Corporate Strategy, Technology Peers, and CEO Compensation

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Key words: CEO Compensation, Pay for Luck, Technology Similarity, Strategic Flexibility, Innovation, Performance benchmarking, and Optimal Contracting.

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Abstract

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1. Introduction

Developing and implementing firm's corporate strategy is one of the most important responsibilities of a CEO.[1] In this paper, we examine the role of CEO compensation in implementing corporate strategy. Theoretically, in the presence of agency conflicts, CEO compensation policy can be used to incentivize the CEO to select the optimal strategy in the best interest of the shareholders (e.g., Dow and Raposo, 2005; and Gopalan, Milbourn, and Song, 2010). In particular, Gopalan, Milbourn, and Song (2010) model CEO's strategic decision of selecting firm's optimal exposure to sector performance, and show that allowing CEO compensation to be exposed to sector performance ("pay for sector performance") is optimal for encouraging managers to adopt and implement strategies that maximize shareholder value. By rewarding CEOs for sector performance, CEOs are incentivized to seek out and increase the firms' exposure to better-performing sectors.

Despite the theoretical arguments for corporate strategy to influence CEO compensation, there has been little empirical work on the role of compensation policies in implementing corporate strategy. While Gopalan, Milbourn, and Song (2010), in support of their theoretical model, provide the only empirical evidence that CEO compensation is positively correlated with product-market sector performance, more recent studies (Albuquerque, 2009; Lewellen, 2015; Jayaraman, Milbourn, and Seo, 2015) have documented contrasting evidence that CEO compensation is *negatively* correlated with product-market sector performance, which is more consistent with the traditional contracting-based view (e.g., Holmstrom, 1979; Holmstrom and Milgrom, 1987) that managerial compensation should be benchmarked against firm's peers, which prevent managers from being rewarded from luck, and are compensated only for their own efforts.

However, all the existing research on relative performance evaluations has been focused on defining firm's peers or sectors based on firm's product market. While the lack of empirical results in

[1] In the 2008 *McKinsey Quarterly Survey* of corporate executives, the respondents answered that the boards spend most of their time on "strategy and execution", and expressed desire to spend even more time developing long-term strategies that can add to shareholder value (Chen, Osofsky, and Stephenson, 2008). This is consistent with the extant literature on the effects of CEO leadership and vision in guiding firm's strategy (e.g., Rotemberg and Saloner, 2000; Van den Steen, 2005).

favor of strategic incentives in looking at product market competitors do not by itself rule out strategic considerations in determining CEO compensation, they do suggest that other factors, such as consideration for inducing managerial effort and minimizing managerial rent may have greater influence on CEO pay with respect to firm performance related to its *product market*. Therefore, to examine the effects of corporate strategy, we explore defining firm's peers and sectors in a way that strategic considerations would have a first-order impact on CEO pay. We propose that examining firm's activities related to its innovation and technology is an ideal setting in which to study the importance of strategic considerations in determining CEO pay. To do so, instead of defining firm's peers based on firm's product market activities, we propose to examine pay for sector performance based on firm's *technology space*.

To further motivate our research question, consider as an example the Hewlett-Packard's (HP) introduction of new high-end workstations and servers in 2002. The innovation in the new products was the new 64-bit processor technology called *Itanium*, which was the result of HP and Intel's joint investments since the 1990s. The consequence of HP's initial decision to invest in the computer chip processor technology was that the subsequent success of HP's investments would depend heavily on the performance of the new processor technology and, specifically, the performance of its joint partner Intel, which are outside of firm's own control. Given that firm's own performance is driven partly by its exposure to certain technologies and the innovation efforts of others working on similar technology that are outside of CEO's own control, we ask in this paper whether CEO compensation should filter out such factors unrelated to CEO's own efforts, as predicted by the relative performance evaluation, or, in contrast, should the CEO be rewarded for the performance of Intel, as well as the overall processor technology sector performance, for making the right strategic decision to invest in this technology in the first place, as predicted by Gopalan, Milbourn, and Song (2010). Such question cannot be answered if we simply follow the traditional product market-based approach of defining firm's peers and sectors as companies like Intel does not compete directly with HP, and would not be captured by any existing studies on performance benchmarking.

Examining the performance of firm's technology peers is ideal setting to test for "pay for sector performance" because it directly reflects firm performance that are attributable to CEO's innovation and technology decisions. First, as argued in Seru (2014), firm's investments in innovation and technology are inherently subject to higher degrees of uncertainty and information asymmetry between the managers and the outside evaluators compared to other traditional investments. This is consistent with the idea that innovation is a process of experimentation and learning, which the agent must rely on the informative signals generated in the intermediate stages to make optimal decisions (Manso, 2011). However, such signals are unlikely to be observed by the outside investors who are far away from the actual innovation activities. Given the intangible nature of innovation, outside investors are less likely to have timely signals to monitor and intervene in manager's decisions regarding technology and innovation. As modeled in Gopalan, Milbourn, and Song's (2010) an important mechanism that drives firms to compensate CEOs based on sector performance is the outside investors cannot observe manager's private signal about the viability of the project. Thus contracting based on sector performance is necessary to induce the manager to exert effort in choosing the optimal strategy. In contrast, if the investors also have other signals of future viability of firm's performance, then pay for sector performance may be unnecessary as they can contract directly on those measures, or directly implement monitoring as an alternative device to induce optimal decision-making. Thus, the high degrees of information asymmetry suggest that pay for technology sector performance is likely to be an important mechanism for inducing strategic efforts.

Furthermore, many scholars have described innovation as a process in which strategic decisions on project selection (innovation versus convention, experimentation of new idea versus exploitation of existing ideas) dominate problem of inducing effort (e.g., Holmstrom, 1989; Holmstrom and Milgrom, 1991; Manso, 2011). This contrasts the traditional models predicting relative performance evaluations in which inducing managerial effort is the primary focus of the principal. Thus, with regards to firm's technology peers, pay for sector performance, rather than performance benchmarking, may play a more prominent role. Lastly, while theoretically, any of firm's peers that share the common economic characteristics can be used to benchmark company's performance, existing research suggest that firms tend to focus on the select number of firm's peers who compete in the same product market (De Angelis and Grinstein, 2013; Lewellen, 2015). Given that many of firm's technology peers do not compete directly with the firm, looking at firm's technology sector is likely to give us variations in firm performance that are outside of board's limited attention in determining appropriate benchmarks.

To construct technology peers, we estimate each pair of firms' closeness in technology space. Specifically, we use companies' portfolio of patent grants and their classifications obtained from NBER's Patents Database (Hall, Jaffe, and Trajtenberg, 2001) to construct a measure of technology similarity which captures the overlap in two firms' patent classifications of their respective patent grants. Such a measure has been used in previous studies examining the effects of technology spillovers (e.g., Jaffe, 1986; Bloom, Schankerman, and Van Reenen, 2013) and more recently in examining the effects of technology similarity on mergers and acquisitions likelihoods and outcomes (e.g., Bena and Li, 2014). Based on this measure of technological closeness, we define, for each firm-year, technology-space peers who have the highest technology proximity to the firm. We then take an (equal- or similarity-weighted) average of technology peers' prior 12-month stock returns to construct a measure of firm's technology peer performance. We also supplement return-based performance metric with accounting-based measures of peer performance. Since a firm's technology space may have an overlap with firm's product market space, which can also be part of firm's compensation benchmarking, we define firm's product market industry peers using the product similarity measure from Hoberg and Phillips' (2010, 2015) textual-based measure of product similarity from firm's product descriptions in annual reports, which is also used in Jayaraman, Milbourn, and Seo (2015) to study performance benchmarking. We then similarly build measures of product market peer performance using past 12-month returns and other accounting-based measures of firm performances.

Using the measure of technology peer performance, we find strong empirical supports for the existence of pay for technology sector performance. Specifically, we show that CEO compensation has positive sensitivity to technology peer performance, suggesting that companies do indeed pay their CEOs more potentially for firm performance that are attributable to positive shocks to firm's technology sectors: A 25% increase in technology peer group returns (corresponding to one standard deviation of technology peer group returns) is associated with 3% to 6% increase in CEO compensation, in par with the opposite direction of change predicted by the performance benchmarking effect in previous literature. We show that this sensitivity is positive and significant even after controlling for other firm-related factors and also controlling for product market peer performance, which can overlap with firm's technology space. Our finding is consistent with Gopalan, Milbourn, and Song's (2010) "pay for sector performance.

One alternative explanation for our result may be that we are simply capturing the increase in the value of CEO's outside options as other related peers compete to hire CEOs from similar technology related companies in response to positive shocks to their technology space. We show that even after controlling for the outside option value of CEOs coming from labor market competition for CEO talent, CEO compensation show positive sensitivity to technology peer performance. Furthermore, in contrast to the notion that the positive sensitivity to peer performance may be the result of managerial rent extraction due to inefficient contracting by CEOs who set their own compensation due to their power of their own boards, we find that the positive sensitivity to technology peer performance is stronger for firms with good governance, as proxied by governance and entrenchment indices from Gompers, Ishii, and Metrick (2003) and Bebchuk, Cohen, and Ferrell (2009).

To further pinpoint the mechanism of relevant strategic choices, we test whether the observed positive sensitivity is stronger for firms that are more likely to make significant strategic decisions. First, we compare the performance sensitivity of recently hired CEOs versus CEOs with long tenure, given that firms with relatively recent changes in CEO position are more likely to be the ones with greater strategic considerations and flexibility. Indeed, we find that the positive sensitivity to technology peer performance is stronger for recently hired CEOs compared to CEOs with longer tenure. Secondly, we compare firms based on their level of M&A activities. Consistent with numerous anecdotal evidence such as mergers and acquisition cases of Google and Motorola, and Pharmacia & Upjohn and Monsanto, previous studies have documented that many firms buy target firms in order to acquire new technologies that do not overlap with the firm's existing technology (e.g., Servilir and Tian, 2012; Bena and Li, 2014). We thus conjecture that firms with higher levels of M&A activities are more likely to be the ones that have the greater intention to shift their technological focus, and therefore, more likely to be concerned with choosing the right corporate strategy. When we test this idea by comparing our main results based on firm's level of M&A activity, we find that the positive sensitivity of CEO compensation to technology peers' performance is stronger for the firms with higher levels of M&A activity. These results are consistent with the idea that the "pay for sector performance" with respect to technology space shocks does not reflect managerial rent extraction, but rather reflect the result of optimal contracting decisions made by the firm's investors and the board.

Finally, we show that our results are robust to various robustness tests and placebo tests. If optimal strategic exposure is the main driver of the positive relation between compensation and technology peer performance, then we should observe weaker, if not negative, relation when we observe CFO compensation, rather than CEO pay, given that CEOs are mainly responsible for making strategic decisions and leading companies with their visions. Indeed, we find that CFO compensation is actually negatively correlated with technology peer performance, which is consistent with optimal performance benchmarking. Lastly, we show that our results are consistent with using both equal-weighted and value-weighted averages of peer performance.

Our paper is closely related to the CEO compensation focusing how peer performance is used in determining CEO compensation (Gibbons and Murphy, 1990, Jensen and Murphy, 1990, Barro and Barro, 1990, Janakiraman, Lambert, and Larcker, 1992, Aggarwal and Samwick, 1999, Murphy, 1999, Bertrand and Mullainathan, 2001; Bebchuk and Fried, 2004; Albuquerque, 2009; Gopalan, Milbourn, and Song , 2010; Lewellen, 2015; and Jayaraman, Milbourn, and Seo, 2015). By measuring and utilizing a unique measure of firm's technology peers, we contribute to the literature by providing novel empirical evidence for the "pay for sector performance" hypothesized by Gopalan, Milbourn, and Song (2010). Since paying for sector performance reflects firm's optimal decision to incentivize greater strategic efforts from the manager, our results provide an explanation for why CEOs often seemed to be compensated for luck. Our evidence of positive sensitivity of CEO pay to technology peer performance, along with the existing evidence that firms benchmark performance against its product market peers, also suggest that firms do not face a naïve choice between performance benchmarking and pay for sector performance, but is able to distinguish firm performance attributable to different types of CEO's efforts (strategic versus hard work), and appropriate compensate CEOs for their decisions.

Our findings also contribute to the growing literature examining the importance of CEO leadership and vision in determining corporate strategy (e.g., Rotemberg and Saloner, 2000; Van den Steen, 2005; Bolton, Brunnermeier, and Veldkamp, 2010), and the role of compensation and incentives in strategic decision-making (Dow and Raposo, 2005; and Gopalan, Milbourn, and Song, 2010). Our empirical evidence suggests that boards of directors and CEOs consider firm's corporate strategy to be an important part of their decision making process , and rationally reflect such considerations in setting CEO compensation. Furthermore, our evidence also suggests that the consideration for strategic decisions are most strongly reflected in CEO compensation, compared to other executives in the firm.

Finally, our paper is related to a growing body of literature examining the links between firm's innovation policy and managerial compensation (Manso, 2011; Baranchuk, Kieschnick, and Moussawi, 2013; Ederer and Manso, 2013), and more broadly, to firm's corporate governance (Tian and Wang, 2014; Seru, 2014). We show that firm's innovation and residing technology space have a first-order effect not only on the types of incentives that are provided to the firm, but also on how firms determine and reward CEOs based on their performance relative to other groups of firms.

The rest of the paper is organized as follows. Section 2 develops our hypotheses and predictions on sensitivity of CEO compensation to technology peer performance. Section 3 explains our empirical design and data. Section 4 contains our main results, and examines potential channels that can explain our main results, along with robustness tests, and Section 5 concludes.

2. Hypotheses Development

2.1. Performance Benchmarking and Pay for Luck

A large body of work in the compensation and incentives literature (e.g., Holmstrom, 1979; Holmstrom and Milgrom, 1987) advocate the use of performance benchmarking, in which the managers are compensated for their own contributions to the outcome (skill), and not on things that are beyond their control, such as good firm performance due to market upswing or industry shocks (luck). One way to avoid paying the managers for luck would be to benchmark managers' performances to their industry peers or to overall market conditions, such that managers would only get paid for beating the performance of its peers. We extend this argument to predict that CEO compensation should also be benchmarked against its technology peers given that they also share the same economic shocks that are out of CEO's controls. A CEO, for example, should not be paid more for an increase in firm performance or stock price due firm's exposure to positive shocks to its technology space.

However, a large body of empirical work has found little evidence for performance benchmarking, and have attributed this to the possibility of suboptimal contracting and managerial rent extraction (Gibbons and Murphy, 1990, Jensen and Murphy, 1990, Barro and Barro, 1990, Janakiraman, Lambert, and Larcker, 1992, Aggarwal and Samwick, 1999, Murphy, 1999, Bertrand and Mullainathan, 2001; Bebchuk and Fried, 2004). Under the managerial rent extraction hypothesis, CEOs are paid inefficiently for luck due to their power over the firm and the boards, and therefore, are able to set their own compensation rather than by the boards of directors on behalf of the shareholders. Thus, CEO compensation should have zero or positive sensitivity to benchmarking peers. In extending this argument to firm's technology peers, we expect under the managerial rent extraction hypothesis that CEO compensation may response positively to technology peer performance as they are paid for luck through positive shocks to their technology space.

2.2. Labor Market Compensation

The presence of pay for luck, however, may not be an evidence of inefficient contracting. One potential explanation for pay for luck is that it reflects the presence of competitive labor market for CEO talents (Oyer, 2004). Under the labor market competition hypothesis, a positive shock to an industry may increase the competition for CEOs as firms compete to increase their investments to benefit from the shocks. Thus, firms have to pay the CEOs more, not because of incentives reasons, but because of an increase in the value of CEOs' outside options. Under this hypothesis, CEO compensation would be sensitive not to peer performance, but to peer CEO compensation, which seems be consistent with recent empirical evidence (Bizjak, Lemmon, and Naveen, 2008; Faulkender and Yang, 2011; Bizjak, Lemmon, and Nguyen, 2011). Under the labor market competition hypothesis, therefore, we expect to see that CEO compensation is positively correlated with technology peer compensation as firms within the same technology space may compete for the same CEO talents.

2.3. Innovation and Strategic Flexibility

While labor market competition may potentially explain the presence of pay for luck, it predicts more precisely that CEO compensation should be benchmarked on peer compensation, and not on peer performance. An alternative theory that predicts efficient contracting on positive peer performance is Gopalan, Milbourn, and Song (2010). In their model, managers have the flexibility to choose the optimal strategy of the firm going forward. In making the optimal decision, managers can put in costly effort to seek valuable information about the future prospects of each possible strategy. Because managerial effort and choosing optimal strategy is unobservable to the principal, Gopalan, et. al. show that it may be optimal to tie managerial compensation to peer performance as a way to incentivize the manager to choose the optimal exposure to sector performance.

Given that firm's technology and R&D efforts are inherently uncertain and face higher degrees of information asymmetry (Seru, 2015), considerations for strategic flexibility is likely to play an important role in determining how CEOs are compensated based on firm performance related to its innovation activities. Furthermore, innovation is often described as a process of learning and experimentation, which generates many intermediate signals in which the agent must react to (e.g., Manso, 2011). Therefore, "pay for sector performance" would be ideal given that alternative methods for inducing optimal strategic decisions are scarce: outside investors and the board lack the power to intervene with monitoring or to contract on observable actions. This environment is consistent with the modeling assumptions in Gopalan, Milbourn, and Song (2010) that managers can obtain private information on future sector profitability that is unobservable to the investors. Furthermore, the agent engaging in innovation always faces a tension between choosing to innovate versus choosing to stay with the convention, which involves different types of incentives than simply inducing greater effort (e.g., Holmstrom, 1989; Holmstrom and Milgrom, 1991; Manso, 2011). Thus, the incentive to induce costly effort from the manager, which is the focus of the performance benchmarking practice, may not be great when we consider firm's innovation activities.

3. Empirical Design and Data

3.1. Empirical Design

To test these hypotheses, we estimate a reduced-form model of CEO compensation and peer performance, which follows Manski (1993), Leary and Roberts (2011), and Lewellen (2015):

$$\Delta CEO\ Compensation_{i,t} = \alpha + \beta_1 \Delta Technology\ Peer\ Performance_{it} + \\ + \beta_1 \Delta Product\ Market\ Peer\ Performance_{it} + \beta_2\ \Delta Firm\ Performance_{it} + \beta_3' \Delta Controls_{it} + e_{it}$$

We implement a weak-form test of the performance benchmarking hypotheses where the optimal benchmarking removes some, but not all, component of peer group effects from managerial compensation. This is motivated by Lambert and Larcker (1992) who show that when a CEO's own action influences the performance of its peers, then it is not optimal remove all component of peer performance as it contains some information about CEO's own performance. We therefore expect that the technology peer sensitivity of CEO compensation, β_1, to be negative under performance benchmarking, and positive in the presence of pay for luck. We estimate our model by first differencing the variables to eliminate any time-invariant firm or industry effects that may bias our estimate on technology peer performance. We also include time fixed effects in all specifications.

Our primary measure of *Technology Peer Performance* is the prior 12-month stock returns of firm's technology peers. We also include other proxies for technology peer performance, such as peer ROA, ROE, and Tobin's Q, to check whether compensation is benchmarked against accounting measures of performance. We also follow the previous literature in controlling for firm's own performance along with technology peer performance. Furthermore, in some specifications, we include and compare the results on technology peer performance to product market peer performance given a likely overlap in firm's technology space and product market space.

One possibility is that the estimate on *Technology Space Peer Returns* may simply capture the effects of labor market competition for CEO talent in a profitable technology space as discussed in Section 2.2. If there are limited number of potential CEOs in a given technology space, then the positive correlation between *Technology Space Peer Returns* and CEO compensation may simply be a reflection of more profitable investment opportunities within the technology space as companies optimally benchmark CEO compensation not on peer performance, but on peer compensation to reflect increased value of CEO's outside options. To test this, we include changes in log of *Technology Space Peers Compensation* as an additional control in our main regressions. Increasing value of CEO's outside options should also be reflected in the compensation for other CEOs in the same technology space. We include both contemporaneous changes in peers compensation and lagged changes in peers compensation because it may be possible that the board of directors do not have information on other firms' compensation levels for the same year in which they set their CEO compensation.

3.2. CEO Compensation and Firm-Related Variables

We begin with a sample of annual CEO compensation from Execucomp database, which contains executive compensation data on US public companies from 1992. We keep only CEO compensation details and eliminate non-CEO executives from the sample. Following the literature on pay for luck, we use natural log of *Total Compensation* (tdc1) from Execucomp data as our measure of CEO compensation. We complement CEO compensation data with other firm-related accounting variables from Compustat. Specifically, we build *ROE* equal to net income (ni) over book value of equity (ceq), *ROA* equal to operating income before depreciation (oibdp) minus income taxes (txp), divided by total book assets (at), *Sales/AT* equal to sales (sale) over book value of assets (at), *Debt/AT* as long-term debt plus short term debt, divided by book assets, and *MB*, which is the market-to-book ratio, as market value of equity (csho*prcc_f) plus total book assets (at) minus the book value of equity(ceq), and *ln(at)* as the natural log of assets. We adjust book value of assets and total compensation for inflation using CPI and 2008 dollars as the baseline. We also use CRSP data file to obtain 12-month fiscal year stock returns, *Firm Return*, for each firm in our sample. In using CRSP data, we eliminate any firms which had observations with price less than five dollars, and added delisting returns if the firm delisted during the year.

3.3. Technology-Space Peers

We next define technology peers for each firm-year. Technology peers are a group of firms with the closest technology similarity as a given firm in each year. To do so, we construct a proxy for technology similarity between two firms using the Jaffe (1986) measure of closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office. Specifically, we define a technology similarity between *firm i* and *firm j* in year t as

$$Technology\ Similarity_{ij,t} = \frac{F_{i,t}F_{j,t}'}{(F_{i,t}F_{i,t}')^{0.5}(F_{j,t}F_{j,t}')^{0.5}}$$

where F_{it} is the 1 by τ vector of firm i's proportion of patents granted in technology space 1 through τ in year t, where τ is the number of different patent classification class. Thus, the *Tech Similarity* measure is the normalized uncentered correlation between the two firms' patent shares. In generating the vector, F_{it} of patent shares for each year, we use the number of patents that have been applied for within that year, granted than the actual granted year. We do so to capture the timing of firm's actual patenting activity since the grant year can be many years away from when the innovation actually took place.

The Jaffe measure of technology closeness and similar variants have been used to examine the effects of technology spillovers (e.g., Jaffe (1986) and Bloom, Schankerman, and Van Reenen (2013)), and more recently, in examining the effect of technology similarity on merger incidence and post-merger outcomes (Bena and Li, 2014). We obtain patent data from NBER Patent database from Hall, Jaffe, and Trajtenberg (2001), which contains patent-level information on patents granted by US Patents and Trade Office from 1976 to 2006, with 428 different possible patent classes that can be assigned to a patent. We match patent assignees from the NBER patent data to Compustat using the assignee name-gvkey link from NBER Patent database.

We then define a group of firms with ten highest technology similarity score as the firm's *Technology-Space Peers*. To examine the effect of technology-peer performance on CEO compensation, we estimate the average stock returns of technology peers to construct *Technology Peer Stock Return*.[7] In addition, to test potential labor market effects of technology peers, we construct *Technology Peer Compensation*, which is the average CEO compensation of technology peers.

3.4. Product Market Peers

Product market rivals and sector performance have also been documented to affect CEO compensation. Because technology-space peers may also be competing in the same product market space, we want to distinguish the effects of technology-space peers from product market rivalry. To define product market peers, we use product market similarity score from Hoberg and Phillips (2010, 2015), who use textual analysis to find overlaps in firms' words in product description from the annual reports.[8] We thus define product market peers for each firm-year as firms with the ten highest product market

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[7] In Section 6, we show that our results are similar when we use value-weighted average performance and compensation.

[8] The data was downloaded from Hoberg and Phillips Data Library at http://alex2.umd.edu/industrydata/. We thank Dr. Hoberg and Dr. Phillips for making the data available.

similarity. We then construct *Product Market Peer Return* as the average *Firm Return* of product market peers, and *Product Market Peer Compensation* as the average CEO compensation of its product market peers.

3.5. Summary Statistics

We winsorize all variables at 1% level for both tails. Table 1 reports the summary statistics. Our final sample consists of 8,346 firm-year observations with 3,219 unique firms from years 1992 to 2006. The average *Firm Return* is 16.0%, with a standard deviation of 43.6%. This is closely matched by the average *Tech Space Peer Return* of 16.6% and the average *Product Market Peer Return* of 17.6%. However, the standard deviations of peer returns are understandably lower compared to firm return. The natural log of CEO's total compensation, *ln(Total Compensation),* has an average of 8.168. The average dollar value of *Total Compensation* per year for the CEO in our sample is 6.82 million dollars, with a standard deviation of 1.77 million dollars. The average *Tech Space Peer Compensation* and *Product Market Peer Compensation* are also close to firm average compensation. Overall, the average firm-level variables closely match the average of firm's technology space and product market space peers.

Table 2 reports the correlation between our main variables. Of note, the correlation between *Firm Return* and *Tech Market Peer Return* is positive at 26.2%. Similarly, the correlation between *Firm Return* and *Product Market Peer Return* is 41.2%. On the other hand, the correlation between *Tech Space Peer Return* and *Product Market Peer Return* is 43.9%. So there's a positive overlap but a significant distinction among firm performance, technology space peer performance and product market space peer performance.

4. Empirical Results

4.1. Main Results

Table 3 reports the main results on the test of technology-space peer effects on CEO compensation. We regress *Technology Peers Return* on the changes in *ln(Total Compensation)* along with various firm-related control variables. All variables except returns are using the changes in variables, so it captures within-firm time variations, and rules out any omitted time-invariant effects. We also include various characteristics of technology peers, including the changes in *ROE*, *ROA, ln(Assets), Sales to Assets*, and *MB* ratio. These results can potentially capture whether other metrics of technology peers' performances are also captured in CEO compensation. Even with additional controls, the *Technology Peer Return* coefficient is positive and significant. First, in Column (1), we implement our analysis using equal-weighted peer performance of ten closest technology peers. We find a positive and statistically significant relation between *Tech Space Peer Returns* and the changes in log compensation. The results are also economically significant: A one standard deviation increase (25% in technology peer group returns) in technology peer group's stock returns is associated with 3% to 6% increase in CEO compensation.

One plausible explanation for this result is the labor market competition for CEO talent as discussed in Section 2.2. When technologically similar firms do well, CEO's outside option value may increase if technologically related firms share in the common CEO talent pool. To test whether our results are driven by the labor market competition, we repeat our result with contemporaneous and lagged *ln*(*Technology Space Peer Compensation)* as additional controls (reported in Column (2)). We find that an increase in technology peer CEO's compensation level is positively correlated with own firm's CEO compensation level, which suggests that there exists indeed a labor market competition for CEO talent. However, *Technology Space Peer Returns* remains positive and significantly correlated with CEO compensation even after controlling for the labor market competition effect, and implies a strong presence of pay for luck with respect to technology peers.

In columns (3) and (4), we repeat our results using weighted-average peer returns where technology similarity scores as used as weights. Consistent with using equal-weighted averages, we find that CEO compensation is positively correlated with *Technology Space Peer Returns*. While we are careful not to interpret our results quantitatively in terms of the actual benchmarking of CEO compensation to peer performance given that this is s weak-form test of the performance benchmarking in

CEO compensation, the sensitivity of CEO to *Technology Space Peer Returns* is similar to the sensitivity to industry peer group effects and about one-fifth of the sensitivity of compensation to own firm stock returns. Hence, performance of peers in same technology space provides economically significant variations in CEO compensation.

Given that firm's closest technology peers are likely to also reside in the same product market space, is the positive sensitivity technology peer performance simply capturing pay for luck with respect to firm's product market as previous been documented in the literature? To avoid capturing the product market effects contained in the technological peers, we have controlled for the product market peer performance in all our specifications. In contrast to the notion of pay for luck in product markets, we actually find that *Product Market Peer Returns* is negatively correlated with CEO compensation, with insignificant estimates for equal-weighted returns, and significant estimates for product market similarity-weighted returns at 10% level. This is consistent with the usage of performance benchmarking in setting CEO compensation, and is consistent with the findings from Lewellen (2015). Overall, the results suggest that companies benchmark CEO compensation to its competitors, but give some degrees of pay for luck with respect to firms' technology space.

4.2. Managerial Rent Extraction

The positive relation between technology peer performance and CEO compensation potentially suggest that CEO compensation is not set optimally to filter out part of firm's performance that is not contributable to CEO's own effort or talent. We explore this possibility of rent extraction by examining whether the presence of pay for luck is more prominent in firms with poor governance versus good governance. The assumption is that firms with good governance would optimally set CEO compensation to filter out luck while poorly governed firms without strong monitoring of the CEO would overpay their CEOs.

We use Gompers, Ishii, and Metrick's (2003) governance index (*G-index*) and Bebchuk and Cohen, and Ferrell's (2009) entrenchment index (*E-index*) to proxy for firm's governance. These measures construct an index based on the number of management-favoring provisions and anti-takeover provisions in firm's charters and bylaws that shield CEO from potential takeover threats, which can serve as a monitoring and punishment mechanism for poorly performing CEOs.

Table 4 reports the results from comparing technology space pay for luck for good governance versus poor governance firms. We group firms into High G-index Firms for firms with higher than median G-index for the year, and Low G-index Firms for firms with lower than median G-index. We likewise sort firms into High E-index (poor governance) and Low E-index (good governance) again based on the median E-index score each year. Columns (1) and (2) repeats our main analysis for High G-index Firms (poor governance) using equal-weighted peer performance measures. For firms with high G-Index (poor governance), we find that *Technology Space Peer Return* is actually negatively correlated with CEO compensation, but the effects seem to be statistically insignificant. On the other hand, for firms with low G-index (good governance), we find a positive correlation between *Technology Space Peer Returns* and CEO compensation, consistent with our main results. The economic magnitude of the effect also seems to be consistent, if not larger, than for the entire sample. We also find similar results for entrenchment index. Firms with high E-index (poor governance) seem to have low and statistically significant sensitivity of CEO compensation to technology peer returns, but firms with low E-index (good governance) have strong positive and significant sensitivity to technology peer returns.

These results sharply contradict the hypothesis that the presence of technology peer pay for luck is due to suboptimal compensation and poor governance. In fact, the positive sensitivity of CEO compensation to technology peers seem to be driven by firms with good governance, which suggest that the firms may be optimally setting CEO compensation to have positive exposure to technology space performance. We explore this possibility further in the following subsection.

4.3. Length of CEO Tenure and Technology Peer Performance Sensitivity

We test in this subsection the possibility that the positive sensitivity of CEO compensation to technology peer performance reflect firm's optimal compensation decision. Gopalan, Milbourn, and Song

(2010) hypothesize that firms may optimally pay the CEO for industry sector performance rather than benchmarking firm performance on industry performance if CEOs have greater strategic flexibility. We test for the strategic flexibility hypothesize by examining whether the length of CEO tenure affects firm's likely to pay CEOs for technology sector performance. We posit that the changes in CEOs and CEOs with relatively short tenure could potentially capture the times in which choosing the right strategy and technology space to enter is of greater importance for the companies. On the other hand, CEOs with long tenure with the firm is likely to focus on developing and maintaining existing line of business.

We test this possibility in Table 5. We repeat our main analysis by dividing sample into firms with short CEO tenure as observations with below the median CEO tenure, and into long CEO tenure as firms with above the median tenure. As reported in columns (1) and (2), we find that the equal-weighted *Technology Space Peer Returns* is positively and significantly correlated with CEO compensation for firms with shorter CEO tenure. On the other hand, for the firms with long CEO tenure, the sensitivity to *Technology Space Peer Returns* is smaller in magnitude and also statistically insignificant. Likewise, we find similar results with similarity score-weighted peer returns as reported in columns (3) and (4). The fact that the pay for luck with respect to technology space peers is only present in CEOs relatively short tenure further point to strategic flexibility as the main motivation for this pay for luck.

4.4. M&A Activity and Technology Peer Performance Sensitivity

Here we examine an alternative proxy to capture the relative importance of strategic decisions in firms. We examine whether firms that are considering expanding their technology, rather than continuing to develop existing technology, is more likely to pay CEOs for sector performance given that strategic decisions would be of greater importance for firms looking to expand into other technology space. Existing studies (Servilir and Tian, 2012; Bena and Li, 2014) have noted that one prominent method of obtaining new technology is through acquisitions, rather than developing new technologies directly through firm's own R&D efforts. Thus, firms with high M&A activities are more likely to be firms wwith greater intent of entering potentially new technology areas while firms with low M&A activities may be focused on developing its existing technology. We therefore examine the heterogeneity in the compensation sensitivity to technology peer performance based on firm's M&A activity.

To test this, we utilize the existing definitions in the M&A literature that defines firms into "serial acquirers" and non-serial acquirers based on the frequency of acquisitions. We define firm as having *High M&A* activity if it has three acquisitions or more within the past three years, and having *Low M&A* activity otherwise. We also test the robustness of our definition using alternative cutoffs that have been used in the literature, such as having four (and five) or more acquisitions, and obtain similar results.

Table 5, columns (5) – (8) reports the sensitivity of CEO compensation to technology peer performance for *High M&A* firms versus *Low M&A* firms. Using equal-weighted 12-month Technology Space Peer Stock Returns in Columns (5) and (6), we find that the sensitivity of CEO compensation to technology peer is positive and significant for firms with *High M&A* activity. On the other hand, the sensitivity is insignificant and negative for firms with *Low M&A* activity. The results are similar when we use the similarity score-weighted technology peer returns in Column (7) and (8). These results confirm our hypothesis that firms with greater likelihood of engaging in strategic changes are more likely to practice pay for technology sector performance, and suggest that the positive sensitivity is unlikely to be driven by managerial rent extraction or labor market competition.

4.5. Technology Peer Performance Sensitivity of CFO Compensation

Our results thus far suggest that strategic flexibility with regards to firm's innovation policies may explain the pay for luck we document. One potential plausible placebo test of this possibility is to check whether chief *financial* officers (CFO) compensation, rather than CEO compensation, also exhibit sensitivity to technology peer performance. Given that CFOs are relatively less likely to be responsible for making strategic decisions firm's technology and innovation policies, testing the sensitivity of CFO pay will potentially tell us whether our results are driven by strategic flexibility considerations or by some other omitted or unconsidered factors. In contrast, managerial entrenchment and pay for luck hypotheses would predict similar sensitivity of CFO pay under the assumption that poorly governed firms with entrenched CEO would also have similar issues with their CFOs. To implement CFO pay sensitivity test, we obtain information on CFO pay from Execucomp, where we flag and keep observations with titles as CFOs. We then follow exact same procedures as with CEO compensation and repeat our main analysis.

Table 6 reports the analysis of technology peer performance sensitivity of CFO pay. The Columns (1) and (2) uses equal-weighted average of peer performance, while Columns (3) and (4) use weighted-average performance based on similarity scores as weights. Here, we find that CFO pay, in sharp contrast to CEO pay, does not exhibit positive sensitivity to technology peer returns in all specifications. In fact, with value-weighted average peer performance, the estimate is negative, which makes the power of the test unlikely to be an issue. On the other hand, CFO compensation exhibit strong negative sensitivity to *Product Market Peer Returns*, suggesting that CFO pays are not paid for luck. Interestingly, despite the lack of sensitivity to technology peer performance, CFO pay is positively related to technology peer compensation, suggesting that technology peer firms are important drivers of CFO's outside option value. These results further strengthen the strategic flexibility hypotheses as an explanation for positive technology peer sensitivity of CEO pay as the results are consistent with the conjecture that CEOs are mainly responsible for making strategic and innovative decisions within the company.

5. Conclusion

We examine in this paper whether or not CEOs are rewarded for firm performance that are attributable to its exposure to certain technology sectors. Traditional incentives and compensation literature advocates that CEOs should only be paid for performance that are attributable to factors under their own controls. However, we find a strong presence of "pay for luck" with respect to firm's technology space as we find that CEO compensation is positively correlated with performance with its closely related technology peers. Our results are stronger for firms with good governance than poor governance, which suggest that such pay for luck is unlikely to be driven by inefficient contracting and managerial rent extraction. However, the positive sensitivity is consistent with the "pay for sector performance" hypothesis of Gopalan, Milbourn, and Song (2010) as firms try to incentivize CEOs to make optimal strategic decisions by tying CEO compensation to sector performance. Our findings that the positive sensitivity to technology peer performance is stronger for recently hired CEOs than for CEOs with long tenure, and for firms who are seeking to enter new technology space rather than developing their existing technology seem to further strengthen the strategic flexibility hypothesis, and are weaker or absent when we examine CFO compensation. These findings overall uncover new channels in which the considerations for future strategy and innovation policies affect firms' compensation and governance practices.

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Table 1: Descriptive Statistics

This table reports the descriptive statistics of our main variables. Our sample consists of yearly CEO total compensation from 1992 to 2006, obtained from the Execucomp database. Firm-related variables include ROE, ROA, log of total assets, sales to assets ratio, and market-to-book ratio, which are obtained from Compustat. We then obtain 12-month fiscal year firm returns from CRSP. We then construct corresponding equal-weighted returns, compensation, ROE, ROA, log assets, Sales to Assets, and Market-to-Book ratio for firm's ten closest technology peers. We define technology similarity between two firms using the Jaffe (1986) measure of technology closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office obtained from NBER Patent Database (see Section 3.3 for details). We also build a corresponding equal-weighted average product market peer returns and variables using Hoberg and Phillip's (2010, 2015) product market similarity measure.

Variables	N	Mean	StDev	Min	Max
A. Technology Space Peer Group Characteristics (Equal-Weighted)					
Tech Peers Return	8346	0.166	0.192	-0.431	1.328
ln(Tech Peers Compensation)	8346	8.351	0.413	6.871	9.997
Tech Peers ROE	8346	0.129	0.081	-0.235	0.445
Tech Peers ROA	8346	0.134	0.028	0.020	0.250
Tech Peers Ln(Assets)	8346	8.174	0.619	5.789	10.410
Tech Peers Sale/Assets	8346	-0.091	0.206	-1.282	0.660
Tech Peers MB	8346	2.093	0.525	1.021	5.693
B. Product Market Peer Group Characteristics (Equal-Weighted)					
PM Peers Return	6746	0.176	0.276	-0.676	1.838
ln(PM Peers Compensation)	6749	8.180	0.501	5.644	10.646
PM Peers ROE	6749	0.113	0.108	-0.946	1.015
PM Peers ROA	6741	0.133	0.045	-0.133	0.413
PM Peers Ln(Assets)	6749	7.640	0.885	4.744	11.504
PM Peers Sale/Assets	6749	-0.147	0.456	-2.801	1.352
PM Peers MB	6749	2.241	0.943	0.845	8.506
C. Firm Characteristics					
ln(Total Compensation)	8346	8.169	1.051	5.644	10.646
Total Compensation (in millions)	8346	6.816	17.74	<0.01	864.7
Firm Return	8346	0.160	0.436	-0.676	2.027
ROE	8346	0.120	0.224	-0.946	1.015
ROA	8346	0.136	0.081	-0.133	0.413
ln(Assets)	8346	7.772	1.595	4.656	12.455
ln(Sale/Assets)	8346	-0.115	0.577	-2.883	1.352
MB	8346	2.201	1.419	0.845	8.506

Table 2: Correlations

This table reports the correlations of our main variables. Our sample consists of yearly CEO *Total Compensation* from 1992 to 2006, obtained from the Execucomp database. *12-month Firm Return* is the firm's stock returns for the fiscal year. Our variable *Technology Peer Returns* is the equal-weighted average of the prior 12-month returns of companies' ten closest technology peers in terms of their technology similarity. We define technology similarity between two firms using the Jaffe (1986) measure of technology closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office obtained from NBER Patent Database (see Section 3.3 for details). We also build a corresponding equal-weighted average product market peer returns and variables using Hoberg and Phillip's (2010, 2015) product market similarity measure. We also have logs of average *Technology Peer Total Compensation* and *Product Market (PM) Peer Total Compensation.*

	12-Month Firm Return	*ln(Total Comp)*	*12-Month TS Peers Return*	*Ln(TS Peers Comp)*	*12-Month PM Peers Return*	*Ln(PM Peers Comp)*
12-Month Firm Return	1.000					
ln(Total Comp)	0.053	1.000				
12-Month Tech Peers Return	0.262	0.009	1.000			
Ln(Tech Peers Comp)	0.021	-0.034	0.014	1.000		
12-Month PM Peers Return	0.412	0.004	0.439	0.021	1.000	
Ln(PM Peers Comp)	-0.023	0.215	-0.031	0.067	0.020	1.000

Table 3: Technology Peer Sensitivity of CEO Compensation

This table examines the regression of technology peer compensation on CEO compensation to examine the sensitivity of CEO compensation to technology peer performance. Our dependent variable is the changes in yearly CEO's *Total Compensation* from 1992 to 2006, obtained from the Execucomp database. In Columns 1 and 2, the main independent variable of interest is the *Technology Peer Returns*, which is the equal-weighted average of the prior 12-month returns of companies' ten closest technology peers in terms of their technology similarity. We define technology similarity between two firms using the Jaffe (1986) measure of technology closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office obtained from NBER Patent Database (see Section 3.3 for details). Alternatively in Columns 3 and 4, we also generate weighted average technology space peer returns by using the technology similarity scores as our relative weights. In Columns 2 and 4, we also add technology peer compensation and lagged technology peer compensation variables to test whether positive correlation between technology peer returns and CEO compensation is due to compensation benchmarking, rather than performance benchmarking. We also include additional control variables related to firm's product market peers, as well as firm's own returns and other accounting measures that may affect CEO compensation. All variables, except returns, are first-differenced. We report two-way clustered standard errors by firm and year.

Dependent Variable = Δ ln(Total Compensation)	Equal-Weighted		Similarity-Weighted	
	(1)	(2)	(3)	(4)
Technology Space Peer Group Characteristics				
12-Month Tech Peers Return	0.134**	0.109**	0.250*	0.249*
	(2.42)	(2.43)	(1.70)	(1.68)
Δ Ln(Tech Peers Compensation)		0.111**		0.0597
		(1.97)		(1.12)
Δ Ln(Tech Peers Compensation) $_{t-1}$		0.00463		-0.0398
		(0.12)		(-0.51)
Δ Tech Peers ROE	-0.0770	-0.0578	-0.429	-0.340
	(-0.65)	(-0.42)	(-1.58)	(-1.03)
Δ Tech Peers ROA	0.434	0.241	1.010	0.300
	(0.78)	(0.41)	(1.01)	(0.28)
Δ Tech Peers Ln(Assets)	0.0147	-0.0218	0.0374	-0.00658
	(0.50)	(-0.59)	(0.49)	(-0.07)
Δ Tech Peers Sale/Assets	0.0996	0.0893	0.280*	0.293
	(1.57)	(1.00)	(1.89)	(1.48)
Δ Tech Peers MB	-0.0716***	-0.0798***	-0.0813	-0.102
	(-3.39)	(-4.01)	(-1.59)	(-1.51)
Product Market Peer Group Characteristics				
12-Month PM Peers Return	-0.0406	-0.0835	-0.0941*	-0.115*
	(-0.75)	(-1.29)	(-1.82)	(-1.90)
Δ Ln(PM Peers Compensation)		-0.0146		-0.00172
		(-0.36)		(-0.08)
Δ Ln(PM Peers Compensation) $_{t-1}$		-0.00723		-0.00783
		(-0.26)		(-0.38)
Δ PM Peers ROE	0.120	0.154	0.164	0.175
	(0.79)	(0.96)	(1.40)	(1.29)
Δ PM Peers ROA	0.254	0.112	-0.113	-0.578
	(0.62)	(0.23)	(-0.29)	(-0.95)
Δ PM Peers Ln(Assets)	-0.00645	0.0178	-0.0152	-0.00195
	(-0.40)	(0.61)	(-0.94)	(-0.09)
Δ PM Peers Sale/Assets	0.00597	-0.00408	0.0171	0.0388
	(0.14)	(-0.08)	(0.42)	(0.84)
Δ PM Peers MB	-0.0316	0.0154	-0.00598	0.0328**
	(-1.41)	(0.78)	(-0.34)	(2.06)
Firm Characteristics				
12-Month Return	0.238***	0.242***	0.247***	0.247***
	(7.41)	(4.94)	(8.46)	(5.83)
Δ ROE	0.0830*	0.0838	0.0848*	0.0912
	(1.93)	(1.44)	(1.92)	(1.56)
Δ ROA	0.934***	1.511***	0.958***	1.578***
	(3.31)	(5.26)	(3.63)	(6.28)
Δ Ln(Assets)	0.268***	0.148*	0.281***	0.178**
	(4.06)	(1.76)	(4.43)	(2.31)
Δ Sale/Assets	-0.0238	-0.0645	-0.0162	-0.0387
	(-0.24)	(-0.73)	(-0.16)	(-0.44)
Δ MB	0.0188	0.0121	0.0143	0.00824
	(1.30)	(0.63)	(0.93)	(0.45)
Constant	-0.167***	0.00120	-0.187***	0.0119
	(-6.91)	(0.09)	(-3.70)	(0.57)
Year Fixed Effects	Yes	Yes	Yes	Yes
N	6002	4781	5999	4777
adj. R-sq	0.050	0.051	0.050	0.049

Table 4: Governance and the Technology Peer Sensitivity of CEO Compensation

This table repeats our main analysis but divide sample into good governance group versus poor governance group based on their Governance-Index from Gompers, Ishii, and Metrick (2003), and by Entrenchment Index from and Cohen (2009). For each year, we assign firms into High G-Index (E-Index) firms for firms with higher than median G-Index (E-Index) score, and into Low G-Index (E-Index) for firms with lower than median scores. Our dependent variable is the log changes in the yearly CEO's *Total Compensation* from 1992 to 2006, obtained from the Execucomp database. In Columns (1) through (4), the main independent variable of interest is Technology Peer Returns, which is the average of the prior 12-month returns of companies' technology peers. We define technology similarity between two firms using the Jaffe (1986) measure of technology closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office obtained from NBER Patent Database (see Section 3.3 for details). Alternatively in Columns (5)-(8), we also generate weighted average technology space peer returns by using the technology similarity scores as our relative weights. We also include additional control variables related to firm's product market peers, as well as firm's own returns and other accounting measures that may affect CEO compensation. We suppress our control variables other than return variables to conserve space. All variables, except returns, are first-differenced. We report two-way clustered standard errors by firm and year.

	Dependent Variable = Δ ln(Total Compensation)							
	Equal Weighted		Similarity -Weighted		Equal-Weighted		Similarity -Weighted	
	Low G-Index	High G-Index	Low G-Index	High G-Index	Low E-Index	High E-Index	Low E-Index	High E-Index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
12-Month Tech Peers Return	0.236***	-0.0336	0.477**	0.0626	0.338***	0.0318	0.501**	0.160
	(2.81)	(-0.24)	(1.97)	(0.43)	(3.43)	(0.45)	(2.08)	(1.21)
12-Month PM Peers Return	-0.143	0.00919	-0.153*	-0.0292	-0.113	-0.0285	-0.190**	-0.0571*
	(-1.53)	(0.16)	(-1.75)	(-0.38)	(-1.00)	(-0.56)	(-2.35)	(-1.67)
12-Month Return	0.164***	0.284***	0.170***	0.296***	0.224**	0.247***	0.254***	0.252***
	(2.59)	(2.96)	(2.61)	(2.86)	(2.48)	(4.78)	(2.74)	(5.82)
Δ ROE	0.0231	0.0751	0.0293	0.0767	0.0334	0.101**	0.0112	0.115***
	(0.24)	(0.99)	(0.33)	(1.10)	(0.17)	(2.27)	(0.07)	(2.84)
Δ ROA	1.162**	1.115**	1.127**	1.094*	0.998	1.029***	0.832	0.908***
	(2.35)	(1.97)	(2.45)	(1.86)	(1.08)	(2.98)	(1.00)	(2.73)
Δ Ln(Assets)	0.270***	0.208**	0.255***	0.193*	0.190**	0.308***	0.186*	0.308***
	(3.49)	(2.02)	(3.59)	(1.93)	(2.02)	(4.70)	(1.71)	(4.98)
Δ Sale/Assets	0.0555	-0.0195	0.0426	-0.0379	0.130	-0.0533	0.120	-0.0244
	(0.69)	(-0.18)	(0.51)	(-0.36)	(0.72)	(-0.45)	(0.65)	(-0.19)
Δ MB	0.0221	-0.0165	0.0259	-0.0196	0.0192	0.00416	0.0144	0.00644
	(0.79)	(-0.35)	(0.92)	(-0.37)	(0.45)	(0.25)	(0.32)	(0.35)
Technology Peer Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product Market Peer Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2644	2489	2780	2638	1500	4496	1585	4769
adj. R-sq	0.039	0.039	0.042	0.039	0.036	0.054	0.039	0.053

Table 5: Likelihoods of Strategic Changes and the Technology Peer Sensitivity of CEO Compensation

This table repeats our main analysis based on firm's likelihood of engaging in significant strategic changes. In Columns (1) - (4), we compare firms based on the length of CEO tenure. For each year, we assign firms into *Long-Tenure* for firms with higher than median number of years CEO has been with the company, and into *Short-Tenure* for firms with lower than median number of years. In columns (5) – (8), we compare firms based on their overall M&A activity, given that firms who are expanding into new technologies often do so by acquiring other firms. For each year, we assign firms into *High M&A* group if they have three or more acquisitions in the previous three years, and into *Low M&A* group otherwise. Our dependent variable is the log changes in yearly *CEO's Total Compensation* from 1992 to 2006, obtained from the Execucomp database. Our main independent variable of interest is *Technology Peer Returns*, which is the average of the prior 12-month returns of companies' technology peers. In Columns (1), (2), (5) and (6), we compute the equal-weighted average of ten closest technology peers. In Columns (3), (4), (7), and (8), we use the similarity-weighted average returns, where the technology similarity scores are used as the weights. We define technology similarity between two firms using the Jaffe (1986) measure of technology closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office obtained from NBER Patent Database (see Section 3.3 for details). We also include additional control variables related to firm's product market peers, as well as firm's own returns and other accounting measures that may affect CEO compensation. We suppress our control variables other than return variables to conserve space. All variables, except returns, are first-differenced. We report two-way clustered standard errors by firm and year.

	Dependent Variable = Δ ln(Total Compensation)							
	Equal Weighted		Similarity -Weighted		Equal-Weighted		Similarity -Weighted	
	Short Tenure	Long Tenure	Short Tenure	Long Tenure	Low M&A	High M&A	Low M&A	High M&A
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
12-Month Tech Peers Return	0.315***	0.0246	0.567***	0.0386	-0.0315	0.230***	0.0876	0.407**
	(3.47)	(0.34)	(3.13)	(0.20)	(-0.31)	(3.07)	(0.46)	(2.19)
12-Month PM Peers Return	-0.149	-0.0148	-0.214***	-0.0128	-0.0178	-0.0271	-0.00302	-0.114***
	(-1.50)	(-0.28)	(-2.96)	(-0.24)	(-0.16)	(-0.41)	(-0.04)	(-3.40)
12-Month Return	0.312***	0.166*	0.303***	0.194**	0.291***	0.202***	0.265***	0.224***
	(7.45)	(1.95)	(5.63)	(2.46)	(3.85)	(4.78)	(3.27)	(4.47)
Δ ROE	0.112	0.0391	0.112	0.0600	-0.0517	0.147**	-0.0421	0.161**
	(1.42)	(0.44)	(1.40)	(0.78)	(-0.52)	(2.31)	(-0.42)	(2.40)
Δ ROA	0.325	1.293**	0.345	1.233***	1.166**	0.850***	1.208***	0.810***
	(0.57)	(2.42)	(0.66)	(2.90)	(2.39)	(2.76)	(2.98)	(3.42)
Δ Ln(Assets)	0.241***	0.313***	0.248***	0.318***	0.149	0.346***	0.166***	0.355***
	(2.81)	(3.27)	(2.75)	(3.50)	(0.15)	(4.69)	(15.98)	(4.95)
Δ Sale/Assets	0.0360	-0.0310	0.0545	0.00689	-0.0926	-0.00955	-0.0980	0.0308
	(0.30)	(-0.21)	(0.44)	(0.04)	(-0.49)	(-0.21)	(-0.55)	(0.52)
Δ MB	-0.0182	0.0491***	-0.0267	0.0373*	0.0175	0.0369	0.0204	0.0272
	(-0.84)	(2.66)	(-0.89)	(1.93)	(0.52)	(1.36)	(0.63)	(0.91)
Technology Peer Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product Market Peer Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2762	2951	2954	3103	1700	3801	1796	4046
adj. R-sq	0.046	0.063	0.043	0.065	0.057	0.055	0.058	0.053

Table 6: Sensitivity of CFO Compensation to Technology Peer Performance

This table repeats our main analysis of the regression of technology peer compensation on CEO compensation, but instead of using CEO compensation, we use CFO compensation obtained from the Execucomp Database. Our dependent variable is log changes in the yearly CFO's *Total Compensation* from 1992 to 2006. Our main independent variable of interest is *Technology Peer Returns*, which is the average of the prior 12-month returns of companies' technology peers. We define technology similarity between two firms using the Jaffe (1986) measure of technology closeness, which utilizes the overlap in two firms' patent portfolios' patent classifications assigned to each patent by the US Patent and Trademark Office obtained from NBER Patent Database (see Section 3.3 for details). In Columns (1) and (2), we compute the equal-weighted average of returns of the ten closest technology peers. In Columns (3) and (4), we compute the weighted average by using technology similarity scores as our weights. In addition, we also include peer compensation measures to check and control for the labor market completion effects. We also include additional control variables related to firm's product market peers, as well as firm's own returns and other accounting measures that may affect CEO compensation. We suppress our control variables other than return variables and peer compensation variables to conserve space. All variables, except returns, are first-differenced. We report two-way clustered standard errors by firm and year.

	Dependent Variable = Δ ln(Total Compensation)			
	Equal-Weighted		Similarity -Weighted	
	(1)	(2)	(3)	(4)
12-Month Tech Peers Return	0.0132	0.0492	-0.0973	-0.0416
	(0.19)	(0.52)	(-1.05)	(-0.34)
Δ Ln(Tech Peers Compensation)		0.113*		0.150**
		(1.88)		(2.48)
Δ Ln(Tech Peers Compensation) $_{t-1}$		-0.0287		0.00956
		(-0.51)		(0.13)
12-Month PM Peers Return	-0.130**	-0.165***	-0.104*	-0.130***
	(-2.15)	(-3.06)	(-1.96)	(-2.98)
Δ Ln(PM Peers Compensation)		-0.00328		-0.00432
		(-0.07)		(-0.22)
Δ Ln(PM Peers Compensation) $_{t-1}$		0.0281		0.0108
		(0.82)		(0.63)
12-Month Return	0.222***	0.208***	0.226***	0.211***
	(4.60)	(3.72)	(5.05)	(3.85)
Technology Peer Controls	Yes	Yes	Yes	Yes
Product Market Peer Controls	Yes	Yes	Yes	Yes
Firm-related Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
N	3825	2637	3823	2634
adj. R-sq	0.055	0.055	0.055	0.055