] (see Schwab and Thomas (2005)) and extract the expiration date of each fixed-term contract. We complement these data with information on renewals from proxy statements and actual separation dates from Boardex and ExecuComp. Executives whose contracts do not specify an employment period and Co-CEOs are excluded. For each contract, we include all firm-years in which the contract is valid, i.e., until it expires or is abnormally terminated prior to expiration. CEO employment agreements are generally abided, with 73% of all contracts honoured until or beyond expiration and most early terminations occurring in the year before contract expiration (Cziraki and Xu, 2014).

1.2 *Innovation data*

We retrieve patent filings and issues for the companies in the sample from Kogan et al. (2012) matched data between patent records from the United States Patent Office (USPTO) and public firms with returns in the Center for Research in Security Prices (CRSP). In addition, we retrieve from Google Patents information about patent sales and the use of patents as collateral from the patent reassignment files (following Serrano (2010), Gonzalez-Uribe (2013), Mann (2013)), and combine it with the matched data using patent number.

In total, we obtain 1,727 employment fixed-term contracts for 571 CEOs, affiliated to 527 firms with at least one U.S. patent grant during the 1994-2008 period. As it is standard in the innovation literature, we use patents that are ultimately granted, and we date them using the application year rather than grant year, as it most closely matches the time of the invention.

[3] The Securities Exchange Act of 1934, Regulation S-K, Item 402 requires the disclosure of terms of employment contracts and agreements between US registrants and named executive officers.

Several of the firms in our sample merge and acquire other companies throughout the sample period. It is likely that some of these acquisitions are technologically driven, with the acquirer strengthening its patent portfolio with the innovations of the target. Although these acquisitions would constitute a different approach to boost innovation other than in-house research, in our analysis we only consider primary assignments of patents, and abstract from this potential source of innovation outsourcing. In future versions of the papers we may investigate this additional source of corporate innovation.

Table 1 describes the composition of our sample. The first four columns in Panel A show the number of and average length (in years) of new and renewal contracts per start year. The number of new contracts ranges from 43 in 1994 to 90 in 2001. Average contract length decreases over time, from 5.45 for new contracts entered in 1994 to 2.66 for contracts entered in 2008. This decline parallels growing public pressure to increase accountability and decrease job security (and entrenchment) of CEOs. Columns (5) and (6) of Panel A in Table 1 show the number of patent filings by filing and grant years, respectively. Patent filings increase over time except in the later years of the sample. The decrease in patent filings reflects the well-known truncation bias in patent data: patents applied to in the later years of the panel may not have been granted yet (Hall et al., 2001).

Panel B in Table 1 provides a list of the number of new and renewal contracts by their length. Most new contracts are less than six years long, with a mode of three (234 contracts), followed by two-year (155) and one-year contracts (127), and this distribution is similar for renewal contracts.[4] Upon renewal, CEOs tend to receive contracts that are either very long or very short.

[4] Of the 31 contracts that are longer than nine years, 12 are explicitly linked to the executive's retirement age. In total, 28 contracts in our sample are explicitly linked to age. As Jenter and Lewellen (2011) document, this typically happens at the age of 65 (23 contracts) or around. Most of the 64 contracts with duration below one year are renewals effective until the end of the respective calendar year (38 contracts); the remaining 26 contracts are for interim CEOs.

Panels C and D display the distribution of the sample across the top 10 U.S. states and the top 10 (Fama-French) industries, and compares it to the overall distribution of firms within the COMPUSTAT database. Similar to the COMPUSTAT universe of companies, most firms in the sample are headquartered in California, followed by Texas, New York, and Massachusetts. As expected, the sample is concentrated in industries that use patents to protect intellectual property such as Pharma and Electronics.

Panel E presents summary statistics for the main variables of the empirical analysis, on a firm-year level. The mean firm has assets of $1.6 billion, spends 15% of its assets on R&D (annually), and files 15 patents per year. The mean CEO is 54 years old, has a tenure of 3.8 years, owns 3% of his company's stock and receives compensation of 3.6 million (TDC2). The vested portion of the average CEO's portfolio increases by 32 USD for a one-dollar increase in the stock price, and the unvested portion by 7 USD.

1.3. *Characterizing innovative investments*

We capture a variety of information about patents, and use it to describe the quality, structure and size of firm's innovative investments. Following the standard practice in the innovation literature (e.g., Jaffe and Trajtenberg (2002)), we start by characterizing the nature of patents in several dimensions using information on backward and forward citations, which correspond to citations made to patents and made by patents, respectively.

Backward citations are very important in patent filings, since they delimit the property rights of inventions and delineate the scope of the granted claims. Patents with more forward citations are thus typically interpreted as having more impact or as being more important than patents with less forward citations. Following Hall et al. (2001), we use the forward citation count, defined as the number of times the patent has been cited by other patents within three years of issuance, as a measure of the quality or the social return of the innovation.

To deal with the well-known censoring in patent data (i.e., patents taken out later in the panel have less time to be cited than patents filed earlier in the panel) we follow Hall et al. (2001) and use *scaled citations* as our main measure of patent quality. Scaled citations control for the censoring by relying on the ratio between the patent's forward citations and the average number of forward citations of patents in the same technology-class and with the same application-year.

Based on work by Trajtenberg, Henderson and Jaffe (1997), our second measure of the subsequent influence of a patent is "generality", that is, the extent to which the follow-up technical advances are spread across different technological fields, rather than being concentrated on just a few of them. Following Jaffe and Traijtenberg (2002) in their adjustment of the measure, we use the distribution of forward citations across technology classes as a measure of the *generality* of the patent.

The variables scaled citations and generality presumably capture important determinants of the social returns to innovations; those with many descendants (i.e., subsequent follow-on innovations), or with descendants that span a wide range of technical fields, are likely to have high social returns (e.g., Trajtenberg (1990)). On the other hand, neither of these two measures necessarily implies high private returns, one of the key intervening variables being appropriability (Trajtenberg, Henderson and Jaffe (1997)).

As a measure of the private value of innovations, we rely on an indicator of whether the firm has pledged the patent as collateral. Pledging patents as collateral has become an increasingly important source of external finance for firms (Mann 2014). We retrieve information on the use of patents as collateral from the reassignment files at the USPTO, which have evidence on all patent reassignments from the beginning of our sample until 2012. We define a *collateral* indicator variable that equals one if the firm registers the reassignment of the patent as a security interest. To control for the potential truncation in

collateral pledging, we also consider a related indicator variable that only lights up if the patent is pledged within 5 years of issuance.

Also as a measure of the private value of innovations, we use the forward self-citation count, defined as the number of times the patent is cited by other patents filed by the same firm within three years of issuance. *Self-citations* reflect the extent to which the firm is able to appropriate the returns to inventions by continuing to develop new filings based on its prior research. Similar to the citation count, we address potential truncation by also scaling self-citations, using the average number of forward self-citations of patents in the same technology-class and with the same application-year.

To measure the size of firm's innovative investments we use firm-year level data such as *R&D* investments, which we normalize by the size of book assets, and number of *patent filings*, following Hall, Griliches and Haussman (1986). To characterize the variety of those investments, we use the distribution of patent filings across technology classes, which we refer to as t*echnological focus*. A value of this measure close to one implies the distribution across technology-classes is more concentrated, and thus that the firm's innovative investments are not very technologically varied. The measure is thus best interpreted as the degree of concentration of filings across technology classes.

To determine the extent to which the innovative efforts of the firm are based on exploiting already known actions, we investigate whether new patents are filed in technology-classes where the firm had previously patented, and set the indicator variable *new technology-class* to one otherwise. Further, we also count the number of *self-citations* made by each patent. Finally, we track the patents that each inventor filed for each firm and classify the patent as filed by a *new inventor* if it is the first patent filed for a specific inventor-firm combination.

As a measure of the degree of exploration involved in firms' research efforts, we compute the variance of subsequent forward citations to its patents and refer to it as *citation variance* throughout. The idea here is that a firm that pursues a more exploratory research strategy should observe a higher dispersion across the quality of its filings. Finally, as an indicator of technological exploration, we use the distribution of backward citations, which we denote as *originality* following Jaffe and Trajtenberg (2002), and construct it as a reverse HHI index of the technology classes of the prior innovations cited by the patent.

Descriptive statistics are presented in Panel E of Table 1.

2. EMPIRICAL STRATEGY

Our empirical strategy characterizes innovations filed by firms along CEO contract horizon. To illustrate with the case for patent quality, we estimate the following regression of forward citations, $Cites_{it}^{C}$, of patent p filed by CEO C of company i in period t,

$$(1) \qquad Cites_{it}^{C} = \alpha + \sum_{h=1}^{>5} \beta_h D_{itT-h}^{C} + \varphi \boldsymbol{x}_{it}^{C} + \eta_i + \gamma^{\tau} + \varepsilon_{it}$$

where D_{itT-h}^{C} are horizon dummies which equal 1 when CEO *C* has *h* years remaining in his/her contract with firm i at time *t*. To avoid multicollinearity with α, we drop from the estimation the dummy that indicates contracts with less than one year before expiration, which means that the estimated β_h should be interpreted as average quality of innovations filed by CEOs when they have h years, relative to less than one year, remaining in their contract. Standard errors are clustered at the firm level throughout.

In alternative specifications we measure CEO horizon, $Horizon_{it}^{C}$, as a continuous variable instead of the horizon dummies. The variable $Horizon_{it}^{C}$ indicates the number of years remaining in CEO *C's* contract with firm i at time *t*.

Unless otherwise specified, all regressions include a full set of firm fixed effects, η_i, and a full set of contract-start effects, γ^{τ}, which correspond to dummies that equal 1 when the

contract starts in year τ. These two sets of fixed effects allow us to compare changes in innovation for the same firm when the CEO has several and few years remaining in his/her contract, relative to other firms with CEOs with the same contract-tenure. This relative comparison allows us to control for the potential learning effects of CEO experience under contract.

The vector of additional controls, $\boldsymbol{x}_{it}^{C}$, varies across specifications. Following the literature, we include several additional controls for CEO and firm characteristics, and measures of CEO compensation. In particular, the decision to innovate is likely affected by the life-cycle of managers (inside and outside firms) and of firms, as shown by Pan et al. (2013) and others, making life-cycle related controls important.[5]

Ideally the specification would include full sets of CEO-tenure, CEO-age, and firm-age fixed effects. However, adding each of these sets poses potential identification problems, since the effects of cohort, age and time cannot all be identified in a linear model (Hall et. al, 2007). To overcome this problem, we follow Berndt and Griliches (1993), and drop a subset of dummy variables whenever we include these fixed effects in the estimation.

Note that we did not have this identification problem in the basic specification (1) because although the firm fixed effects, η_i, together with the contract-start fixed effects, γ^{τ}, uniquely identify CEOs in the data (i.e., no firm can have two CEOs with contracts that start the same year, unless in the cases where contracts last for less than one year), the contract horizon dummies are identified from the variation across time in citations for patents filed at different contract horizons. Including the contract-start fixed effects is thus crucial, otherwise one may worry that the variation identifying the estimate confounds citation trends. Also note

[5] Yim (2013) and Low et al. (2014) find that younger CEOs undertake more acquisitions; Jenter and Lewellen (2013) show that CEOs close to a common retirement age of 65 accept bids more often, consistent with lower greater career concerns close to retirement. Pan et al. (2013a) document divestments in the first three years of a CEO's tenure and more subsequent investments, as they have freed themselves from their predecessor's projects and feel freer to pursue their own. Bereskin and Hsu (2013), in contrast, find that new CEOs are associated with greater quantities and qualities of innovation measured by the number and citations of patents.

the advantage in including contract-start year, as opposed to calendar year, fixed effects. While both types of fixed effects will help us control for citation trends, only the former can help us control for potential learning-under-contract effects that may be present in the data.

Finally, also note that contract-start fixed effects by themselves cannot alleviate the concern that this variation may also confound the truncation in citation data (i.e., patents taken out later in the panel have less time to be cited than patents filed earlier in the panel). As explained in section 1.3, we address this concern by only counting citations within 3 years of issuance, and by using relative measures of patent quality (scaled citations).

We explore this identification problem more in additional specifications where we include CEO fixed effects instead of firm fixed effects, which allow us to compare patent quality for the same CEO across different contract-horizons, and relative to other firms whose CEOs started their current contract the same year. In these regressions, the effect of contract horizon is identified only from the subset of CEOs for which we have information of more than one contract.

In the robustness tests section we extend the set of control variables to include variables related to CEO compensation. Finally, in unreported regressions we verify the results are robust to estimating the regressions using the logarithm of the dependent variable. We report those for untransformed citation counts for ease in interpretation. In future versions of the paper we may report results based on the transformed dependent variable, or on non-linear estimation methods like Poisson.

3. FINDINGS

3.1. Patent Quality

We begin the analysis by examining the quality of the patents in the sample. We use two measures of quality based on the social value of innovations: the count of forward citations

and the generality of forward citations to patents; and two measures of quality based on the private value of innovations: the use of patents as collateral and self-forward citations.

3.1.1 Citation counts

Panel A in Table 2 reports ordinary least squares (OLS) estimates of different specifications of equation (1). The list of covariates is included in the final rows of each column.

Column (1) presents estimates of equation (1) including the contract horizon dummies (D^C_{itT-h}), the start-year contract fixed effects (γ^τ), and the firm-fixed effects (η_i) as explanatory variables. The coefficient on the dummy for a 5 year contract horizon is 3.238, which should be interpreted as follows: for a given firm, patents filed when the CEO has 5 years left in the contract receive 3.238 more citations (within 3 years of issuance) than those filed less than one year before contract expiration, and relative to the patents filed by all other CEOs with the same contract-tenure (i.e., number of years working under the same contract). This estimated coefficient compares to an unconditional mean of 14.63, a median of 1, and a standard deviation of 66.27 citations per patent.

Column (1) shows the decreasing pattern in the estimated coefficients for the contract-horizon dummies. This pattern confirms the prediction of innovation cycles within firms that match the length of CEO employment contracts. CEOs with longer contract horizons file higher quality innovations.

Contract horizon is strongly correlated with CEO-tenure. To make sure that our results are not driven by CEO-tenure, in column (2) we include tenure fixed effects in the estimation. The point estimates of the contract horizon dummies change slightly but remain significant.

Column (3) tests whether the decreasing pattern in citations along contract horizon reported in column (1) is significant, by estimating equation (1) excluding the horizon

dummies an instead including the continuous variable of horizon. The coefficient on contract horizon is 0.505, which implies that an extra year in the contract horizon of a company's CEO is associated with patents that get 0.505 more citations within 3 years of issuance, relative to other CEOs with the same contract tenure.

In columns (4) - (6) we present estimates of the less parsimonious specification of column (3) additionally controlling for CEO-tenure, CEO-age, and also for firm-age in the estimation, respectively. Column (7) reports estimates of the full-model including CEO-tenure, CEO-age and firm-age fixed effects, but replacing firm fixed effects, with CEO fixed effects. Again, the point estimates change only slightly, and continue to be significant. Finally, column (8) presents estimates of equation (1) including CEO-tenure and CEO-age fixed-effects restricting the sample to contract renewals. The estimates are robust to this restriction in the sample, which is reassuring, as this provides further evidence that our estimates are not confounding the effect of CEO time-varying characteristics.

Panel B in Table 2 reports ordinary least squares (OLS) of equation (1) using scaled citations as dependent variable. Column (2) presents our preferred specification, which includes CEO-tenure fixed effects. The coefficient on the dummy for a 5 year contract horizon is 0.508, which should be interpreted as follows: for a given firm, patents filed when the CEO has 5 years left in the contract receive 0.508 more citations (within 3 years of issuance and relative to other patents in the same technology-class and filed the same year), than those filed less than one year before contract expiration, and relative to the patents filed by all other CEOs with the same contract-tenure (i.e., number of years working under the same contract) and the same overall tenure in the firm. This estimated coefficient compares to an unconditional mean of 0.75 and a standard deviation of 1.27 scaled citations per patent.

Panel A in Figure 1 plots the estimated coefficients in Column (3) (solid line), together with the 95% confidence interval (dashed lines) around those estimates. The figure illustrates the decreasing pattern in innovation quality along contract horizon.

3.12 Patent generality

We now examine the distribution of patent citations to test whether patents generated under a longer CEO horizon are more general.

In Table 3 and Figure 2, we present results from estimating equation (1) using patent generality as dependent variable.[6] We report the estimated coefficients using the same structure as in Table 2. Panel A shows a strong association between contract-horizon and generality: CEOs engage in research that is of a more fundamental nature when they have long-contract horizons.[7]

In Panel B we present results using generality measure based on citations within 3 years of issuance. The pattern in the point estimates is still statistically decreasing along contract horizon. Overall results suggest that CEOs under long contract horizons not only pursue innovations that are more economically important, they also appear to follow research strategies that lean towards more general and fundamental fields.

3.13 Patents pledged as collateral and self-citations - private value of patents

Citation counts are associated to the economic importance of patents as shown by several papers starting with Trajtenberg (1990). Higher citation counts, however, do not necessarily reflect higher shareholder value, as firms may not be able to appropriate the returns to their research. In this subsection, we complement the previous analysis with suggestive evidence

[6] The sample size is smaller in regressions using generality as dependent variable because computing this measure requires that patents be subsequently cited.
[7] In unreported regressions we use a coarser technological classification based on Hall et al. (2001) and results are quantitatively similar.

that patents generated under a long CEO contract horizon also have a direct impact on shareholder value.

We start by estimating the likelihood that patents are pledged as collateral as a function of the number of years remaining in the contract of the CEO when the patent was filed. Tables 4 present results. We find that patents filed when CEOs have longer contract horizons are more likely to be pledged as collateral and be used by the firm to raise external finance, thus, possibly positively affecting firm value.

Similar to patent citations, the indicator variable of collateral is likely truncated because patents taken out later in the panel have less time to be pledged as collateral than patents filed earlier in the panel. To make sure our estimates are not confounding truncation in data on collateral pledges, we repeat the analysis using as dependent variable the indicator that only lights up if the patent is pledged within 5 years of issuance. The point estimates remain similar. In unreported regressions we repeat the analysis using an alternative truncated collateral indicator which lights up if the patent is pledged as collateral within 3 years of issuance. Results are qualitatively similar, but they are no longer statistically significant.

These results are consistent with the patterns in self-citations, which exhibit a monotonic decrease along contract horizon as documented in Table 5. This pattern is found both for raw and scaled self-citation counts, although it is slightly more pronounced for the scaled-citations that control for the timing and industry composition of patents. Overall, the results indicate that patents filed when CEOs have more years remaining in their contract are not only more influential, but are also of higher value to the firm.

3.2. Innovation activity

In the following tables, we move from analyzing the quality of individual patents to an analysis of the overall innovation activity across the contract horizon of the CEO. We begin with the question of whether the increase in patent quality can be explained by higher

investments in R&D. We then explore whether the higher quality of patents filed when CEOs have more years remaining in their contract is at the expense of overall patenting activity. Finally, because a significant part of R&D expenses corresponds to salaries to researchers, we explore whether patents generated under a longer horizon are more likely to be filed by newly hired inventors.

3.2.1 R&D expenditures

We assemble a dataset at the firm cross year level, and regress the level of R&D expenses (scaled by lagged assets) against the contract horizon dummies, and including firm fixed effects and contract-start year fixed effects in the estimation.

Results from this exercise are reported in Panel A of Table 6. This and the following tables follow a similar structure to Table 2, and the covariates included in the regression are specified in the last rows of each column. The reported observations in Table 6 decrease compared to Tables 6 as observations are now at the firm cross year level.

Firms invest significantly more in R&D when CEOs have long contract horizons. The coefficient in Column (3) shows that for a given firm, R&D expenditures when the CEO has 5 years remaining in the contract are on average 6 percentage-points higher that when there is less than one year to contract expiration, and relative to all other CEOs who initiated their contracts the same year.

3.2.2 Level of patent filings

If the average number of successful patent filings decreases dramatically with CEO contract-horizon, our interpretation of the earlier finding that the importance of issued patents is increasing in contract-horizon might be quite different: it would suggest cutbacks of unproductive innovative activities rather than exploration of new research areas, or substitution from high-quality to low-quality areas.

Panel B in Table 6, however, shows no evidence of a significant correlation between CEO contract-horizon and number of filings, which reduces the credence of this alternative interpretation. If anything, the point estimates show an increasing pattern between the two variables, although the coefficients are very imprecisely estimated. In unreported regressions we deal with the truncation concern in patent data by scaling patent counts. There is no consistent pattern in patenting activity, using this alternative measure.

These results are overall consistent with the Stein models of managerial myopia, and less consistent with the model by Bebchuck and Stole (2003). In their model, Bebchuck and Stole (2003) show that in an economy where the level of investment is observable but the quality of those investments is not, CEO myopia can lead to over-investment. Although arguably innovative investments are observable but their quality is not, results are overall more consistent with the predictions of Stein (1989).

3.2.3 Composition of inventors

The bulk of R&D expenditures in a firm are salaries to inventors. One potential mechanism through which longer horizon CEOs are able to shift the research efforts to new areas is by hiring new inventors.

To test this hypothesis we use data from the HBS data set on inventors. We classify as inventor as new to the firm in a given year, if that is the year in which for the first time he/she inventor files a patent that is assigned to the firm.

We estimate the probability that a patent is filed by a new inventor and present results in Table 7. Overall, the evidence suggests that longer contract horizons are associated with a higher probability of patents being filed by inventors that are new to the firm.[8]

[8] The vast majority of inventors that appear to patent for the first time in the firms in our sample are first-time inventors in the U.S.: less than 3% of the patents classified as being invented by a new inventor-firm pair are not classified as a new inventor observation.

One limitation of the results reported in Table 7 is that we only detect that an inventor joins a firm if he/she invents a patent and assigns it to the firm. Hence, inventors that we define as new may have previously joined the company but since they had not patented yet we erroneously classify them as new workers.

One thing is clear though, even if the inventors had already joined the company, they are more likely to file their invention when CEOs have longer horizons. It is likely then, that longer horizon CEOs do not necessarily hire new inventors, but instead, incentivize them better. In future versions of the paper we plan to explore more this topic using information on contracts given to the Chief Research Officers.

3.3 *Exploration and exploitation*

In this section we explore whether the higher (lower) quality of innovation filed by longer (shorter) horizon CEOs is associated to investments in more exploratory (exploitative) research. Since the previous section suggests that the positive link between patent quality and CEO contract horizon is not driven by long contract-horizon CEOs filing fewer patents, is it natural to wonder about the dynamics behind the change in quality.

There are, broadly speaking, two phases for the innovation process: exploration and exploitation (Manso, 2013). In exploratory research, firms invest to learn about the distribution of possible returns to a specific project, which can be generated in later exploitative research. While the value created by exploitation is more immediately evident and possibly more important in making firing decisions, exploratory research is important because it generates and evaluates longer-term projects with potentially higher net present values. A greater contract horizon protects the CEO from immediate evaluation and therefore should motivate more exploratory research.

To test this prediction more directly, we investigate how five different measures of research exploration correlate to contract horizon. First, we measure the concentration of patents across technological classes (a quasi-Herfindahl index) in which patents are assigned. A lower concentration of patent filings across technology-classes is suggestive of a more exploratory research effort by the firm.

Panel A of Table 8 reports results from regressions that link this technological concentration measure to contract horizon. Across all the columns the relation between CEO contract-horizon and technological concentration is negative: firms generate a greater variety of patents when CEOs have more years remaining in their contract before expiration, and become more concentrated on certain technologies, as the CEO comes closer to contract expiration.

Our second metric of research exploration is the average variance of citation counts (in the subsequent three years) across all patents generated by the firm in any given year. A higher variance is suggestive of more exploratory research, since it implies that the patents filed by firms are not equally successful, with some patents getting most of the citations, which is representative of exploratory efforts.

Panel B of Table 8 replicates the analysis reported in panel A for this second measure of research exploration, and results point to the same direction: longer horizons are associated with more variance in citations which is suggestive of more exploratory research.

Third, we measure the extent to which a patent is based on previous innovations filed by the firm, by counting the number of self-backward-citations, i.e. citations made in the patent application to other patents assigned to the firm. A higher number of self-backward-citations suggest the firm is focusing on exploiting already existing innovation inside the firm.

CEOs with shorter horizons rely more on existing innovation to invent their new patents than longer horizon CEOs, as shown by the decreasing pattern between self-citations and contract horizon reported in Panel C of Table 8. In unreported regressions we use as dependent variable the share, rather than number, of self-citations, relative to total backward-citations. The decreasing pattern continues to hold although significance is weaker.

Fourth, we estimate the probability that a patent is filed in a technology-class in which the firm had not previously patented. Results are reported in Panel A of Table 9. CEOs with longer horizons are more likely to file patents in technology-classes that are new to the firm, which is consistent with more exploratory research as it suggests the firm is expanding its research boundaries.

To gain additional insight into the source of the increase in patent importance, we report in Panel B Table 9, results from a regression akin to equation (1), adding an indicator variable for patents filed in technology-classes new to the firm, as well as interactions between this patent variable and the contract horizon.

The coefficient for *New technology-class* is positive and significant, suggesting that patents in the firm's unexplored areas, are disproportionally more likely to be more cited patents. The point estimate of the interaction term is negative although not significant. Thus, new patents are more important, but their impact does not appear to increase substantially with longer horizons. One interpretation of this finding is that longer horizons are associated to more important innovations because they shift the research efforts to more exploratory areas, and not because having achieved the shift they produce significantly more meaningful innovation.

Finally, in unreported regressions we explore the originality of patents filed when CEOs have several and few years remaining in their contract, but there are no significant differences. This ensures that longer-horizon CEOs do not file patents that are so novel they

simply do not cite other patents, such that their novelty is not captured by the originality index.[9] One interpretation of this result is that although long-horizon CEOs pursue more exploratory research strategies, they don't appear to drastically change the nature of the innovation strategy of the firm.

Overall results suggest that CEOs with more years remaining in their contracts pursue more exploratory innovation strategies. These results are consistent with Cziraki and Xu (2014) which show that CEOs that face a lower turnover threat take more risk. Our different patent-based measures for degree of exploration in firms' innovation strategies could be interpreted as alternative measures of corporate risk-taking. Under this interpretation, our findings suggest that CEOs with more years remaining in their contracts take on more technology-related risk. These results are consistent with recent.

3.4 Why do longer contracts set long-term incentives for CEOs?

Overall, results presented so far suggest that a longer contract horizon allows CEOs to conduct more exploratory research. Under a longer contract horizon CEOs are able to generate a greater variety of higher quality patents that draw on a broader range of technology. The higher patent quality is associated with larger R&D investments, and not with a decline in patent production or concentration of patent production in fewer, more focused areas.

These results are consistent with several mechanisms through which longer contract duration can set long-term incentives for CEOs.

First, longer contracts can increase the chance that the value of uncertain projects is realized while the CEO is employed, which implicitly gives CEOs longer planning horizons.

[9] In general, patents filed when CEOs have longer contract horizons do tend to cite fewer patents than when there are fewer years to contract expiration. However, they do not cite relatively fewer innovations than other patents filed in the same year and in the same technology-class. In unreported regressions we use a coarser technological classification based on Hall et al. (2001) and results are quantitatively similar.

Indeed, Cziraki and Xu (2014) find that the likelihood a contract is terminated before expiration is decreasing in the number of years that remain in the contract.

Second, longer contracts provide CEOs with more years to signal their ability before potential contract renewal, and thus allow CEOs to take up of long-term projects at the expense of short-term decreases in earnings. Indeed, long contracts can set long-term incentives for CEOs by insulating them from the pressure to constantly deliver short-term profits.

To test this hypothesis, we comparing innovative investments made by CEOs with different contract horizons in the face of increasing market pressure. We use 12-months returns on the S&P 500 index to measure market pressure: specifically, we interact contract horizon with the lowest quintile of S&P 500 returns.

In Table 10 we present results from regressions where we include indicator variables for the S&P quintiles, and the interactions of the lowest S&P quintile (and all other quintiles) with the remaining years in the CEO's contract. Across all specifications the contract horizon effect persists when market pressure is very high (lowest quintile of S&P returns). In most specifications, the contract horizon effect is even stronger for the lowest quintile, although the difference in coefficients is not statistically significant. The result is most striking for patent filings. Even though contract horizon is not related to patent output in normal times, column (5) shows that it insulates patent filings especially in periods of high market pressure.

In unreported regressions, we also investigate how the probability of contract termination before expiration varies with R&D investments along contract horizon. We don't find any consistent pattern in the results.

3.5 *Additional Analysis*

In unreported regressions, we examine the relation of CEO contract horizon and a number of other variables including: advertising expenses and product announcements from Capital IQ. Consistent with CEOs reducing their exploration of new innovation opportunities, and exploiting the commercial value of their existing innovations as contract near expiration product announcements and advertising expenditures are smaller for long contract horizon CEOs. These effects are however not statistically significant partly because we lack statistical power. We also explore whether the commercial value of patents changes with CEO contract horizon by looking at the probability that patents are sold (reassigned). We find evidence, albeit weak, that long contract-horizon CEOs generate patents that are more likely to be sold.

Finally, in unreported regressions we also count citations in the five years after the grant year, as opposed to three years in our baseline regressions, and exclude observations of companies headquartered in California. Results are robust to these changes.

In future versions of the paper we plan to explore whether the effect varies with firm governance.

4. Alternative explanations

4.1 *Compensation*

An alternative explanation of the findings is that CEO's short-term incentives, as determined by the compensation structure, increase as contracts reach expiration. This alternative explanation is feasible as firms are likely to also use compensation-based incentives to motivate innovation by managers. Indeed, several empirical studies provide evidence on this regard.[10] To investigate this alternative explanation, we proceed in three steps.

First, we explore the variation along contract horizon of several compensation-based measures of CEO short-term incentives including: (1) the share of unvested shares owned by

[10] Evidence is provided by the following papers among many others: Holthausen, Larcker, and Sloan (1995), Dechow and Sloan (1991), Eng & Shackell (2001), Lerner and Wulf (2007), Baranchuck et al. (2014) and Chang et al. (2014).

the executive to total compensation (Baranchuck et al., 2014), (2) the present value of vested compensation, (3) the present value of non-vested compensation (4) the delta of non-vested compensation, (5) the value-weighted *duration* of all currently restricted grants (Gopalan et al., 2014), (6) the maximum years to vesting of all restricted grants held by the CEO (Baranchuck et al., 2014).

Figure 3 plots the coefficient estimates of regressions where each compensation-based measure of CEO short-term incentives is ran against contract horizon and control variables including firm, contract-start, and CEO-tenure fixed effects. There is no consistent relation between any of these measures and contract horizon, which provides evidence against this alternative story, and suggests that contract horizon is an additional channel, other than CEO compensation, through which CEO career concerns interact with firm innovation.[11]

Second, we add several compensation-based control variables to our main regression: the fraction of shares owned by the executive, the level of his compensation (log of TDC1), and the sensitivity of compensation to stock-price increases, in order to test the robustness of our results. The stock-price sensitivity is calculated following Core and Guay (2002), and split into the sensitivity of unvested and vested equity. We obtain these variables from Execcomp, which only provides data for 58% of our sample.

The results are documented in Panel A of Table 11.[12] The captions of the columns report the dependent variable. All our results are robust to controlling for these measures of compensation, and the magnitude of the contract horizon dummies reduce only slightly. Out of the compensation variables, few are significantly related to our outcomes, and only in few specifications. The reduction in magnitude is partly due to the restricted availability of

[11] Consistent with this evidence in unreported regressions we find that results continue to hold even after we control for these compensation measures in the regression.

[12]Because compensation is likely to be endogenous, however, adding these compensation-based control variables in the regression is likely to bias our estimates. Thus, even though all our results continue to go through once we add these controls, Table 11 does not report our preferred set of results.

ExecuComp data. In unreported regressions we repeat our main regressions on the ExecuComp sample, and results continue to hold although significance is reduced.

Finally, we focus on one aspect of the compensation structure that is of particular importance in our setting: firms can restrict sales of equity-based compensation for a certain period ("vesting period") to generate long-term incentives.[13] Because such restricted compensation can mimic the contract horizon cycle, for example with a vesting period of the same duration as the contract, it may account for our findings. To investigate this alternative explanation further, we start by comparing our measure of CEO horizon (as implied by the contract length) to an alternative measure of CEO horizon as implied by the maximum years to vesting of all restricted grants held by the CEO (Baranchuck et al., 2014). There is no consistent association between these two measures of CEO horizon, as depicted in the right-hand side chart of the last panel of Figure 3. Further, in unreported regressions we replace our measure of CEO horizon with this alternative measure of horizon and we find no association with corporate innovation, which further decreases the credence of this alternative explanation of our findings.

4.2 *Unrelated cycles*

Our results thus far indicate that CEOs with longer horizons pursue more influential and exploratory innovation, which is consistent with the theoretical literature. One potential limitation is that we cannot formally distinguish whether CEO contracts cause these patterns in innovative investments. While we do not have an instrumental variable to help us resolve the causation question, we use two complementary strategies to rule out basic selection-driven alternative explanations.

[13] Consistent with this idea, Edmans et al. (2014) find that corporate R&D is negatively associated with the price-sensitivity of stock and options that vest over the same year.

Two broad classes of alternative explanations may generate the same qualitative pattern – cyclical variation in innovation output that correlates with the contract horizon. First, firms may be able to predict the innovation cycle itself and write CEO contracts to match those predictions. Second, firms may write CEO contracts to match other cycles that explain innovation. Such cycles may be related to the demand for innovation, the cost of generating innovation, the availability of financing, or the supply of new technology.

To rule out these alternative explanations, we forecast innovation-related cycles using the historical incidence of cycles at the firm level, and use these forecasts to control in the estimation for changes in innovation opportunities that are likely to be anticipated by the firm's board (and that are observable to us). To forecast innovation cycles, we use historical data on capital expenditure. This approach is feasible given that prior research suggest strong persistence in R&D (Cohen et al., 2013). We construct cycles as the time elapsed between peaks in investment spending growth. We define peaks as years in which capital expenditures grow more than 5% compared to the previous year.

We use the same technology to forecast a range of alternative cycles. To forecast demand-side cycles, we use historical data on sales. While this measure has the advantage that it does not require any assumptions on the nature of customers, it naturally depends on the nature of products and may be driven as much by the firm itself as its customers. Therefore, we supplement it with data on receivables, which measures the financial situation of customers more closely. To forecast cost cycles, we use data on the number of employees, as the bulk of R&D expenditures are wages. All cycles are on average three years long, consistent with our observation that most CEO contracts also have a duration of three years.

Panel A in Table 12 presents results when we include the remaining time under the predicted cycles in the estimation. All cycles—investment (column 1), sales (2), receivables (3), and employees (4)—are positively related to the number of citations, but do not change

our conclusions. On the contrary, after controlling for the predicted investment horizon, the magnitude of the coefficient of contract horizon on scaled citations almost doubles compared to the basic specification of Column (3) in Panel B of Table 3. Note that we restrict this analysis to firms that are able to predict cycles based on past data (firms that had sufficient fluctuation to generate peaks). Results for generality (Panel B) and technological focus (Panel C) are equally comparable to our baseline results.

Next, we complement our firm-specific cycle measures with industry-level or macro-level variables that may affect innovation cycles. First, we use the (log) number of PhD graduates in any given year to proxy for the availability of researchers. We use both the total number of graduates and the graduates that fit the industry best (for example agricultural engineers for agricultural firms). Second, financial constraints are difficult to disentangle from investment opportunities on the firm level (Farre-Mensa and Ljungqvist). Therefore, we use the (log) number of finance transactions such as mergers, acquisitions, equity offerings etc. (following Schlingemann et al., 2002) in the industry to measure the availability of equity capital and the real interest to measure the availability of debt capital. Third, we use the year-on-year change in the number of patents applications and the number of citations in the industry to measure trends in technology. The results are reported in columns 5 to 7. Our results hold controlling for these variables.

Because our expansion cycle predictions are based on historical data, they may still not capture novel, firm-specific expansion plans that are reflected in the actual contract horizon. To address this concern, our second strategy to sharpen identification exploits the fact that contract cycles are sticky (Shue and Townsend, 2013; Hall 1999) and use information on companies' previous contracts to predict current CEO contract's length. The intuition here is that the length of past contracts is predictive of future contract terms, but

does not contain information about anticipation of innovation cycles for the *new* contract period.

We implement this idea by replacing the actual contract length with the most recent historical contract length for all firms for which we observe at least one previous contract, in the year after the previous contract ends. This procedure is implemented on all firms, regardless of the actual contract length and regardless of whether the new contract actually has a fixed term. The resulting contract length is comparable to the baseline sample, with a mean of three years. It is sticky within firms, with a standard deviation of 0.23.

Using the predicted length, we compute the predicted contract horizon of CEOs. The average difference between this measure and the actual contract horizon is 0.61 years. We then estimate equation (1) using the predicted contract horizon. Because previous contracts are made to match past innovation cycles, they do not reflect any information on the current cycle, unless the last cycle repeats. To control for this possibility, we include in the estimation the aforementioned measure of investment cycle. The main assumption behind this second identification strategy is that company boards do not select CEO contract lengths to match future innovation cycles above and beyond those predicted by prior innovation occurrences.

Results from regressions in which we replace the actual contract horizon with the predicted contract horizon based on the firm's previous contracts are reported in Table 13. Controlling for recurring innovation cycles, we find that results continue to hold. Note that using historical contracts shrinks our sample. This applies especially to technological focus, for which the coefficient becomes statistically insignificant when controlling for receivable or employee cycles reduces the sample to 128/87 observations.

Finally, because it is still likely that board members predict innovation cycles with information that is not observable to us, we are currently collecting information on contract

length for other executives that are more closely related to innovation decisions inside a company such as CROs and CTOs. This additional information can help us sharpen identification by focusing on variation across contract horizon for different executives in the same firm (a la Lerner and Wulf (2007)).

4.3. *General trends*

Even if firm-specific cycles cannot explain our results, they may be driven by general cyclical trends that affect innovation. In this section, we test this prediction using firms with comparable cycles but no fixed-term CEO contracts and document that such firms do not exhibit general cyclical patterns parallel to ours.

To investigate whether similar firms exhibit comparable trends, we create two subsamples that are comparable for all covariates and only differ in terms of contract type (Rosenbaum and Rubin, 1983, Hirano, Imbens, and Ridder, 2003). To create similar subsamples, we estimate the propensity score, the probability of treatment (fixed-term contract) conditional on year, industry, size, profitability, and the market-to-book ratio. We then match firms with fixed-term contracts to ten firms without fixed-term CEO contracts but are similar in terms of their propensity score, stratified by the position in the respective cycle. For example, when matching on the investment cycle, we only match firms that have three years left to the next predicted investment peak (two years, one year, etc.). We then compare firms with a long vs. short CEO-horizon with their respective comparable firms.

We report results in Table 14. Panel A reports the difference in the average number of citations between the matched samples, with t-statistics of the differences underneath. Patents generated by firms with a five-year CEO-horizon on average receive 5.82 more citations than those generated by comparable firms in the same position of their investment cycle. This difference becomes less pronounced over time and insignificant for firms with a CEO-horizon of one year. When we compare all firms with a CEO horizon of two years and below

to those of four years and above, the differences are insignificant 0.17 for short-horizon CEOs and significant 3.70 citations for long-horizon CEOs, respectively. We obtain similar patterns when we match on other cycles instead, with consistently more citations for firms with long-horizon CEOs, compared to peers in the same cycle position.

In Panel B and C, we repeat the analysis for generality and technological focus. We obtain similar results, albeit weaker for technological focus, for which we are able to match much fewer observations with peer in the same cycle position.

4.4. *Selection into the sample*

Because not all companies use fixed-term contracts, another reason why the coefficient of the CEO contract-horizon dummies in equation (1) may be biased is that innovation opportunities can vary across companies that select into and out-of fixed contracts. To control for the potential selection bias arising from this non-random exclusion, we follow Cziraki and Xu (2014) and use the standard Heckman (1979) sample selection correction, based on heterogeneity across states of at-will exceptions' adoption.[14] At-will exceptions (here forth exception rules) are rules of good faith and fair dealing that prohibit terminations made in bad faith or motivated by malice. These rules protect rank-and-file employees with shorter contracts or without contracts, which makes the choice of avoiding fixed-term contract in the states with these exception rules more attractive. We confirm this predicted correlation in our data: consistent with Miles (2000), firms with headquarters in states that have adopted the exception rules are significantly less likely to offer fixed-term contracts.[15] We generalize this correlation using a Probit regession to model the choice of fixed-term contract. Following Gillian et al. (2009), who estimate the probability of being awarded an explicit contract as a function of risk, we include as dependent variables the homogeneity of stock returns, median

[14] Most states adopted the rules between 1960 and 1980, following debates that were driven by political sentiment of that time as well as the particularities of isolated precedent cases. Based on Walsh and Schwarz (1996) and Muhl (2001), we report the list of the exception rules across U.S. states in appendix A.1.
[15] The contracts explicitly declare the governing state law. It coincides with the state of the headquarter location in most cases. In contrast, the choice of contract type and the state of incorporation are not significantly related.

sales volatility and the industry-level average annual survival rate. We also control in the estimation for CEO characteristics such as age and tenure, whether the CEO is incumbent; and for state-level characteristics other than adoption of exception rules: the anti-takeover index (for the state of incorporation) of Bertrand and Mullainathan (1999) and the anti-competition enforceability index of Garmaise (2011).

Column 1 in Table A.2 of the Appendix presents results from the estimation of the Probit model in column (1). To improve the model used to produce the Heckman Mills ratios, we remove the non-significant variables and report the final model in Column (2). These results are used to compute the inverse Mills ratio for the Heckman-selection correction approach.[16]

In Panel C of Table 15 we present results from estimating the Heckman-selection correction model, where we include the predicted Inverse Mills Ratio into the groups of controls in the estimation of equation (1). Results continue to hold.

5. CONCLUSION

This paper examines changes in innovation activity along the span of CEO employment contracts. We analyze 1,727 CEO contracts, and 82,736 patents filed by CEOs while working under their employment agreements. As time passes towards the expiration of contracts, CEO horizons decline, which provides useful variation within firms to analyze the relation between CEO incentives and innovation.

We find that CEOs with long-horizons, as measured by the number of years remaining in their contract, invest in more influential and higher quality innovations. Patents filed by long-horizon CEOs, as measured by the number of years remaining in their contract, receive a greater number of citations, and from patents in more disperse technology classes, suggesting they have higher scientific and social value. These patents are also more likely to

[16] For more details see Cziraki and Xu (2014).

be subsequently used as collateral, which suggests they are also of greater value for shareholders. The increases in patent quality are accompanied by more investment into R&D and more patents filed by new inventors.

As CEO horizon declines over time, firms continue to generate the same level of patents, suggesting no deterioration in research but rather a shift of focus. Indeed shorter-horizon CEOs generate a portfolio of patents that is less dispersed across technologies and has a lower variation of subsequent citation count. These shorter-horizon CEOs also generate a lower fraction of patents in new technologies and are more likely to base their innovation strategy in the firm's previous inventions. Taken together, the results suggest that CEOs with a long horizon invest into more uncertain, explorative research while CEOs with a short horizon focus on known, exploitative projects. These findings are consistent with recent work by Manso (2011), which shows that a certain degree of managerial entrenchment, such as that provided by long employment contracts, may be optimal to motivate more disruptive innovation by helping mitigate CEO myopia.

While we do not have exogenous variation on horizon to distinguish whether CEO horizon causes these patterns to innovation, we address several plausible alternative explanations of our results. In particular, we show that our results hold when we control for CEO tenure or age, firm age, compensation, and innovation cycles. We also exploit the stickiness of contract length and use previous contracts to estimate the current contract length. Our results hold when we use the historical information to estimate contract horizon, thereby excluding any unobserved information about the innovation cycle that affected the current contract length. Because the pattern we document is cyclical and re-sets upon renewal of contracts, it is unlikely to be exclusively driven by other unobservable, cyclical characteristics.

In the public debate on corporate governance, critics often hold that managerial entrenchment is detrimental because it undermines incentives to exert effort by protecting the manager from termination after poor performance. In the UK, for example, proponents of the 2001 executive contract length reduction in the Combined Code[17] (from three-five years to one year) argued that reducing contract length increased accountability of CEO performance and challenged the "reward for failure" mentality of CEO compensation (House of Commons, 2002).[18]

Overall our results are consistent with the predictions of Manso (2011) and of other theoretical work on CEO short-termism and myopia (e.g., Stein (1988, 1989), Narayanan (1985)). Whether the short-term incentives set by short contracts lead to modest investments in innovation, or instead simply decrease innovative investments to their optimal level, is likely to be firm specific. While both effects could be at play, we are less likely to believe that optimal investment by firms follows the cyclical patterns driven by the duration of CEO contracts. Thus, our results likely suggest that forcing firms to provide shorter CEO contracts can be detrimental for innovation and have negative real consequences on companies.

Understanding further the interaction between compensation and CEO contract duration is crucial for contract design. Whether and how other components of incentives provided to CEOs, especially their compensation within tenure and as severance, can dampen or accentuate some of the of contract horizon on real outcomes are promising questions for future research.

[17] The Combined Code is the document that sets out the corporate governance standards for UK listed companies.
[18] Proponents also argued that reducing contract length would diminish the value of the redundancy package an outgoing executive can expect to receive (House of Commons, 2002).

References

Acharya, V., Baghai, R., and Subramanian, K. 2014. Wrongful discharge laws and innovation. *Review of Financial Studies* 27, 301-346.

Acharya, V., and Subramanian, K. 2009. Bankruptcy codes and innovation. *Review of Financial Studies* 22, 4949-4988.

Aghion, P., and Jackson, M. O. 2014. Inducing Leaders to take risky decisions: dismissal, tenure, and term limits. Working paper, Harvard.

Aghion, P., Van Reenen, J., and Zingales, L. 2013. Innovation and institutional ownership. *American Economic Review* 103, 277-304.

Anderson, R., Bustamante, M. C., and Guibaud, S. 2013. Agency, firm growth and managerial turnover, Manuscript, LSE.

Antia, M., Pantzalis, C., and Park, J. C. 2010. CEO decision horizon and firm performance: an empirical investigation. *Journal of Corporate Finance* 16, 288-301.

Asker, J., Farre-Mensa, J., and Ljungqvist, A. 2011. Does the stock market distort investment incentives? CEPR Discussion Paper No. DP7857.

Atanassov, J.,2007. Quiet Life or Managerial Myopia: Is the Threat of Hostile Takeovers Beneficial for Technological Innovation?," SSRN eLibrary.

Azoulay, P., Zivin, G., and Sampat, B., 2012, The diffusion of scientific knowledge across time and space: Evidence from professional transitions for the super-stars of medicine. In Lerner, J., and Stern, S. (ed.): The rate & direction of inventive activity revisited. University of Chicago Press.

Barrot, J. 2013. Investor horizon and innovation: evidence from private equity funds. Manuscript, MIT.

Bebchuk, L. A., and Stole, L. A. 1993. Do short-term objectives lead to under- and overinvestment in long-term projects? *Journal of Finance* 48. 719-729.

Berndt, E.R. and Griliches, Z (1993). Price indices for microcomputers: An exploratory study, in Murry Foss, Marylin Manser, and Allan Young, ed. *Price Measurements and Their Uses* (University of Chicago, Chicago).

Baranchuk, N., R. Kieschnick, and Moussawi, R. 2014. Motivating innovation in newly public firms. *Journal of Financial Economics* 111, 578-588.

Bereskin, F. L., and P. Hsu. 2013. Bringing in changes: the effect of new CEOs on innovation. Working paper, University of Hong Kong.

Bertrand, M., and Mullainathan, S. 1999. Is there discretion in wage setting? A test using takeover legislation. *RAND Journal of Economics* 30, 535-554.

BIS. 2011. Executive Remuneration. Discussion paper, September 2011.

Bolton, P., Scheinkman, J., and Xiong, W. 2006. Executive compensation and short-termist behaviour in speculative markets. *Review of Economic Studies* 73, 577-610.

Brickley, J. A., Coles, J. L., and Linck, J. S. 1999. What happens to CEOs after they retire? New evidence on career concerns, horizon problems, and CEO incentives. *Journal of Financial Economics* 52, 341-377.

Brickley, J.A., 2003. Empirical research on CEO turnover and firm-performance: A discussion. *Journal of Accounting and Economics* 36, 227-233.

Brown, S., and Hillegeist, S. A. 2007. How disclosure quality affects the level of information asymmetry. *Review of Accounting Studies* 12: 443-477.

Campbell, J.Y., 1996. Understanding risk and return. *Journal of Political Economy* 101, 298-345.

Carter, M., and Lynch, L. 2001. An examination of executive stock option repricing. *Journal of Financial Economics* 61, 207-225.

Chava, S., and Purnanandam, A. 2010. CEOs versus CFOs: incentives and corporate policies. *Journal of Financial Economics* 97, 263–278.

Chang, X., Fu, K., Low, A., and Zhang, W. 2014. Non-executive employee stock options and corporate innovation. *Journal of Financial Economics*, forthcoming.

Conyon, M. 1994. Tenure and contracts: the experience of UK CEOs. *Personnel Review* 23, 25-33.

Core, J., Guay, W., 2002. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. Journal of Accounting Research 40, 613-630.

Core, J., Larcker, D., 2002. Performance consequences of mandatory increases in executive stock ownership. *Journal of Financial Economics* 64, 317–340.

Coughlan, A. T., and Schmidt, R. M. 1985. Executive compensation, management turnover and firm performance. *Journal of Accounting and Economics* 7: 43-66.

Cziraki, P., and Xu, M. 2014. CEO job security and risk-taking. Manuscript, LSE.

Dechow, P. M., and Richard G. Sloan. 1991. Executive incentives and the horizon problem. *Journal of Accounting and Economics* 14, 51-89.

DTI, 2003. Competing in the global economy – the innovation challenge. DTI Economics Paper 7, London: DTI.

Ederer, F., and Manso, G. 2012. Is Pay-for-performance detrimental to innovation? Manuscript, Yale.

Eng, L., and Shackell, M. 2001. The implications of long-term performance plans and institutional ownership for firms' research and development (R&D) investments. *Journal of Accounting, Auditing & Finance* 16, 117-139.

Fama, E. 1980. Agency problems and the theory of the firm. *Journal of Political Economy* 88, 288-307.

Farre-Mensa, J., and Ljungqvist, A. 2014. Do measures of financial constraints measure financial constraints? Working paper, Harvard.

Froot, K. A., Perold, A.F., and Stein, J. 1992. Shareholder trading practices and corporate investment horizons. *Journal of Applied Corporate Finance* 5, 42-58.

Gao, H., Hsu, P.H., Li, K. 2014. Managerial short-termism and corporate innovation strategies. Manuscript, UBC.

Garmaise, M. J. 2011. Ties that truly bind: non-competition agreements, executive compensation and firm investment. *Journal of Law, Economics & Organization* 27, 376-425.

Gibbons, R., and Murphy, K. J. 1992. Optimal incentive contracts in the presence of career concerns: theory and evidence. *Journal of Political Economy* 100, 468-505.

Gillan, S. L., Hartzell, J. C., and Parrino, R. 2009. Explicit vs. implicit contracts: evidence from CEO employment agreements. *Journal of Finance* 64, 1629-1655.

Goldman, E., and Huang, P. 2010. Contractual versus actual severance pay following CEO departure, Manuscript.

Gonzalez-Uribe, J. 2013. Venture capital and the diffusion of knowledge. Manuscript, LSE.

Gopalan, R., Milbourn, T. T., Song, F., and Thakor, A. V. 2014. The optimal duration of executive compensation: theory and evidence. Forthcoming, *Journal of Finance*.

Hall, B. J. 1999, The design of multi-year stock option plans *Journal of Applied Corporate Finance* 12, 97-106.

Hall, B., Mairesse J. and L. Turner. 2007. Identifying age, cohort ad period effects in scientifics research productivity: discussion and illustration using simulated and actual data on French physicists. *Economics of Innovation and New Technology* 16 (2): 159-177

Hartzell, J. C. 2001. The impact of the likelihood of turnover on executive compensation, Manuscript.

Heckman, J. J. 1979. Sample selection bias as a specification error. *Econometrica* 47, 153-161.

Hirano, K., Imbens, G. and G. Ridder (2003), “Efficient Estimation of Average Treatment Effects Using the Estimated Propensity Score”, Econometrica 71, 1161-1189.

Hirshleifer, D., Low, A., and S. H. Teoh. 2012. Are overconfident CEOs better innovators? *Journal of Finance* 67, 1457-1498.

Holmstrom, B. 1999. Managerial incentives problems: a dynamic perspective. *Review of Economic Studies* 66, 169-182.

Holthausen, R., Larcker, D., and Sloan, R. 1995. Business unit innovation and the structure of executive compensation. *Journal of Accounting and Economics* 19, 279-313.

House of Commons, 2002. Rewards for failure. Sixteenth report of session 2002-03. HC 914.

Iossa, E., Rey, P., 2013. Building repuration for contract renewal: implications for performance dynamics and contract duration. Working paper, Toulouse.

Ittner, C., Lambert, R., and Larcker, D. 2003. The structure and performance consequences of equity grants to employees of new economy firms. *Journal of Accounting and Economics* 34, 89-127.

Jaffe, A., and Trajtenberg, M. 2002. Patents, citations and innovations: A window on the knowledge economy. MIT Press, Cambridge, MA.

Jenter, D., and Lewellen, K. 2013. CEO preferences and acquisitions. Journal of Finance, forthcoming.

Kang, J.K., Liu, W.L., Low, A., and Zhang, L. 2014. Friendly boards and innovation. FIRN Research paper.

Kaplan, S. N., and Minton, B. A. 2012. How has CEO turnover changed? *International Review of Finance* 12, 57-87.

Kogan, L., Papanikolaou, D., Seru, A., and Stoffman, N. 2012. Technological innovation, resource allocation, and growth. Manuscript, MIT.

Lang, M., and Lundholm, R. 1993. Cross-sectional determinants of analyst ratings of corporate disclosures, *Journal of Accounting Research* 31, 246-271.

Lerner, J., Sorensen, M. and P. Stromberg. 2011. Private Equity and Long-Run Investment: The Case of Innovation. *Journal of Finance* 35 (2), 445-477.

Lerner, J., and Wulf, J. 2007. Innovation and incentives: evidence from corporate R&D. *Review of Economics and Statistics* 89, 634-644.

Li, X., Low, A., and A. Makhija. 2011. Career concerns and the busy life of the young CEO. *Fisher College of Business Working Paper Series.*

Lustig, H.N., Van Nieuwerburgh, S.G., 2008. The returns on human capital: Good news of Wall Street is bad news on Main Street, *Review of Financial Studies* 21, 2097-2137.

Mann, W. 2013. Creditor rights and innovation: evidence from patent collateral. Manuscript, Wharton.

Manso, G. 2011. Motivating innovation. *Journal of Finance* 66, 1823-1860.

Miles, T. J. 2000. Common law exceptions to employment at-will and U.S. labor markets, *Journal of Law and Economics, and Organization* 16, 74-101.

Muhl, C. J. 2001. The employment-at-will doctrine: three major exceptions, *Monthly Labor Review* 124, 3-11.

Murphy, K. J., and Zimmerman, J. L. 1993. Financial performance surrounding CEO turnover, *Journal of Accounting and Economics* 16, 273-315.

Narayanan, M. P. 1985. Managerial incentives for short-term results, *Journal of Finance* 40, 1469-1484.

Nguyen and Nielsen 2010. The value of independent directors: Evidence from sudden deaths. *Journal of Financial Economics* 98, 550-567.

Pan, Y., Wang, T. Y., and Weisbach, M. S. 2013a. CEO investment cycles. NBER working paper.

Pan, Y., Wang, T. Y., and Weisbach, M. S. 2013b. Learning about CEO ability and stock return volatility. NBER working paper.

Porter, M. 1992. Capital choices: changing the way America invests in industry. *Journal of Applied Corporate Finance 5,* 4-16.

Rau, R., and Xu, J. 2009. How do ex-ante severance pay contracts fit into optimal executive incentive schemes? Forthcoming, *Journal of Accounting Research*.

Rosenbaum, P.R. and D.B. Rubin (1983), "The Central Role of the Propensity Score in Observational Studies for Causal Effects", Biometrika 70, 41-55.

Rusticus, T. O. 2006. Executive severance agreements, Manuscript.

Schlingemann, F.P.; Stulz, R.M.; and R.A. Walkling. „Divestitures and the Liquidity of the Market for Corporate Assets." Journal of Financial Economics, 64 (2002), 117-144.

Schwab, S. J., and Thomas, R. T. 2005. What do CEOs bargain for? *Washington and Lee Law Review* 63, 231-70.

Serrano, C. 2010. The dynamics of the transfer and renewal of patents. *RAND Journal of Economics* 41, 686-708.

Seru, A. 2012. Firm boundaries matter: evidence from conglomerates and R&D activity, *Journal of Financial Economics* (forthcoming).

Shue, K., and Townsend, R. 2013. Swinging for the fences: executive reactions to quasi-random option grants. Working paper, Chicago Booth.

Stein, J. C. 1988. Takeover threats and managerial myopia, *Journal of Political Economy* 96, 61-80.

Stein, J. C. 1989. Efficient capital market, inefficient firm: A model of myopic corporate behaviour, *Quarterly Journal of Economics* 104, 655-669.

Tian, X., and Wang, T. 2014. Tolerance for failure and corporate innovation. *Review of Financial Studies* 27, 211-255.

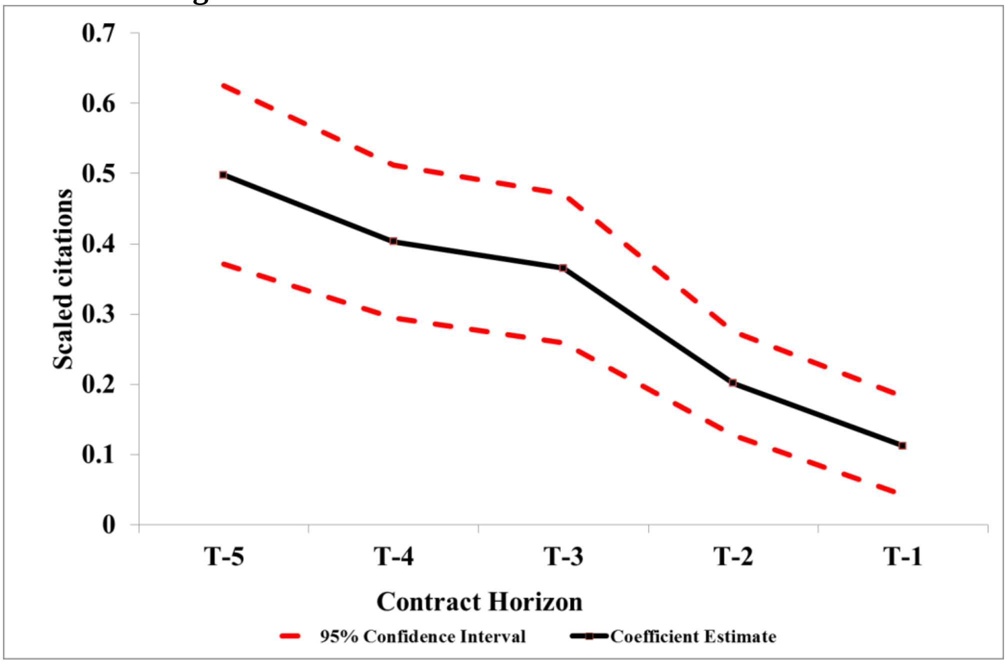
Walsh, D. J., and Schwarz, J. L. 1996. State common law wrongful discharge doctrines: up-date, refinement, and rationales, *American Business Law Journal* 33, 645-689.

Weisbach, M. S. 1988. Outside directors and CEO turnover, *Journal of Financial Economics* 20, 431-460.

Yanadori, Y., and Marler, J. 2006. Compensation strategy: does business strategy influence compensation in high-technology firms? *Strategic Management Journal* 27, 559-570.

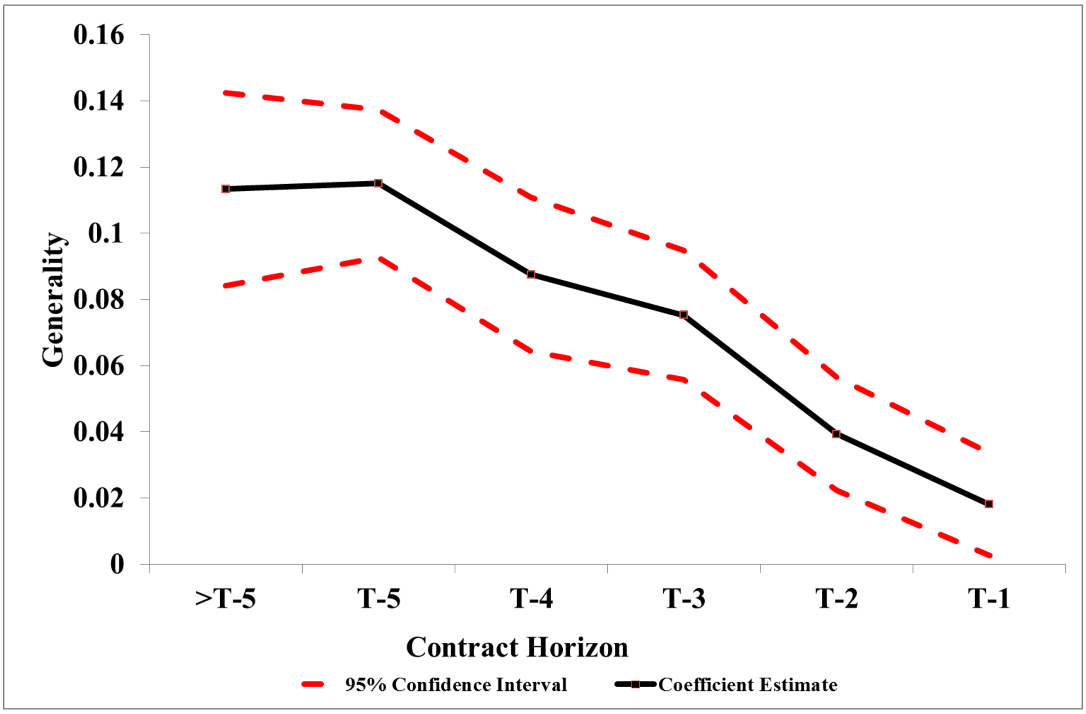
Yim, S. 2013. The acquisitiveness of youth: CEO age and acquisition behavior. *Journal of financial economics*: 108, 250-273.

Figure 1 – Scaled Citations and Contract Horizon



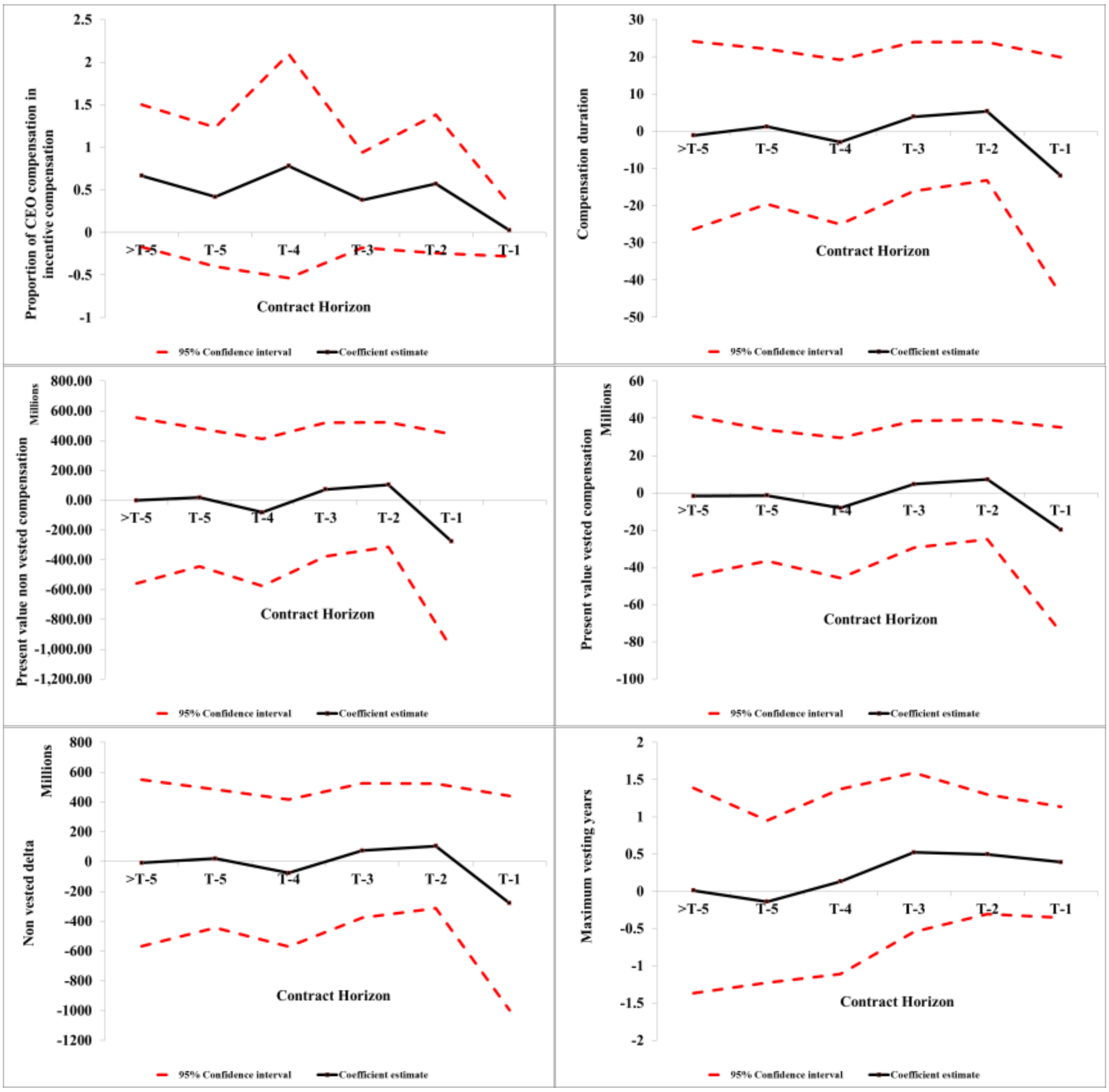
The Figure presents OLS estimates of equation (1) where scaled citations are ran against contract horizon dummies, including start-year contract fixed effects and the firm-fixed effects. The solid line corresponds to the estimated coefficients (Column (1) in Panel B of Table 2) and the dashed lines to the 95% confidence interval around those estimates.

Figure 2 – Generality and Contract Horizon



The Figure presents OLS estimates of a model where patent generality is ran against contract horizon dummies, including start-year contract fixed effects and the firm-fixed effects. The solid line corresponds to the estimated coefficients (Column (1) of Table 4) and the dashed lines to the 95% confidence interval around those estimates.

Figure 3 – Variation in CEO compensation structure along CEO contract horizon



The Figure presents OLS estimates of models where different measures of the structure of CEO compensation (proportion of CEO compensation in incentive compensation, duration, present value of vested compensation, present value of non-vested compensation, non-vested delta and maximum vesting years) are ran against contract horizon dummies, including start-year contract fixed effects and the firm-fixed effects. The solid line corresponds to the estimated coefficients and the dashed lines to the 95% confidence interval around those estimates.

Table 1 – Sample Statistics

Panel A. Distribution by year

Year	Number of contracts		Mean contract length		Patents		Citations	
	New	Renewed	New	Renewed	Applications	Grants	Raw	Scaled
1994	43	14	5.45	3.91	1,346	33	6.09	1.03
1995	46	30	5.49	3.61	1,770	439	7.10	1.14
1996	69	78	5.17	3.25	3,329	1,070	9.99	1.10
1997	76	79	3.96	3.49	5,298	1,552	10.32	1.06
1998	82	68	3.95	3.06	5,582	2,903	8.74	1.01
1999	77	84	3.91	3.01	7,300	4,154	8.45	1.02
2000	75	68	3.76	3.25	7,385	5,159	7.28	1.02
2001	90	53	3.84	2.91	8,537	6,109	5.39	0.89
2002	90	46	3.54	3.23	9,218	6,663	4.64	0.87
2003	71	40	3.42	3.06	7,715	6,757	2.77	0.70
2004	72	48	2.98	3.03	7,084	6,722	1.45	0.49
2005	80	38	3.08	2.88	8,522	6,124	0.73	0.31
2006	71	45	2.58	2.93	5,708	7,441	0.40	0.20
2007	50	44	2.66	2.67	3,084	6,892	0.19	0.11
2008					740	6,978	0.07	0.05
2009					118	6,801	0.02	0.02
2010						6,939		
Total	992	735	3.83	3.19	82,736	82,736	4.87	0.75

Panel B. Distribution by contract length

Contract length	Number of contracts		
	New	Renewed	Total
1	127	70	194
2	155	110	259
3	234	233	457
4	108	64	165
5	114	77	187
6	51	14	63
7	30	1	31
8	17	6	22
9	13	1	12
>9	143	159	337
Total	992	735	1727

Panel C. Distribution by governing state (10 states with largest number of contracts)

State	CA	NY	TX	MA	NJ	OH	IL	PA	MN	MD
Number of contracts	300	129	128	101	87	74	71	61	54	45
Average contract length	3.25	3.62	3.53	4.75	3.37	3.56	3.81	3.00	2.72	3.52
Sample distribution	17%	7%	7%	6%	5%	4%	4%	4%	3%	3%
COMPUSTAT distribution	18%	8%	6%	1%	6%	5%	5%	5%	3%	2%
Sample patent applications	21,213	3,538	7,068	3,395	13,201	3,279	3,256	1,119	4,651	1,018
% of all applications	26%	4%	9%	4%	16%	4%	4%	1%	6%	1%
Citations (raw)	7.87	6.96	9.53	7.66	6.94	7.75	6.35	6.72	5.30	4.95

Panel D. Distribution by industry (10 industries with largest number of contracts)

Industry	Pharma	Electronic	Software	Medical	Machinery	Business Services	Computer Hardware	Oil & Gas	Telecommunication	Chemicals
N	213	187	171	132	108	85	72	48	46	44
mean	3.40	3.86	3.54	3.10	3.65	3.51	3.59	4.42	3.51	3.28
Sample distribution	12%	11%	10%	8%	6%	5%	4%	3%	3%	3%
COMPUSTAT distribution	5%	5%	8%	3%	2%	6%	2%	4%	4%	1%
Patent applications	9,427	16,361	4,928	1,761	6,677	524	7,733	1,752	3,611	971
% of all	11%	20%	6%	2%	8%	1%	9%	2%	4%	1%
Citations (raw)	6.30	6.10	4.24	4.30	3.27	3.63	3.54	6.72	4.40	3.47

Panel E. Descriptive statistics

		Obs.	Mean	Std. Dev.	Min	Median	Max
		Patent level					
Patent	Citations	82,580	4.87	10.10	0.00	2.00	328.00
	Scaled citations	82,580	0.75	1.27	0.00	0.34	22.56
	Originality adjusted	76,912	0.90	0.19	0.00	0.98	1.00
	Generality adjusted	44,197	0.81	0.29	0.00	0.94	1.00
	Used as collateral	82,580	0.03	0.18	0.00	0.00	1.00
	First patent by filing inventor	80,363	0.66	0.47	0.00	1.00	1.00
	Self citations made by patent	80,548	2.15	5.31	0.00	1.00	139.00
		Firm-year level					
Firm	Assets (million USD)	5,137	1560.79	2575.41	3.88	334.09	9172.09
	Patents filed	5,234	14.63	66.27	0.00	1.00	1265.00
	Scaled patent filings	5,234	0.17	0.38	0.00	0.01	2.91
	Product announcements	2,313	2.71	9.95	0.00	0.00	176.00
	Technological variety	1,709	0.12	0.16	0.00	0.06	0.91
	Citation variance	1,949	6.27	8.28	0.00	3.87	127.33
	R&D expenses/Assets	3,831	0.15	0.25	0.00	0.06	1.63
	Advertising expenses/Assets	1,312	0.05	0.08	0.00	0.02	0.39
CEO	Age	3,899	53.95	7.86	30.00	54	81.00
	Tenure	5,234	3.78	5.92	0.00	1	40.00
	Ownership	5,234	3.1%	5.4%	0.00	1.2%	33%
Compensation	TDC1 ('000 USD)	2,431	5,705.89	7,737.40	239.38	2,664.82	41,746.07
	TDC2 ('000 USD)	3,345	3,642.17	6,240.88	21.74	1,291.27	34,853.59
	Delta (vested compensation)	2,243	32.26	259.79	-	-	8,372.79
	Delta (unvested compensation)	2,243	7.40	57.23	-	-	2,126.44

Table 2 – Citation count

Panel A. Raw Citations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	3.910***	3.673***						
	(0.954)	(0.781)						
T-5	3.238***	3.143***						
	(0.554)	(0.545)						
T-4	2.390***	2.545***						
	(0.454)	(0.435)						
T-3	1.854***	1.949***						
	(0.290)	(0.266)						
T-2	1.011***	1.158***						
	(0.228)	(0.225)						
T-1	0.409**	0.522***						
	(0.166)	(0.148)						
Horizon			0.505***	0.526***	0.562***	0.544***	0.726***	0.520***
			(0.130)	(0.090)	(0.099)	(0.089)	(0.136)	(0.141)
Constant	1.876***	-3.571**	1.696***	-3.294**	-2.042	0.816	7.383	10.767
	(0.586)	(1.685)	(0.471)	(1.614)	(2.871)	(5.620)	(6.153)	(7.231)
Observations	81,895	81,895	81,895	81,895	66,464	58,582	58,582	23,463
R-squared	0.217	0.221	0.215	0.220	0.215	0.215	0.224	0.221
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	No	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel B. Scaled Citations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.434***	0.453***						
	(0.066)	(0.091)						
T-5	0.530***	0.508***						
	(0.053)	(0.063)						
T-4	0.432***	0.409***						
	(0.054)	(0.056)						
T-3	0.387***	0.367***						
	(0.068)	(0.054)						
T-2	0.220***	0.203***						
	(0.049)	(0.037)						
T-1	0.119***	0.118***						
	(0.042)	(0.036)						
Horizon			0.064***	0.075***	0.062***	0.045***	0.082***	0.053**
			(0.015)	(0.011)	(0.014)	(0.015)	(0.024)	(0.021)
Constant	-0.741***	-1.440**	-0.747***	-1.375**	-2.547***	-0.106	0.921	0.022
	(0.140)	(0.594)	(0.184)	(0.617)	(0.756)	(0.744)	(1.103)	(1.322)
Observations	81,895	81,895	81,895	81,895	66,464	58,582	58,582	22,436
R-squared	0.132	0.135	0.131	0.134	0.132	0.127	0.132	0.157
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level and * 10% level.

Table 3 – Patent Generality

Panel A. Generality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.137***	0.113***						
	(0.021)	(0.015)						
T-5	0.117***	0.116***						
	(0.011)	(0.011)						
T-4	0.083***	0.088***						
	(0.012)	(0.012)						
T-3	0.070***	0.076***						
	(0.011)	(0.010)						
T-2	0.042***	0.039***						
	(0.009)	(0.009)						
T-1	0.019**	0.018**						
	(0.007)	(0.008)						
Horizon			0.018***	0.018***	0.016***	0.008***	0.018***	0.015***
			(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.004)
Constant	0.483***	0.153*	0.495***	0.172**	0.302**	0.777***	0.380***	0.157
	(0.083)	(0.087)	(0.083)	(0.086)	(0.121)	(0.140)	(0.106)	(0.260)
Observations	43,785	43,785	43,785	43,785	34,689	30,227	30,227	13,789
R-squared	0.140	0.144	0.138	0.142	0.145	0.150	0.156	0.156
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel B. Generality for citations within 3 years of issuance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.105***	0.078***						
	(0.021)	(0.014)						
T-5	0.095***	0.095***						
	(0.012)	(0.011)						
T-4	0.060***	0.064***						
	(0.012)	(0.012)						
T-3	0.053***	0.059***						
	(0.011)	(0.009)						
T-2	0.028***	0.029***						
	(0.010)	(0.009)						
T-1	0.019***	0.020***						
	(0.007)	(0.007)						
Horizon			0.013***	0.012***	0.012***	0.006**	0.012***	0.009**
			(0.004)	(0.002)	(0.003)	(0.002)	(0.004)	(0.004)
Constant	0.758***	0.627***	0.756***	0.444***	0.442***	0.547***	0.335***	0.119
	(0.008)	(0.143)	(0.007)	(0.096)	(0.120)	(0.120)	(0.099)	(0.101)
Observations	41,315	41,315	41,315	41,315	32,898	28,760	28,760	13,058
R-squared	0.108	0.111	0.107	0.110	0.113	0.117	0.123	0.127
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variable is indicated in the title of each Panel. The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects.. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 4 – Use of patent as collateral

Panel A. Patent used as collateral

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.005	0.015**						
	(0.007)	(0.006)						
T-5	0.021***	0.013**						
	(0.006)	(0.005)						
T-4	0.020***	0.012**						
	(0.007)	(0.005)						
T-3	0.011***	0.009**						
	(0.004)	(0.004)						
T-2	0.005*	0.003						
	(0.003)	(0.003)						
T-1	0.004	0.003						
	(0.003)	(0.003)						
Horizon			0.002*	0.002***	0.001	0.001	0.001	
			(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	
Constant	0.025***	-0.265**	0.023***	-0.263**	-0.108**	-0.247***	-0.027	
	(0.003)	(0.124)	(0.002)	(0.124)	(0.049)	(0.055)	(0.081)	
Observations	79,521	79,521	79,521	79,521	64,529	56,909	56,909	
R-squared	0.253	0.256	0.252	0.256	0.244	0.248	0.257	
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	
CEO age FE	No	No	No	No	Yes	Yes	Yes	
Firm age FE	No	No	No	No	No	Yes	Yes	
CEO FE	No	No	No	No	No	No	Yes	

Panel B. Patent used as collateral within 5 years of issuance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
>T-5	0.009**	0.014**					
	(0.004)	(0.006)					
T-5	0.022***	0.013**					
	(0.007)	(0.005)					
T-4	0.022***	0.013***					
	(0.008)	(0.004)					
T-3	0.010**	0.011***					
	(0.004)	(0.004)					
T-2	0.006*	0.004					
	(0.003)	(0.004)					
T-1	0.002	0.002					
	(0.003)	(0.003)					
Horizon			0.002**	0.002***	0.001	0.001	0.001
			(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Constant	0.019***	-0.239**	0.017***	-0.236**	-0.120**	-0.235***	-0.085
	(0.004)	(0.111)	(0.002)	(0.111)	(0.051)	(0.051)	(0.086)
Observations	79,521	79,521	79,521	79,521	64,529	56,909	56,909
R-squared	0.205	0.210	0.204	0.210	0.198	0.200	0.210
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes
CEO FE	No	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 5 – Self-citation count

Panel A. Raw self-citations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.719	0.322						
	(0.470)	(0.539)						
T-5	0.735***	0.697***						
	(0.218)	(0.237)						
T-4	0.455***	0.521***						
	(0.145)	(0.148)						
T-3	0.620**	0.680***						
	(0.244)	(0.257)						
T-2	0.281***	0.284***						
	(0.070)	(0.063)						
T-1	0.175***	0.127*						
	(0.067)	(0.073)						
Horizon			0.087	0.075	0.090***	0.106***	0.129***	0.167**
			(0.063)	(0.069)	(0.029)	(0.033)	(0.040)	(0.083)
Constant	-0.435***	0.088	-0.408***	0.272	-0.017	-0.776	-2.654	-5.763
	(0.146)	(0.408)	(0.079)	(0.380)	(0.788)	(1.389)	(2.448)	(3.511)
Observations	81,895	81,895	81,895	81,895	66,464	58,582	58,582	23,463
R-squared	0.176	0.180	0.174	0.178	0.225	0.237	0.253	0.346
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel B. Scaled self-citations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.225**	0.128*						
	(0.092)	(0.077)						
T-5	0.206***	0.200***						
	(0.043)	(0.046)						
T-4	0.140***	0.171***						
	(0.037)	(0.036)						
T-3	0.156***	0.177***						
	(0.039)	(0.039)						
T-2	0.084***	0.093***						
	(0.024)	(0.020)						
T-1	0.032*	0.032*						
	(0.019)	(0.019)						
Horizon			0.028**	0.026***	0.029***	0.030***	0.034**	0.034**
			(0.012)	(0.010)	(0.009)	(0.010)	(0.014)	(0.016)
Constant	-0.174***	0.186***	-0.174***	0.220***	-0.057	-0.356	-0.772	-1.778
	(0.032)	(0.071)	(0.023)	(0.070)	(0.225)	(0.397)	(0.863)	(1.347)
Observations	81,895	81,895	81,895	81,895	66,464	58,582	58,582	23,463
R-squared	0.253	0.255	0.252	0.254	0.303	0.316	0.319	0.477
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	Yes	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level and * 10% level.

Table 6 – Innovation Activity

Panel A - R&D Investments

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.043**	0.038*						
	(0.020)	(0.020)						
T-5	0.047**	0.044**						
	(0.021)	(0.021)						
T-4	0.044***	0.041***						
	(0.015)	(0.015)						
T-3	0.040***	0.038***						
	(0.014)	(0.014)						
T-2	0.032***	0.030**						
	(0.012)	(0.012)						
T-1	0.025**	0.024**						
	(0.010)	(0.011)						
Horizon			0.006**	0.006**	0.006**	-0.002	-0.002	0.012**
			(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)
Constant	0.061***	-0.007	0.079***	0.009	-0.022	0.035	0.201**	0.410
	(0.019)	(0.046)	(0.017)	(0.047)	(0.049)	(0.059)	(0.084)	(0.274)
Observations	3,765	3,765	3,765	3,765	2,744	2,744	2,744	1,061
R-squared	0.672	0.673	0.671	0.672	0.712	0.731	0.774	0.770
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel B – Patent filings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	5.047	5.064						
	(4.494)	(4.285)						
T-5	4.800	4.732						
	(3.659)	(3.242)						
T-4	3.436	3.019						
	(2.469)	(1.904)						
T-3	0.915	0.383						
	(1.756)	(1.560)						
T-2	-0.278	-0.409						
	(1.427)	(1.395)						
T-1	-0.072	-0.083						
	(0.887)	(0.926)						
Horizon			0.552	0.589	0.524	-0.043	2.843	-0.440
			(0.433)	(0.447)	(0.575)	(0.735)	(2.018)	(0.535)
Constant	8.382***	14.592***	8.252***	12.982***	37.921***	-21.447	55.020	-5.249
	(2.875)	(4.361)	(2.676)	(4.485)	(11.193)	(59.414)	(49.027)	(25.338)
Observations	5,139	5,139	5,139	5,139	3,814	3,771	3,771	1,412
R-squared	0.847	0.859	0.846	0.859	0.855	0.862	0.913	0.929
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variable is the value of R&D investments scaled by firm assets (Panel A) and number of patent filings (Panel B). The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, and * 10% level.

Table 7 – Probability first patent filing by inventor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.314***	0.295***						
	(0.052)	(0.039)						
T-5	0.153**	0.155***						
	(0.064)	(0.057)						
T-4	0.125***	0.115***						
	(0.043)	(0.034)						
T-3	0.105**	0.109***						
	(0.043)	(0.032)						
T-2	0.054**	0.055**						
	(0.023)	(0.023)						
T-1	0.009	0.009						
	(0.018)	(0.020)						
Horizon			0.038***	0.035***	0.018***	0.030***	0.053***	0.041***
			(0.009)	(0.007)	(0.007)	(0.006)	(0.008)	(0.009)
Constant	0.970***	1.010***	0.968***	1.018***	1.214***	0.636***	-0.100	-0.122
	(0.012)	(0.114)	(0.010)	(0.126)	(0.179)	(0.214)	(0.259)	(0.338)
Observations	79,519	79,519	79,519	79,519	64,527	56,907	56,907	23,070
R-squared	0.146	0.163	0.143	0.161	0.173	0.171	0.179	0.232
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variable is a dummy that equals one when the patent corresponds to the first patent of the filing inventor in the firm. The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects.. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 8 – Innovation Variety

Panel A. Technological Focus

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	-0.109***	-0.108***						
	(0.036)	(0.036)						
T-5	-0.102***	-0.087***						
	(0.032)	(0.032)						
T-4	-0.072***	-0.063**						
	(0.025)	(0.026)						
T-3	-0.077***	-0.071***						
	(0.021)	(0.021)						
T-2	-0.040**	-0.037*						
	(0.020)	(0.021)						
T-1	-0.004	-0.005						
	(0.019)	(0.019)						
Horizon			-0.015***	-0.014***	-0.019***	-0.006	-0.027***	-0.020
			(0.004)	(0.004)	(0.005)	(0.006)	(0.007)	(0.017)
Constant	0.956***	0.388***	0.944***	0.363***	0.162	0.713***	0.749***	1.419***
	(0.059)	(0.080)	(0.057)	(0.089)	(0.100)	(0.152)	(0.263)	(0.219)
Observations	3,223	3,223	3,223	3,223	2,434	2,413	2,413	880
R-squared	0.700	0.708	0.698	0.706	0.730	0.747	0.781	0.799
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel B. Quality variance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.918	1.469						
	(1.531)	(1.596)						
T-5	4.343***	4.530***						
	(1.323)	(1.340)						
T-4	4.047***	4.278***						
	(1.151)	(0.921)						
T-3	1.981***	2.272***						
	(0.621)	(0.652)						
T-2	1.442***	1.742***						
	(0.557)	(0.613)						
T-1	0.907	1.035*						
	(0.601)	(0.616)						
Horizon			0.367**	0.439**	0.274	-0.365*	0.211	0.447
			(0.179)	(0.179)	(0.192)	(0.204)	(0.274)	(0.656)
Constant	-5.608***	-2.647	-3.202	0.566	-8.836**	-22.912***	-13.749**	-3.529
	(2.080)	(6.174)	(2.460)	(6.858)	(4.070)	(4.854)	(6.368)	(14.159)
Observations	1,899	1,899	1,899	1,899	1,482	1,471	1,471	482
R-squared	0.642	0.663	0.632	0.653	0.640	0.676	0.705	0.797
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel C. Citations to own prior innovations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	-1.493**	-1.770**						
	(0.611)	(0.729)						
T-5	-0.972**	-1.067**						
	(0.444)	(0.528)						
T-4	-0.701*	-0.681						
	(0.394)	(0.434)						
T-3	-0.891**	-0.963**						
	(0.390)	(0.413)						
T-2	-0.612**	-0.630**						
	(0.258)	(0.279)						
T-1	-0.491**	-0.484*						
	(0.232)	(0.254)						
Horizon			-0.164**	-0.193**	-0.066*	-0.061	-0.097*	-0.176*
			(0.076)	(0.090)	(0.038)	(0.042)	(0.050)	(0.106)
Constant	2.112***	1.674***	2.112***	1.885***	0.892	-0.703	6.709***	9.545***
	(0.176)	(0.368)	(0.243)	(0.413)	(0.978)	(1.878)	(2.573)	(3.448)
Observations	79,712	79,712	79,712	79,712	64,729	57,012	57,012	22,761
R-squared	0.197	0.198	0.196	0.197	0.224	0.229	0.238	0.303
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. The main explanatory variables are time to expiration dummies, *T-i*, that equal 1 when there are i years remaining in the contract of the CEO, and Horizon, the number of years remaining in the contract of the CEO. All specifications include contract-start year fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, and* 10% level.

Table 9 – Exploration of new technological classes

Panel A. Probability patent is issued in a technology class new to the firm

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
>T-5	0.047***	0.054***						
	(0.015)	(0.020)						
T-5	0.031***	0.024**						
	(0.009)	(0.011)						
T-4	0.025***	0.020***						
	(0.007)	(0.007)						
T-3	0.022***	0.021***						
	(0.008)	(0.008)						
T-2	0.013**	0.008						
	(0.005)	(0.005)						
T-1	0.003	-0.000						
	(0.005)	(0.006)						
Horizon			0.006***	0.007***	0.005***	0.008***	0.011***	0.013***
			(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Constant	-0.066***	-0.287***	-0.068***	-0.285***	-0.075	-0.081	-0.898***	-1.248***
	(0.010)	(0.079)	(0.011)	(0.079)	(0.099)	(0.162)	(0.198)	(0.197)
Observations	81,895	81,895	81,895	81,895	66,464	58,582	58,582	23,463
R-squared	0.203	0.206	0.203	0.206	0.191	0.184	0.197	0.190
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	No	No	Yes

Panel B. Scaled citations

	(1)	(2)	(3)	(4)	(5)	(6)
Horizon	0.062***	0.073***	0.060***	0.042***	0.079***	0.044**
	(0.014)	(0.011)	(0.014)	(0.014)	(0.023)	(0.021)
New technology-class	0.545***	0.523***	0.500***	0.428***	0.421***	0.284
	(0.131)	(0.130)	(0.164)	(0.158)	(0.158)	(0.227)
Horizon × New technology-class	-0.028	-0.025	-0.013	-0.006	-0.008	0.044
	(0.037)	(0.037)	(0.043)	(0.045)	(0.045)	(0.056)
Constant	-0.719***	-1.253**	-2.514***	-0.072	1.254	0.683
	(0.182)	(0.634)	(0.761)	(0.759)	(1.188)	(1.353)
Observations	81,895	81,895	66,464	58,582	58,582	23,463
R-squared	0.132	0.136	0.133	0.128	0.133	0.158
Firm FE	Yes	Yes	Yes	Yes	No	Yes
Tenure FE	No	Yes	Yes	Yes	Yes	Yes
CEO age FE	No	No	Yes	Yes	Yes	Yes
Firm age FE	No	No	No	Yes	Yes	No
CEO FE	No	No	No	No	Yes	No
Only renewals	No	No	No	No	No	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are indicated at the top of each panel. Horizon is the number of years until contract expiration. New technology class is a dummy that equals one if the patent is classified in a patent class in which the firm had no previous filings. All specifications include contract-start year fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, and * 10% level.

Table 10 – Insulation from market pressure

Dependent variable	(1) Citations	(2) Scaled Citations	(3) Generality	(4) R&D	(5) Patent Filings	(6) Technological focus	(7) Citation variety
Interaction with Horizon							
Lowest quintile	0.556***	0.064***	0.015***	0.007**	0.845**	-0.020***	0.497*
	(0.131)	(0.016)	(0.003)	(0.003)	(0.395)	(0.006)	(0.289)
2nd -5th quintile	0.474***	0.064***	0.012***	0.006**	0.445	-0.014***	0.482***
	(0.129)	(0.014)	(0.004)	(0.003)	(0.471)	(0.005)	(0.172)
1st quintile	-0.467**	0.007	-0.015**	-0.009	-2.014*	0.034	-2.693***
	(0.194)	(0.032)	(0.007)	(0.014)	(1.177)	(0.027)	(0.913)
2nd quintile	-0.374**	-0.066	-0.021***	0.000	-0.101	-0.009	-2.416**
	(0.177)	(0.040)	(0.007)	(0.013)	(0.816)	(0.020)	(0.976)
3rd quintile	-0.383**	-0.011	-0.011*	0.003	-2.172	0.046*	-2.851***
	(0.149)	(0.040)	(0.006)	(0.016)	(2.029)	(0.027)	(0.944)
4th quintile	-0.204	-0.061**	-0.013***	0.006	-1.227	0.008	-1.902**
	(0.131)	(0.027)	(0.004)	(0.013)	(1.450)	(0.019)	(0.848)
Constant	1.914***	-0.724***	0.278***	0.084***	9.523***	0.921***	1.767
	(0.454)	(0.176)	(0.028)	(0.022)	(2.700)	(0.060)	(1.809)
Difference in Coefficients (2nd -5th quintile × Horizon- Lowest quintile × Horizon)							
F-stat	3.34	0.00	2.83	0.16	1.53	0.64	0.01
p-value	0.07	0.99	0.09	0.69	0.22	0.43	0.94
Observations	81,895	81,895	41,315	3,765	5,139	3,223	2,720
R-squared	0.215	0.131	0.107	0.671	0.846	0.699	0.605

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the column titles. Observations are classified in the i^{th} quintile, if returns to the S&P 500 in the period are in the i^{th} quintile over all the sample period. Horizon is the number of years until contract expiration. All specifications include contract-start year fixed effects and firm fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 11 – Compensation

Dependent variable	(1) Scaled Citations	(2) Generality	(3) R&D	(4) Patent Filings	(5) Technological focus	(6) Citation variety
Horizon	0.044***	0.019***	0.002*	1.143	-0.022***	0.074
	(0.012)	(0.004)	(0.001)	(0.961)	(0.006)	(0.215)
Fraction of shares	-0.077***	-0.040***	-0.002	0.391	0.017	-0.200
Owned	(0.018)	(0.014)	(0.002)	(0.385)	(0.011)	(0.342)
Total Compensation	-0.000	-0.000	-0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Delta (vested equity)	-0.000	0.000*	0.000***	-0.008	0.000	-0.004
	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.014)
Delta (unvested	0.000	-0.000***	0.000	0.056	-0.000	-0.003
equity)	(0.000)	(0.000)	(0.000)	(0.036)	(0.000)	(0.002)
Constant	0.814***	0.665***	0.037***	18.280***	0.852***	-1.914
	(0.101)	(0.024)	(0.008)	(4.002)	(0.074)	(2.933)
Observations	59,161	30,339	1,432	2,089	1,413	968
R-squared	0.103	0.129	0.729	0.833	0.695	0.586

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the column title. Contract horizon is the number of years until expiration. All specifications include contract-start year fixed effects and firm fixed effects. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 12 – Historical innovation cycles

Panel A. Scaled Citations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alternative cycle	Investment	Demand	Demand	Cost	Cost	Finance	Technology
Measure	Capex	Sales	Receivables	# Employees	Researchers	Transactions /interest	Patents
Horizon	0.057***	0.082**	0.115***	0.064***	0.059***	0.045***	0.053***
	(0.013)	(0.037)	(0.016)	(0.015)	(0.011)	(0.013)	(0.008)
Alternative cycle	0.033**	-0.065**	0.018	-0.031			
	(0.012)	(0.026)	(0.02)	(0.046)			
Graduates					-1.589**		
					(0.681)		
Industry graduates					0.142		
					(0.46)		
Financial transactions						-0.092*	
						(0.048)	
Real interest						0.022	
						(0.019)	
Changes in patent appl.							0.006
(industry)							(0.004)
Changes in citations							-0.047
(industry)							(0.04)
Constant	0.464**	1.141***	-0.108	-0.825**	16.279***	1.219***	0.719***
	(0.206)	(0.221)	(0.391)	(0.36)	(4.583)	(0.283)	(0.1)
Observations	16001	10588	11907	9326	65027	76751	76680
R-squared	0.176	0.138	0.225	0.126	0.096	0.091	0.091
Contract start FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Generality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alternative cycle	Investment	Demand	Demand	Cost	Cost	Finance	Technology
Measure	Capex	Sales	Receivables	# Employees	Researchers	Transactions /interest	Patents
Horizon	0.026***	0.022*	0.025***	0.027***	0.024***	0.016***	0.025***
	(0.004)	(0.01)	(0.005)	(0.004)	(0.004)	(0.002)	(0.003)
Alternative cycle	0.011*	-0.002	0.030***	0.022***			
	(0.005)	(0.013)	(0.006)	(0.006)			
Graduates					0.651*		
					(0.314)		
Industry graduates					-0.252*		
					(0.132)		
Financial transactions						-0.041***	
						(0.009)	
Real interest						0.026***	
						(0.004)	
Changes in patent appl.							0.002***
(industry)							(0.001)
Changes in citations							-0.003
(industry)							(0.009)
Constant	0.735***	0.958***	0.669***	0.553***	-4.135	0.734***	0.523***
	(0.037)	(0.109)	(0.046)	(0.051)	(2.951)	(0.051)	(0.042)
Observations	8324	5966	4571	6068	39011	49739	49693
R-squared	0.12	0.089	0.117	0.078	0.084	0.1	0.096
Contract start FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel C. Technological Focus

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alternative cycle	Investment	Demand	Demand	Cost	Cost	Finance	Technology
Measure	Capex	Sales	Receivables	# Employees	Researchers	Transactions /interest	Patents
Horizon	-0.046***	-0.034*	-0.061***	-0.059*	-0.026***	-0.031***	-0.027***
	(0.013)	(0.017)	(0.015)	(0.027)	(0.004)	(0.009)	(0.008)
Alternative cycle	-0.026**	0.011	0.015	0.037*			
	(0.01)	(0.025)	(0.012)	(0.019)			
Graduates					1.631***		
					(0.321)		
Industry graduates					0.116		
					(0.183)		
Financial transactions						0.027	
						(0.025)	
Real interest						0.013	
						(0.012)	
Changes in patent appl.							-0.004*
(industry)							(0.002)
Changes in citations							0.014
(industry)							(0.011)
Constant	0.980***	0.856***	1.061***	0.718***	-17.679***	0.797***	1.005***
	(0.119)	(0.099)	(0.099)	(0.162)	(2.08)	(0.12)	(0.041)
Observations	957	458	668	364	2439	2914	2872
R-squared	0.567	0.643	0.527	0.539	0.591	0.563	0.557
Contract start FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. Contract horizon is the number of years until expiration. Alternative cycle is the position in the cycle indicated in the column caption. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 13 – Sticky contracts and historical innovation cycles

Panel A. Scaled Citations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alternative cycle	Investment	Demand	Demand	Cost	Cost	Finance	Technology
Measure	Capex	Sales	Receivables	# Employees	Researchers	Transactions /interest	Patents
Predicted Horizon	0.143***	0.242***	0.169***	0.222***	0.089***	0.109***	0.106***
	(0.042)	(0.023)	(0.035)	(0.039)	(0.023)	(0.014)	(0.013)
Alternative cycle	0.072	-0.048***	0.023	-0.07			
	(0.042)	(0.013)	(0.017)	(0.056)			
Graduates					-2.103		
					(1.153)		
Industry graduates					0.012		
					(0.45)		
Financial transactions						-0.115*	
						(0.061)	
Real interest						-0.001	
						(0.023)	
Changes in patent appl.							0.087
(industry)							(0.092)
Changes in citations							0.073
(industry)							(0.16)
Constant	-0.675**	0.517***	1.832***	-2.404***	21.197**	-0.753	-1.163**
	(0.256)	(0.067)	(0.305)	(0.36)	(9.335)	(0.519)	(0.524)
Observations	5363	6917	5506	3538	17899	19100	19096
R-squared	0.116	0.073	0.077	0.089	0.103	0.102	0.102
Contract start FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Generality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alternative cycle	Investment	Demand	Demand	Cost	Cost	Finance	Technology
Measure	Capex	Sales	Receivables	# Employees	Researchers	Transactions /interest	Patents
Predicted Horizon	0.036***	0.062***	0.031***	-0.039***	0.036***	0.026***	0.028***
	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
Alternative cycle	0.023	-0.016***	0.037***	0.093***			
	(0.016)	(0.004)	(0.005)	(0.007)			
Graduates					0.354		
					(0.236)		
Industry graduates					-0.255*		
					(0.124)		
Financial transactions						0.054**	
						(0.021)	
Real interest						0.016**	
						(0.006)	
Changes in patent appl.							0.004
(industry)							(0.008)
Changes in citations							0.064***
(industry)							(0.019)
Constant	0.970***	0.520***	0.580***	0.252***	-1.179	0.349**	0.556***
	(0.085)	(0.041)	(0.045)	(0.034)	(2.069)	(0.119)	(0.091)
Observations	2015	3365	2264	1523	7933	9005	9005
R-squared	0.142	0.089	0.073	0.097	0.12	0.131	0.129
Contract start FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel C. Technological Focus

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alternative cycle	Investment	Demand	Demand	Cost	Cost	Finance	Technology
Measure	Capex	Sales	Receivables	# Employees	Researchers	Transactions /interest	Patents
Predicted Horizon	-0.072**	-0.050*	-0.013	-0.049	-0.016*	-0.026**	-0.024***
	(0.028)	(0.026)	(0.037)	(0.046)	(0.007)	(0.011)	(0.008)
Alternative cycle	-0.028	0.001	-0.057	0.028			
	(0.029)	(0.031)	(0.051)	(0.046)			
Graduates					0.302		
					(0.619)		
Industry graduates					0.950**		
					(0.372)		
Financial transactions						0.035	
						(0.096)	
Real interest						-0.001	
						(0.019)	
Changes in patent appl.							-0.154*
(industry)							(0.078)
Changes in citations							0.137*
(industry)							(0.065)
Constant	0.945***	0.977***	1.098***	0.954***	-11.059**	0.704	0.813***
	(0.161)	(0.173)	(0.111)	(0.219)	(4.34)	(0.458)	(0.066)
Observations	211	88	128	87	364	384	381
R-squared	0.625	0.696	0.687	0.674	0.654	0.613	0.627
Contract start FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. Predicted contract horizon is the number of years until a hypothetical expiration year, calculated as the start-year of the contract plus the distance between start and expiration years of the previous contract. Alternative cycle is the position in the cycle indicated in the column caption. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 14 – Matched firms without fixed-term contracts

Panel A. Citations

Matching	Contract horizon 5		4		3		2		1		Short <3		Long >3	
Capex cycle	5.82	***	2.97	***	3.35	***	1.14	***	0.28		0.17		3.70	***
	51.63		33.01		15.71		5.23		0.91		1.32		56.20	
Sales cycle	0.21		-1.12	***	-1.43	***	1.33	***	0.55	**	-1.60	***	-0.93	***
	0.75		-10.65		-5.52		6.31		2.16		-8.41		-8.26	
Receivables cycle	-1.95	***	-0.89	**	1.37	***	-3.40	***	-1.76	***	-2.39	***	-0.34	**
	-4.10		-3.48		7.88		-10.86		-4.77		-15.21		-2.14	
Employee cycle	2.51	***	2.95	***	1.87	***	3.03	***	3.72	***	1.38	***	1.78	***
	33.34		20.42		5.91		7.69		7.81		6.90		26.45	

Panel B. Generality

Matching	Contract horizon 5		4		3		2		1		Short <3		Long >3	
Capex cycle	0.09	***	0.14	***	0.02	*	0.00		-0.01		0.00		0.09	***
	7.43		11.85		1.89		0.08		-0.64		-0.25		13.50	
Sales cycle	0.09	**	0.01		-0.01		0.00		0.04	*	0.00		0.03	**
	2.73		0.84		-1.26		0.16		1.65		0.36		2.82	
Receivables cycle	-0.04		0.05	**	0.05	**	-0.06	**	-0.03		-0.02	*	0.05	**
	-0.94		2.05		3.60		-3.18		-1.18		-1.96		3.26	
Employee cycle	0.12	***	0.04	***	-0.07	***	0.02		0.09	**	0.06	***	0.09	***
	9.15		3.70		-6.07		1.12		3.43		4.32		12.94	

Panel C. Technological Focus

Matching	Contract horizon 5		4		3		2		1		Short <3		Long >3	
Capex cycle	-0.13	**	-0.01		0.00		0.01		0.00		0.01		-0.07	**
	-2.48		-0.29		0.00		0.17		0.00		0.58		-2.34	
Sales cycle	-0.05		-0.07		-0.01		0.03		0.03		0.02		-0.06	*
	-0.64		-1.35		-0.23		0.80		0.70		0.92		-1.71	
Receivables cycle	-0.01		-0.02		-0.03		0.06	*	0.04		0.04	**	-0.06	*
	-0.07		-0.41		-0.69		1.69		1.30		2.11		-1.64	
Employee cycle	0.10		-0.07		-0.05		0.00		0.02		0.01		-0.05	
	0.70		-0.81		-1.03		0.01		0.50		0.21		-1.01	

This table presents the covariate means for the original sample and a matched sample including firm-years of the COMPUSTAT population between 1992 and 2008 with no fixed-term CEO contract and the closest propensity scores to the original sample (10 nearest neighbours). Propensity scores are computed as fitted values of regressions with the contract type as the dependent variable. Independent variables are size, ROA, market-to-book, industry, year, and the position in the cycle indicated in the left column. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

Table 15 – Selection into the sample

Dependent Variable	(1) Scaled Citations	(2) Generality	(3) R&D	(4) Tech. Variety
Horizon	0.053***	0.020***	0.008***	-0.020***
	(0.014)	(0.004)	(0.003)	(0.004)
Mills ratio	0.100	0.028	0.059	0.711***
	(0.084)	(0.019)	(0.079)	(0.186)
Constant	0.811***	0.657***	0.101***	0.027
	(0.095)	(0.024)	(0.038)	(0.051)
Observations	57,643	31,447	3,414	2,870
R-squared	0.122	0.132	0.670	0.707
Start contract FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

This table presents the results of OLS regressions, reporting coefficients and standard errors underneath that are heteroskedasticity robust and clustered by firm. The dependent variables are as reported in the Panel title. Contract horizon is the number of years until expiration. The Mills ratio is computed using the regression reported in Table A.2, column 2. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.

APPENDIX

Table A.1. At-will Exceptions

Code	State	At-will exceptions		
		Public policy	Implied contract	Good faith and fair dealing
AL	Alabama	0	1	1
AK	Alaska	1	1	1
AZ	Arizona	1	1	1
AR	Arkansas	1	1	0
CA	California	1	1	1
CO	Colorado	1	1	0
CT	Connecticut	1	1	0
DC	District of Columbia	1	1	0
DE	Delaware	1	0	1
FL	Florida	0	0	0
GA	Georgia	0	0	0
HI	Hawaii	1	1	0
ID	Idaho	1	1	1
IL	Illinois	1	1	0
IN	Indiana	1	0	0
IA	Iowa	1	1	0
KS	Kansas	1	1	0
KY	Kentucky	0	1	0
LA	Louisiana	0	0	0
ME	Maine	0	1	0
MD	Maryland	1	1	0
MA	Massachusetts	1	0	1
MI	Michigan	1	1	0
MN	Minnesota	1	1	0
MS	Mississippi	1	1	0
MO	Missouri	1	0	0
MT	Montana	1	0	1
NE	Nebraska	0	1	0
NV	Nevada	1	1	1
NH	New Hampshire	1	1	0
NJ	New Jersey	1	1	0
NM	New Mexico	1	1	0
NY	New York	0	1	0
NC	North Carolina	1	0	0
ND	North Dakota	1	1	0
OH	Ohio	1	1	0
OK	Oklahoma	1	1	0
OR	Oregon	1	1	0
PA	Pennsylvania	1	0	0
RI	Rhode Island	0	0	0
SC	South Carolina	1	1	0
SD	South Dakota	1	1	0
TN	Tennessee	1	1	0
TX	Texas	0	0	0
UT	Utah	1	1	1
VT	Vermont	1	1	0
VA	Virginia	1	0	0
WA	Washington	1	1	0
WV	West Virginia	1	1	0
WI	Wisconsin	1	1	0
WY	Wyoming	1	1	1

This table presents the at-will exceptions by state.

Table A.2 – Selection into the sample

		(1)	(2)
		Dependent variable: Fixed-term contract	
Geography	Exception rule	-0.135***	-0.148***
		(0.05)	(0.04)
	Anti-takeover	-0.006	
		(0.03)	
	Garmaise	0.006	
		(0.01)	
Disclosure quality	Assets	-0.051***	-0.052***
		(0.01)	(0.01)
	Log number of SEOs	0.213***	0.213***
		(0.07)	(0.07)
	Restatement	0.063	
		(0.06)	
	Analyst forecast STD	0.001	
		(0.0014)	
Risk	Industry survival rate	1.510***	1.443***
		(0.56)	(0.54)
	Industry homogeneity	-0.628**	0.052
		(0.25)	(0.52)
	Industry sales volatility	-0.203	
		(0.17)	
Governance	Renewal	2.879***	2.880***
		(0.07)	(0.07)
	Tenure	0.010***	0.010***
		(0.002)	(0.002)
	Age	-0.006***	
		(0.002)	
Constant		-3.125***	-2.811***
		(0.63)	(0.62)
Observations		21,745	21,745
Industry FE		Yes	Yes
Year FE		Yes	Yes

This table presents marginal effects from Probit regressions and standard errors (in parentheses) that are heteroskedasticity robust and clustered by year. All variables are measured in the last fiscal year ending before the start date of the contract. Asterisks indicate that the estimates are significantly different from zero at the *** 1% level, ** 5% level, * 10% level.