Product Market Peers and Relative Performance Evaluation

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Abstract

We investigate the role of Relative Performance Evaluation (RPE) theory in CEO pay and turnover. RPE predicts that firms will filter out common shocks (i.e., those affecting the firm and its peers) while evaluating CEO performance and that the extent of filtering increases with the number of firms in the peer group. Despite the intuitive appeal of the theory, previous tests of RPE find weak and inconsistent evidence. To examine this hypothesis, we exploit recent advances in textual analysis and define peers based on firms' product descriptions in their 10-K filings (Hoberg and Phillips, 2016). This alternative classification not only captures common shocks to firms' product markets more effectively but also tracks the evolving nature of these markets as 10-Ks are updated annually. Using product market peers, we find three pieces of evidence consistent with RPE in relation to CEO pay – (i) firms on average filter out common shocks to stock returns, (ii) the extent of filtering increases with the number of peers, and (iii) firms completely filter out common shocks in the presence of a large number of peers. We also find consistent evidence for forced CEO turnover.

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"…despite the obvious attractive features of relative performance evaluation, it is surprisingly absent from U.S. executive compensation practices. Why shareholders allow CEOs to ride bull markets to huge increases in their wealth is an open question…we view the weak evidence of relative performance evaluation as an important puzzle for executive compensation research."

Abowd and Kaplan (1999, pg. 157)
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1. Introduction

One of the central tenets of agency theory is that increasing the "signal-to-noise" ratio of the performance measure reduces risk without compromising the level of incentive alignment (Holmstrom, 1979). In other words, eliminating sources of variation from firm performance, such as an industry-wide movement in stock returns that is beyond an individual manager's influence, results in a more efficient contract, i.e., one that achieves greater alignment without increasing risk. This is the idea behind Relative Performance Evaluation (RPE) where managerial performance evaluation should not only be positively correlated with own firm performance, but also negatively correlated with industry-wide or market-wide performance to filter out uncontrollable common performance. Despite the intuitive appeal of the theory, prior research documents weak and inconsistent empirical evidence on RPE and refers to this weak evidence as the RPE puzzle (e.g., Abowd and Kaplan, 1999; Frydman and Jenter, 2013; Jenter and Kanaan, 2015).[1] RPE theory also predicts that this filtering should increase with the number of peers in the same group, and in the limit, common performance should be completely filtered out from firm performance (Holmstrom, 1979, 1982; Gibbons and Murphy, 1990).[2] However, the empirical evidence supporting this stringent form of RPE is also limited and mixed (e.g., DeFond and Park, 1999; Ali et al., 2009; Aggarwal and Samwick, 1999b; Bushman and Smith, 2001). In this study, we re-visit these unresolved attempts to provide evidence consistent with optimal contracting theory.

The crucial empirical issue in investigating RPE is how to identify appropriate peers whose aggregated performance serves as the proxy for common shocks. RPE theory assumes homogenous agents in the same group that share a common uncertainty parameter. Arguably, the empirical counterpart of this

[1] See also Antle and Smith (1986), Barro and Barro (1990), Gibbons and Murphy (1990), Janakiraman, Lambert and Larcker (1992), Prendergast (1999), DeFond and Park (1999), Bushman and Smith (2001), and Lambert (2001). See Edmans, Gabaix, Jenter (2017) for a recent survey.

[2] Holmstrom (1982) states that "we would expect that with many agents we would be able to achieve approximately the same solution as if there were no common uncertainty at all."

common uncertainty parameter would be common demand and supply shocks that affect all firms producing similar products. Hence, we posit that the ideal peer group needs to explicitly consider firms having similar products, and are subject to common product market factors. Surprisingly, this simple but important consideration has been largely ignored by prior research. Instead, most prior RPE studies rely on pre-defined industry classifications to identify peers, such as the Standard Industry Classification (SIC), North American Industry Classification System (NAICS), and Global Industry Classification Standard (GICS) without a clear economic rationale.[3] This could be problematic because prior research shows that these pre-defined industry classifications are noisy proxies for peers, and that they fail to effectively group firms that operate in the same product market.[4] Dikolli, Hofmann, and Pfeiffer (2013) show analytically that the use of noisy proxies for peers creates a bias against finding support for RPE. Also, these industry classifications are rarely updated over time, failing to capture the dynamic and evolving nature of product markets that corporate boards presumably take into account when evaluating managerial performance. Hence, our paper uses peer group definitions that explicitly incorporate product similarities to better measure common shocks which the theory purports to capture, thus allowing us to perform a cleaner test of RPE.

To operationalize the concept of product market peers, we use the Hoberg and Phillips' (2016) Text-based Network Industry Classifications (TNIC) that are constructed based on firms' product similarities. Hoberg and Phillips (2016) calculate product similarity scores of all possible pairs of firms in each year by parsing firms' product descriptions in annual 10-K filings. If the similarity score between a firm and its potential peer firm is above the pre-determined similarity threshold, the latter is identified as a product market peer. Thus, each firm has its own distinct set of product market peers under this scheme.

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[3] See Table 1 of Albuquerque (2009) for a review of prior RPE studies in relation to CEO pay and their use of peer group definitions. Among 15 empirical RPE studies between 1986 and 2009, including Albuquerque (2009), ten studies use SIC industries, three studies use market index, one study uses geographically close peers, and one study uses the banking industry to identify peer performance. This tendency is similar in forced CEO turnover studies.

[4] These pre-defined industry classifications focus on whether firms' *production processes* are similar rather than whether firms produce *similar products*. For example, "NAICS will be erected on a production-oriented, or supply-based, conceptual framework. This means that producing units that use identical or similar production processes will be grouped together in NAICS." http://www.naics.com/info.htm. See also Clarke (1989), Kahle and Walkling (1996), Bhojraj et al. (2003), Dopuch et al. (2008), Brickley and Zimmerman (2010), and Guenther and Rosman (1994) for additional discussions.

Also, the composition of the TNIC-based peer group varies over time because TNIC is based on firms' product descriptions in 10-K filings, which are updated annually. This reflects the changing nature of the firms' product markets as business strategies change. To form peer groups, we consider only firms in the focal firm's TNIC group, and, in addition, match on firm size and market-to-book ratio.[5] Hence, we identify as peers those firms that are most similar to the focal firm in the dimensions of product market, size, and valuation. Equal-weighted average stock returns of these peers provide the measure of peer performance.[6]

We begin by verifying whether TNIC-based peers indeed reflect common product market shocks (e.g., demand or supply shocks) better than those based on pre-defined industry classifications. To do so, we estimate the correlation between firm sales and peer average sales (i.e., a proxy for the common demand shocks) using three alternative industry classifications – TNIC, SIC, and GICS. We also estimate the correlation between operating costs of the firm, i.e., the sum of the cost of goods sold and SG&A expenses, and peer firm average operating costs (a proxy for the common supply shocks).[7] Consistent with our expectation and prior evidence in Hoberg and Phillips (2016), we find that the correlation between firm sales and peer sales is the strongest based on TNIC as compared to SIC or GICS. Further, consistent with TNIC classifications better capturing the evolving nature of product markets, the above results are generally stronger in more recent time periods.[8] Overall, these tests indicate that TNIC-based classifications better capture product market factors than pre-defined classifications such as SIC or GICS.

[5] We use firm size and market-to-book as additional matching criteria as these characteristics have been shown to improve peer group identification (see, e.g. Albuquerque, 2009; 2014; Lys and Sabino, 1992). Specifically, we choose one-quarter of TNIC peers with the smallest Mahalanobis distance using the market value of equity and the book-to-market ratio within each focal firm's TNIC group in each year. Section 3 presents a detailed discussion.

[6] Some firms self-report their compensation peers and this disclosure is enhanced after 2006. We repeat our analysis using this alternative definition of peers and obtain similar but statistically weaker results as showm in Appendix Table 1. We do not use these self-reported peers for our main analysis for several reasons. First, SEC regulations allow firms some leeway in reporting compensation peers, and few firms choose to report peers. This substantially reduces the sample size (to about 6% of the original sample size available with TNIC peers) and thereby reduces statistical power and external validity. Second, previous studies have shown that firms opportunistically choose self-reported peers, creating a self-selection issue in the estimation. See section 2 for more details.

[7] Hoberg and Phillips (2016) use a slightly different method by examining the extent to which alternative peer group classifications (TNIC/SIC/NAICS) generate higher levels of across-industry co-variation in profitability, sales group and stock market betas – where greater co-variation indicates a more informative industry classification.

[8] For example, the correlation between firm operating costs and TNIC-peer average operating costs is 0.834 in the 1996-2000 period, 0.965 in the 2000-2005 period, and 0.958 in the 2006-2010 period. In contrast, operating costs correlations based on SIC are decreasing over time – 0.250 in 1996-2000, 0.113 in 2001-2005, and 0.158 in 2006-

Next, we turn to the RPE evidence. Using a firm-year panel of 26,182 observations spanning from 1996 to 2015, we first investigate the presence of RPE in CEO compensation. Specifically, we regress (the natural log of) total CEO compensation on firm return, equal-weighted peer firm return, control variables including the existing level of equity-based incentives, firm-CEO fixed effects, and calendar year fixed effects. First, we find a significantly positive coefficient on own firm stock return and a significantly negative coefficient on peer firm average return, consistent with CEOs being rewarded by positive own firm stock return, but filtering out the common performance shocks experienced by the peer group. While the latter result (i.e., negative coefficient on peer returns) is consistent with RPE, the magnitude of the own firm effect (coefficient = 0.213) is significantly larger than the absolute magnitude of the peer firm effect (coefficient = -0.101) indicating only *partial* filtering (i.e., weak-form RPE, see Gibbons and Murphy, 1990). In other words, a 1% increase in the firm's own stock return is associated with a 21.3 basis points increase in total CEO compensation when the peer group experiences a 0% return. On the other hand, if the peer group also experiences a 1% return, CEO compensation reduces by 47.4% (-0.101/0.213), and the CEO still enjoys a net 11.2 basis points (i.e., 0.213 - 0 .101) increase in total annual compensation.

Second, we find that the extent to which common performance is filtered out increases with the number of firms in the peer group (e.g., Holmstrom, 1982). The idea is that common shocks can be estimated with less noise when the peer group consists of many firms because noise averages out more effectively when aggregating the performance of many peers, leading to more a precise measure of common uncertainty (Holmstrom 1982). Consistent with this idea, we find that the negative coefficient on peer stock returns becomes larger in magnitude as the number of firms in the same peer group increases, suggesting that filtering increases with the number of peers.

Lastly and more importantly, we find evidence that common performance is completely filtered out when the firm has many peers operating in the same product markets. In particular, the coefficient estimates suggest that net CEO compensation increases by a statistically insignificant 0.1 (i.e., 0.208 –

2010. These effects become weaker in the most recent post-crisis period of 2011-2015 – in particular, the TNIC-based correlations drop relative to prior periods but are still larger than those based on SIC/GICS.

0.207) basis points when both the firm and the peer group experience stock returns of a similar magnitude – but only in firms with many peers. This evidence is referred to as strong-form RPE where common performance does not figure in CEO compensation, and she is compensated solely based on idiosyncratic performance. This evidence speaks to Abowd and Kaplan's (1999) opening quote about CEO rent-extraction and indicates that firms do not allow CEOs to walk away with millions during bull markets.

Our main results are robust to various sensitivity checks. First, consistent with our conjecture, using SIC or GICS provides evidence of weak-form RPE but not strong-form RPE even in the presence of many firms in the same industry group. These findings are consistent with Dikkolli et al. (2013) showing that the use of noisier peer groups in the RPE tests works against finding evidence of RPE. In addition, we find that pre-defined industry classifications depict evidence of weak-form RPE because they are also correlated with product market peers, which are better captured by TNIC. In other words, we find that including TNIC-based peer performance in the regression drives out the marginal explanatory power of SIC/GICS-based industry classifications, consistent with the notion that pre-defined industry classifications are noisier peer group definitions (Hoberg and Phillips, 2016). In addition, we exploit the time-varying nature of TNIC-classifications. We find that current stock performance of firms that have already exited the focal firm's product markets (i.e., past peers) as well as current stock performance of firms that will enter the focal firm's product markets in future periods (i.e., future peers) do not in general provide information about common performance while only current performance of current peers does. These results not only suggest that corporate boards consider the evolving nature of product strategies when evaluating CEO performance but also that our results are not capturing some mechanical aspect connecting the focal firm with its peers.

To strengthen our inferences that product market considerations are significant factors that corporate boards focus on, we perform two cross-sectional tests and examine situations where corporate boards might not want to filter out common performance in compensating CEOs due to the product market considerations. First, Aggarwal and Samwick (1999b) show that RPE is weaker when there is a need to soften product market competition. Consistent with this prediction, we find weaker evidence of RPE when rival firms' products are strategic complements because RPE, in this case, decreases shareholders' returns by encouraging more aggressive product market strategies. Second, Gopalan et al. (2010) show theoretically that common performance should not be filtered out when a firm's exposure to common external shocks is the CEO's choice (i.e., strategic flexibility). Consistent with their theory, we find that our RPE effect is weaker in situations where the CEO has greater strategic flexibility.

To substantiate our inferences, we investigate the evidence of RPE in another important setting of managerial performance evaluation viz., forced CEO turnover decisions. This evidence fills the lack of evidence consistent with the RPE theory in the setting of forced CEO turnovers (e.g., Jenter and Kanaan 2015). Also, if our underlying RPE mechanism is true, it should describe the observed data in a consistent manner regardless of the context in which corporate boards evaluate managerial performance. In particular, given the fact that the firing decision is a more extreme consequence of managerial performance evaluation, corporate boards should be more careful in evaluating managerial performance by isolating idiosyncratic performance. Hence, this additional test would further bolster our findings in the CEO pay setting and shed light on potential product market frictions that corporate boards face in CEO retention decisions.

Using hand-collected forced CEO turnover data following Parrino (1997) and Peters and Wagner (2014), we find evidence of RPE in forced CEO turnover decisions consistent with our CEO pay results. Specifically, we find a significantly negative coefficient on own firm stock return and a significantly positive coefficient on peer firm average return, consistent with CEOs being fired for negative own firm performance while common performance shocks experienced by the same peer group being filtered out. Similar to the pay results, the magnitude of the own firm effect is significantly larger than the absolute magnitude of the peer firm effect, indicating only partial filtering, consistent with Jenter and Kanaan (2015). Next, we find that our primary results for the pay regressions translate to CEO replacement decisions: the filtering of common shocks increases with the number of peers, and complete filtering is observed when the number of peers is sufficiently large. In addition, we find that current stock performance of past peers as well as current stock performance of future peers do not in general provide information about common performance while only current performance of current peers does, which is the same as CEO pay results and consistent with the idea that product market dynamics matter in the managerial performance evaluation.

Our study contributes to the RPE literature in three ways. First, in both the CEO pay and the forced CEO turnover settings, we confirm the original and more stringent predictions of RPE theory, i.e., that the extent of common performance filtering increases with the number of peers, and that with a sufficiently large number of peers, the optimal contract resembles one with no common uncertainty (Holmstrom, 1982). Prior attempts to find evidence supporting these predictions examine whether product market competition is positively associated with RPE, but ultimately only find mixed evidence (e.g., Aggarwal and Samwick, 1999b; DeFond and Park, 1999; Bushman and Smith, 2001; Ali et al., 2009).[9] We provide direct evidence consistent with RPE increasing with the number of peers operating in the firm's product markets and with the firm optimally using RPE in the presence of a sufficiently large number of peers. We do not necessarily contend that RPE theory unambiguously predicts that common shocks should be completely filtered out and that the lack of complete filtering indicates failure of governance or the failure of approaches to identify such filtering. For example, Oyer (2004) shows analytically that when managerial retention is a concern, firms may not want to filter out common shocks. Gopalan et al. (2010) propose a model in which corporate boards take the strategic flexibility of the CEO into account and optimally use less RPE when strategic flexibility is more important. In our paper, we argue that the optimal contracting theory originally proposed by Holmstrom (1982) is an important underlying channel, and thus the availability of sufficient number of peer firms is one significant friction that corporate boards face when they apply RPE.

Second, we argue (and find confirmatory evidence) that a key identification strategy to testing RPE theory lies in accurately defining the peer group. Our study builds on the recent literature arguing that prior RPE research has failed to find evidence of RPE due to the incorrect identification of RPE peers (e.g., Albuquerque, 2009; Gong et al., 2011; Lewellen, 2013). In contrast to using static, predefined industry

[9] Aggarwal and Samwick (1999b) find a negative association between product market competition and RPE in compensation contracts. DeFond and Park (1999) find a positive association between competition and RPE in CEO turnover decisions, while Ali et al, (2009) fail to replicate DeFond and Park (1999). Ali et al. (2009) point out that the competition measure used in DeFond and Park (i.e., Sales-based HHI) is based on sales of only publicly-traded firms, resulting in a biased measure of competition. Overall, it is a still open question whether greater product market competition is positively associated with RPE in both CEO compensation and turnover decisions. Bushman and Smith (2001), for example, call for research to resolve conflicting results.

classifications, we employ new identification strategies by exploiting recent advances in textual analysis to identify product-market peers and find evidence consistent with RPE. In this sense, our study is also in line with Albuquerque, De Franco, and Verdi (2013) who suggest that an appropriate identification strategy helps researchers to draw clearer implications regarding efficient or opportunistic contracting practices.

Third, our results also speak to the long-standing debate about optimal contracting versus rent-extraction in explaining CEO compensation. While the presence of "pay-for-luck" is often cited as evidence in favor of CEO rent-extraction, our results suggest that this phenomenon is less prevalent in firms where market participants are privy to a relatively large number of reference points concerning CEO compensation. A fuller exploration of the role of corporate governance in the use of product-market peers based RPE is a fruitful area for further exploration.

2. Literature Review and Hypothesis development

2.1. Relevant Literature

Holmstrom (1979) predicts that when the agent's efforts are unobservable and non-contractible, the second-best contracting mechanism is to provide an incentive contract where the agent's compensation is contingent on observable measures of firm performance. Consistent with this prediction, prior research shows that CEOs are rewarded by increases in the own firm stock returns (i.e., positive pay-for-performance sensitivity; Jensen and Murphy, 1990; Aggarwal and Samwick, 1999a). This incentive contract, however, imposes an unnecessary risk on the risk-averse agent to the extent that firm performance is influenced by external shocks that are not under the agent's control. These uncontrollable shocks potentially decrease the utility of the agent thereby reducing contracting efficiency. One solution proposed by Holmstrom (1982) is to filter out these external shocks from firm performance, thereby resulting in a greater "signal-to-noise" ratio, which in turn results in greater contracting efficiency. That is, the agent should not be rewarded solely for her own *total* performance but rather for performance relative to that of her peers. This is the idea behind the Relative Performance Evaluation (RPE) theory.

Prior studies have attempted to test this RPE theory primarily in CEO compensation contracts (e.g., Antle and Smith, 1986; Gibbons and Murphy, 1990; Jensen and Murphy, 1990; Janakiraman, Lambert, and Larcker, 1992; Aggarwal and Samwick, 1999a, among others). Also, several prior studies investigate the RPE theory in managerial retention decisions made by corporate boards (e.g., DeFond and Park, 1999; Jenter and Kanaan, 2015). However, this evidence is mixed (Prendergast, 1999; Lambert, 2001; Frydman and Jenter, 2013), which in turn has resulted in alternative theories that seek to explain this "RPE puzzle."

For example, Bertrand and Mullainathan (2001) argue the lack of RPE is attributed to the rent-seeking behavior of managers. They argue that firms with weak corporate governance are less likely to use RPE because CEOs in these firms can affect their pay-setting process and are paid for positive external shocks, but not similarly penalized for negative external shocks (i.e., pay-for-luck). Another stream of research seeks to find cross-sectional evidence of RPE by identifying factors that alter the costs and benefits of using RPE. For instance, Gopalan et al. (2010) show that if the exposure to common external shocks is a strategic choice of the CEO (i.e., strategic flexibility), then RPE is less likely to be used in compensation contracts. In the setting of CEO turnover, DeFond and Park (1999) find a positive association between product market competition (based on sales-based HHI using 2-digit SIC) and RPE in CEO turnover decisions. Ali et al. (2009) use an alternative measure of product market completion and fail to replicate these results in DeFond and Park (1999). Recently, Jenter and Kanaan (2015) confirm this weak evidence of RPE in evaluating CEO performance: CEOs are significantly more likely to be fired due to industry-wide negative shocks. Peters and Wagner (2014) also find similar results in CEO retention decisions.

The third stream of research seeks to test RPE by identifying more appropriate peers. For instance, Albuquerque (2009) argues that using the entire SIC group as peers is problematic because all firms in this group may not face common external shocks and firms' abilities to respond to common shocks is likely to vary substantially within the same industry. She argues that firms with similar size in the same industry are more likely to face similar shocks and have similar abilities to respond to those shocks. Accordingly, Albuquerque (2009) refines the set the peers within the focal firm's two-digit SIC industry group to those in the same size quartile portfolio and finds evidence consistent with RPE. In a similar vein, Dikolli at al.

(2013) show analytically that aggregating heterogeneous firm performance within the same industry adds significant summarization bias in the measure of common shocks, leading to the failure in detecting RPE.

While the aforementioned studies match RPE peers on industry and size, other work uses peer firms that are self-reported by the firm (e.g., Murphy, 1999; Bannister and Newman, 2003; Carter et al., 2009; Gong et al., 2011; Lewellen, 2013). These studies are referred to as the explicit peer approach (Ferri 2009) and also argue that using industry and size matched peers might lead to a noisy measure of common external shocks, failing to detect RPE in the data. For example, Gong et al. (2011) use compensation disclosures mandated by the SEC after 2006 to identify peer firms and examine RPE theory using those self-reported peer groups. They find evidence of weak-form RPE using self-identified RPE peers, but no evidence of RPE when using industry-size matching to identify peers.

We have repeated our analysis using this alternative definition of peers and obtain similar but statistically weaker results as we show in Appendix Table 1. We do not use self-reported peers for our main analysis for several reasons: First, SEC regulations in 2006 allow firms some leeway in reporting compensation peers, and relatively few firms choose to report peers. Few firms voluntarily disclose their compensation peers before 2006, but this voluntary disclosure is much limited. This lack of disclosure substantially reduces sample size (to about 6% of the sample size available with TNIC peers) and thereby reduces statistical power and external validity.[10] Second, prior research has shown that firms strategically and opportunistically choose self-reported peers. For example, Faulkender and Yang (2010) show that companies use those self-selected peers to justify high CEO compensation levels rather than to best reflect the firms that are operating in the same product market. Therefore, potential self-selection issues may prevent us drawing an appropriate inference if we rely on these self-reported peer firms to identify peers. Finally, even for the majority of public firms that do not disclose their peer firms through regulatory filings, corporate boards can still implicitly use RPE using their subjective discretion (see Ferri 2009). In a similar

[10] SEC regulations require disclosure of compensation peers only *if* they are used. The relevant regulation reads: "[…] whether the registrant engaged in any benchmarking of total compensation, or any material element of compensation, identifying the benchmark and, if applicable, its components. — SEC final rules 33-8732a, Item 402(b)(2)(xiv), August 29, 2006."

vein, even for firms that disclose those explicit peers, corporate boards might use peers other than those their report in SEC filings using their discretion. Overall, using the explicit peers does not enable us to effectively test the optimal contracting theory with an unbiased manner.

2.2. Product Market Peers

In this study, one of important arguments we made is that the prior lack of consistent RPE evidence can be attributed to the use of noisier peer groups based on the pre-defined industry classifications such as SIC, GICS, and NAICS (e.g., Dikolli et al., 2013). This is because these pre-defined industry classifications group firms based on inputs rather than the similarity in products or outputs (e.g., Bhojraj et al., 2003, Guenther and Rosman, 1994). However, according to the RPE theory, the peer group should consist of homogenous agents that shares the same common uncertainty parameter (Holmstrom, 1982). Arguably, the empirical counterpart of common uncertainty is common demand and supply shocks that affect all firms producing similar products, rather than, for example, having similar production functions. The distinction is important because having similar production functions does not necessarily imply those firms producing similar products (e.g., see Bernard and Skinner [1996]and Brickley and Zimmerman [2010] for detailed discussions).

Furthermore, pre-defined industry classifications rarely change over time and consequently do not capture the evolving nature of the firm's product markets as the firm's product offerings change (Hoberg and Phillips, 2016). A firm enters or exits its peers' product market space if the latter starts or stops producing similar products (not whether or not it uses similar production processes). Although the firm's product market peers also change accordingly, in this case, traditional industry classifications do not reflect this as these classifications do not evolve rapidly. Accordingly, pre-defined industry classifications fail to capture this dynamic nature of evolving product markets. If so, RPE tests relying on these pre-defined industry classifications might fail to detect consistent evidence. Gibbons and Murphy (1990, p. 49) allude to this possibility by stating that "…our inability to detect an industry effect after controlling for market movements may reflect the inappropriateness of industry definitions based on SIC codes for purposes of relative performance evaluation."

Hence, we argue that the empirical analysis should identify peer firms producing similar products who face similar demand and supply shocks as RPE peers. By doing so, the proxy for the common shocks better captures the common uncertainty parameter in the theory, allowing us to test the RPE theory more effectively with less biases. To this end, we use Text-based Network Industry Classifications (TNIC) recently developed by Hoberg and Phillips (2016) to identify RPE peers. Hoberg and Phillips (2016) identify peer firms based on the pairwise product similarity scores among firms by parsing firms' product descriptions in annual 10-K filings (Item 1 or 1A). They argue that firms producing similar products are more likely to be peer firms competing in the same product markets. Hoberg and Phillip (2016) validate that TNIC better explains differences in industry characteristics such as profitability, sales growth, and market risk across the industry. They show that positive (negative) industry demand shocks lead to more (less) firms entering into those industries. They also show that these classifications better reflect competitors identified by managers. Several other studies using TNIC find that this classification scheme provides new insights regarding a firm's product market peers. For example, Hoberg and Phillip (2010) show that M&A transactions are more likely between firms having similar product descriptions and long-term outcome such as profitability is better when the target and the acquirer have similar product descriptions ex-ante, possibly due to product market synergies. Foucault and Frésard (2014) show that a firm's investment is sensitive to the stock returns of product market peers.

To compute the product similarity, Hoberg and Phillips (2016) specifically convert each firm's product description in 10-K filings into a word vector and calculate product cosine similarity scores for every pair of firms (i.e., the distance between two-word vectors for every pair of firms). For example, a firm *i*'s product similarity score with a firm *j* is calculated as the dot product of the word vector of the firm *i*, which consists of vocabularies describing the firm *i*'s products, and that of the firm *j*. This cosine product similarity score between firm *i* and firm *j* is bounded in [0,1] and increases with the number of same words that both firm *i* and firm *j* use, implying that firm pairs with high cosine similarity scores are likely to operate in the similar product markets. Firm j is classified as firm i's product market peer if product similarity score between firm i and firm j is above a pre-specified minimum similarity threshold.[11] This classification yields a group of product market peers for every firm, which allows peer group composition to vary year-to-year and firm-by-firm. Hoberg and Phillips (2016) argue that this procedure can capture the notion that the most appropriate peer firms are firms producing similar products. In addition, Hoberg and Phillips (2016) also argue that TNIC captures the changing nature of product markets over time because all firms' update their product descriptions annually and the updates are required to be correct and timely by SEC. Hence, we test the RPE theory using product-market-based peers. This leads to our first testable RPE prediction:

H1: Firms evaluate CEO performance not only on own firm performance but partially filter out the performance of their product market peers.

2.3. Implication of the Number of Product Market Peers in RPE

While prior studies also find evidence in favor of the RPE hypothesis above, we go one step further and devise more stringent tests based on RPE theory. In particular, we hypothesize that the extent of RPE (i.e., filtering out of peer performance) increases with the number of firms in the peer group. In addition, we predict that common performance is completely filtered out in the presence of a large number of peers (i.e., strong-form RPE).

In Holmstrom (1982), each agent's performance (x_i) is determined by effort a_i, common uncertainty parameter η, which affects all agents in the same team, and idiosyncratic error term e_i, which is determined by the agent-specific efforts (i.e., $x_i = a_i + \eta + e_i$). Hence, each agent's uncertainty is determined by common uncertainty parameter η and idiosyncratic error term e_i. By aggregating performance of all agents in the same team, the idiosyncratic error terms are averaged out in the aggregate performance index, and thus the common uncertainty parameter η can be estimated. Holmstrom (1982) proceeds to predict that if the number

[11] Hoberg and Phillips (2016) state that "Although one can use any minimum similarity threshold to construct a classification, we focus on thresholds generating industries with the same fraction of membership pairs as SIC-3 industries, allowing us to compare our industries to SIC-3 in an unbiased fashion."

of agents is large enough to infer the precise value of the common uncertainty parameter, the principal can completely filter out common uncertainty in evaluating the agent's performance. On the other hand, if the number of agents in a team is small, then the idiosyncratic performance of agents is not sufficiently eliminated in the aggregation process, resulting in the principal only partially filtering out common uncertainty in evaluating the agent's performance (Gibbons and Murphy, 1990). This prediction forms our second and third testable hypotheses that are stated as follows:

H2: ***The extent of filtering of common performance in CEO performance evaluation increases with the number of product market peers.***

H3: ***Firms completely filter out common performance in CEO performance evaluation in the presence of a large number of product market peers.***

3. Research Design

3.1. Empirical Specification

First, we examine the RPE hypothesis as it pertains to CEO compensation (Holmstrom 1982). We use the empirical specification proposed by Holmstrom and Milgrom (1987) and widely used in prior RPE studies in compensation contracting (e.g., Gibbons and Murphy, 1990; Albuquerque, 2009; Albuquerque, 2014).

$$ln(Total\ Comp_t) = \beta_1\, Firm\ Ret_t + \beta_2\, Peer\ Ret_t + \beta_3\, Size_{t-1} + \beta_4\, BM_{t-1} + \beta_5\, Vol_{t-1} + \beta_6\, ROA_{t-1} + \beta_7\, Tenure_t + \beta_8\, Age_t + \beta_9\, Duality_t + \beta_{10}\, Ownership_{t-1} + \beta_{11}\, lnDelta_{t-1} + \varepsilon_{i,t} \quad (1)$$

The dependent variable is the natural logarithm of one plus annual total CEO compensation, measured as the sum of salary, bonus, the grant-date fair value of stock and option grants, long-term incentive payouts, other annual compensation, and all other annual compensation (i.e., variable TDC1 in ExecuComp). $Firm\ Ret_t$ captures firm *i*'s own stock price performance and is defined as the annual buy-and-hold stock return including dividends. $Peer\ Ret_t$ captures the average stock performance of firm *i*'s product market peers and is measured as the equal-weighted average of annual stock returns of product market peers excluding firm *i*. To define product market peers, we choose one-quarter of TNIC peers with the smallest the Mahalanobis distance using the market value of equity and the book-to-market ratio within each focal firm's TNIC group in each fiscal period (e.g., Albuquerque, 2009; Lys and Sabino, 1992).[12]

Following prior studies, we include several control variables in the model. We include $Size_{t-1}$, which is measured as the natural log of total revenue for firm *i* at the beginning of period *t* (Smith and Watts, 1992). BM_{t-1} proxies for growth options and is measured as the book-to-market ratio for firm *i* at the beginning of period *t* (Smith and Watts, 1992). Following Aggarwal and Samwick (1999a), we also include idiosyncratic volatility (Vol_{t-1}), which is measured as the standard deviation of the residuals obtained from a regression of monthly firm return on the monthly equal-weighted average peer return using the preceding 12 months of observations for firm *i* in period *t* (a minimum of 6 observations is required). Prior research finds that accounting performance affects CEO compensation. We include return on assets (ROA_{t-1}), which is measured as earnings before extraordinary items in period *t-1* divided by average total assets in period *t-1*. We include (the natural logarithm of) CEO tenure ($Tenure_t$), CEO age (Age_t), and CEO stock ownership (Own_{t-1}) to control for the effects of CEO characteristics on firms' compensation policies. We include a dummy variable, $Duality_t$, which is set to one if the CEO is chairman of the board, and zero otherwise. Portfolio delta is included in the regression model to control for any potential influences of existing incentives on corporate boards' decisions to filter out common shocks. Portfolio delta measures the dollar change in wealth experienced by the CEO for a 1% change in the firm's stock price (Core and Guay, 2002; Coles, Daniel, and Naveen, 2006). $lnDelta_{t-1}$ is defined as the natural logarithm of one plus portfolio delta for the CEO at the beginning of period *t*. We also include CEO-firm fixed effects to control for unobservable time-invariant effects specific to the CEO-firm match, and calendar year fixed effects to control for time-varying common factors. Also, including Firm-CEO fixed effects allows us to identify whether changes in

[12] Specifically, we take the following steps to choose the closest RPE peers in terms of size and book-to-market. First, we merge the latest market value of equity and book-to-market of TNIC peers as of the beginning of the focal firm *i*'s fiscal period. We drop peer firm observations with missing values of market value of equity and book-to-market. We truncate stock returns at the .5st and 99.5th percentiles before computing averages to mitigate the influence of extreme observations. We compute the Mahalanobis distance between the focal firm and each peer firm using the market value of equity and book-to-market in each year. Finally, we choose one quarter of TNIC peers that are closest to firm *i* in terms of the distance. Lys and Sabino (1992) show that researchers can maximize the power of their tests by placing 27% of the sample on each of the extreme portfolios. We require a minimum of two peers for each focal firm in each year.

total CEO compensation are associated with firm return and peer return (Gormley and Matsa, 2014). We winsorize all continuous variables at the 0.5% and 99.5% levels to mitigate the influence of extreme observations. We cluster standard errors by firm (Petersen, 2009).

The coefficient on $Firm\ Ret_t$ in Equation 1 is expected to be positive (i.e., pay-performance sensitivity), while that on $Peer\ Ret_t$ captures the RPE effect and is expected to be negative (i.e., lower compensation for greater common performance). In addition, optimal contracting theory predicts that the sum of the coefficients on $Firm\ Ret_t$ and $Peer\ Ret_t$ is statistically zero if common performance is completely filtered out while compensating the CEO, and thus she is evaluated solely based on idiosyncratic performance (Holmstrom, 1982; Gibbons and Murphy 1990).

3.2. Data and Descriptive Statistics

We retrieve market values of equity and stock returns data from CRSP, financial statement data from Compustat, and CEO compensation data from ExecuComp. We adjust delisting returns following Beaver, McNichols, and Price (2007). Following Garvey and Milbourn (2006), we use a sample of ExecuComp firms with non-negative CEO tenure. We also delete observations with missing financial and compensation data. The above data requirements yield a sample of 26,182 firm-year observations. The sample period ranges from 1996 to 2015 because TNIC are only available for this sample period.[13]

Panel A of Table 1 presents descriptive statistics for our main dependent and independent variables. The mean (median) of total compensation is $5.453 million ($3.188 million), which shows significant right skewness as in prior compensation studies (e.g., Albuquerque, 2009). Hence, we take the natural logarithm of total compensation to reduce skewness. Firms on average have 82 peers in the same TNIC industry. This number is similar to 88 peers in the same three-digit SIC industry (Hoberg and Phillips, 2016).[14] Six-digit

[13] TNIC data is obtained from http://hobergphillips.usc.edu/.

[14] TNIC is comparable with three-digit SIC because the pre-specified minimum product similarity threshold use in constructing TNIC is set to generate industries with the same fraction of industry pairs as three-digit SIC industries (Hoberg and Phillips, 2016).

GICS industries, which are comparable to three-digit SIC, have a slightly lower number of firms in the same industry, 69 firms.

Panel B of Table 1 presents Pearson correlations among main variables. We note that total compensation is significantly positively correlated with firm return (Pearson correlation of 0.08) and peer return (Pearson correlation of 0.04). We find that total CEO compensation is significantly positively correlated with firm size (Pearson correlation of 0.61) and negatively correlated with the book-to-market ratio (-0.15), suggesting that both large firms and growth firms incur greater compensation costs to hire talented managers (Smith and Watts, 1992).

4. Results

4.1. Validity Check

Before examining the RPE hypothesis, we first validate our main assumption that TNIC better captures a firm's demand and supply shocks in product markets relative to SIC and GICS. Using average sales as a measure of demand shocks, we run a regression of firm *i*'s sales on peer firm average sales based on TNIC, SIC, and GICS (excluding firm *i*). This test allows us to examine the correlation between firm *i*'s sales and peer sales holding the effect of other industry classifications fixed. With regard to supply shocks, we estimate correlations between firm *i's* operating costs (i.e., the sum of cost of goods sold and SG&A expenses) and average operating costs based on TNIC, SIC, and GICS.

Table 2 tabulates these results. In panel A, we examine sales correlations. In column (1) of Panel A, we find that the coefficient on *Average Sales* (*TNIC*) is 0.785 while the coefficients on *Average Sales* (*SIC*) and *Average Sales* (*GICS*) are 0.249 and 0.169, respectively. This result is consistent with our expectation and Hoberg and Phillip (2016) and suggests that TNIC better captures firms' demand shocks than SIC or GICS. Correlations based on operating cost are even stronger. In column (1) of Panel B, the coefficient on *Average Costs* (*TNIC*) is 0.933 while the coefficient on *Average Costs* (*SIC*) and *Average Costs* (*GICS*) is 0.164 and 0.133, respectively. This evidence suggests that TNIC better captures firms' supply shocks than SIC or GICS.

We further examine whether the above results are stronger in more recent periods. If TNIC better captures the evolving nature of product markets and is updated annually, we would expect the TNIC-based correlations to be stronger in more recent periods. To this end, we partition our full sample into four subsamples based on 5-year periods, and estimate sales and operating costs correlations for each period (columns (2) through (5) in each panel). In general, we find that sales and operating costs correlations based on TNIC are increasing in more recent periods. In particular, in Panel B, we find that the correlation between firm *i*'s operating costs and TNIC-peer average operating costs is 0.834 in the 1996-2000 period, 0.965 in the 2001-2005 period and 0.958 in the 2006-2010 period. In contrast, COGS correlations based on SIC are decreasing over time: – 0.250 in 1996-2000; 0.113 in 2001-2005 and 0.158 in 2006-2010. These effects become weaker in the most recent post-crisis period of 2011-2015 – in particular, the TNIC-based correlations drop relative to prior periods, but remain larger than those based on SIC/GICS.

Overall, the findings in Table 2 suggest that TNIC better captures a firm's supply and demand shocks as evidenced by stronger correlations between firms' sales and TNIC-peer average sales and between firms' operating costs and TNIC-peer average operating costs. In the next section, we present results of our main RPE hypotheses.

4.2. Main Results

Table 3 presents the estimation results using Equation 1. We start with the full-sample results in column 1. Consistent with positive pay-for-performance sensitivity, the coefficient on *Firm* Ret_t is positive (coefficient of 0.213) and significant at the 1% level. Furthermore, consistent with our first RPE prediction, the coefficient on *Peer* Ret_t is negative (coefficient of -0.101) and also significant at the 1% level. The evidence supports the weak-form version of RPE (i.e., partial filtering of common performance, Gibbons and Murphy 1990), given that the absolute value of the coefficient on *Peer* Ret_t is significantly less than that on *Firm* Ret_t (F-stat = 32.18). Stated in economic terms, CEO compensation increases by 21.3 basis points when the firm experiences a 1% increase in its own stock price and its peers experience a 0% stock return during the fiscal year. However, if peer stock returns also increase by 1%, the CEO only experiences an increase in annual total compensation of 11.2 basis points (0.213-0.101).

To test our second prediction that the extent of common performance filtering increases with the number of suitable peers, we divide the sample into three subsamples based on the tercile of the number of TNIC peers in period *t* and estimate Equation 1 within each subsample. Firm-year observations that belong to the first, second, and third tercile of the number of TNIC peers are classified as the Few, Moderate, and Many groups, respectively. We expect the coefficient on $Peer\ Ret_t$ to become increasingly more negative as we move from the Few group to the Moderate group to the Many groups, and that is exactly what we find. The coefficient on $Peer\ Ret_t$ is -0.039 in the Few peer group and statistically insignificant, -0.107 in the Moderate peer group and significant at the 5% level, and -0.207 in the Many peer group and significant at the 1% level. The coefficient on $Peer\ Ret_t$ is insignificantly different between the Few and the Moderate groups (difference of -0.067), and significantly different between the Moderate and the Many groups at the 10% level (difference of -0.100), and also between the Few and the Many groups at the 1% level (difference of -0.167). Importantly, the coefficient on $Firm\ Ret_t$ does not vary significantly across these subsamples (0.219, 0.227 and 0.208). This is comforting because there is no a priori reason for the extent of pay-for-own-firm-performance sensitivity to differ based on the size of the peer group – only the extent of RPE is predicted to be affected by the size of the peer group. In terms of economic significance, when both the firm and its peers experience the same magnitude of common stock return, the positive pay-for-performance sensitivity decreases by 17.81% (-0.039/0.219) in the Few peer group, by 47.14% (-0.107/0.227) in the Moderate peer group, and by 99.52% (-0.207/0.208) in the Many peer group.

The latter result is consistent with our third prediction of complete filtering (i.e., strong-form evidence on RPE, Holmstrom, 1982). In particular, the sum of the coefficients on $Firm\ Ret_t$ and $Peer\ Ret_t$ is indistinguishable from zero (F-stat = 0.000 p-value = 0.971), suggesting that common performance is completely filtered out while evaluating the CEO. Overall, these results suggest that firms use RPE in rewarding their CEOs, and the extent of RPE usage depends on the presence of a large enough number of true product market peers.

4.3. Alternative Industry Classifications

In this section, we replicate our results using pre-defined industry classifications. In Panel A of Table 4, we use three-digit SIC codes and calculate *SIC Peer Ret*$_t$ based on the same method used in the construction of our main peer return variable using TNIC, *Peer Ret*$_t$. In column 1, we find the same result documented in column 1 of Table 3, i.e., weak-form evidence of RPE. This result is consistent with prior RPE research (e.g., Gibbons and Murphy, 1990; Albuquerque, 2009). Next, we partition the sample into three subsamples based on the tercile of the number of firms in the same SIC industry and estimate Equation 1 within each subsample. In this analysis, we do not find evidence consistent with our two predictions relating the efficacy of RPE to the number of peers. In particular, the coefficient on *SIC Peer Ret*$_t$ does not show monotonicity as we move from the Few group to the Moderate group to the Many groups based on the number of SIC peers – rather the coefficient on *SIC Peer Ret*$_t$ is most negative and significant in the moderate peers subsample. Furthermore, we are also unable to find evidence consistent with our third prediction of complete filtering in the Many peers subsample. In particular, the coefficient on *Firm Ret*$_t$ is 0.137 while that on *SIC Peer Ret*$_t$ is -0.063 and marginally insignificant, indicating that the CEO continues to enjoy a 7.4 basis points increase in annual compensation even when both the firm and the peer group experience a 1% stock return during the year (F-statistic = 4.070 p-value 0.044).

In Panel B of Table 4, we use GICS industry codes to define peers. GICS industry codes are the most recent and improved industry classification method developed by MSCI Inc. and S&P (e.g., Bhojraj et al., 2003). Consistent with GICS industries improving SIC classifications, we find that results are slightly stronger than results using SIC industries. Here again, however, while we find evidence consistent with weak-form RPE in the full-sample, we are unable to find evidence consistent with our other two predictions. The coefficient on *GICS Peer Ret*$_t$ shows patterns similar to those in Panel A. They do not show monotonicity as we move from few peers to moderate peers to many peers, and the most negative and significant one is found in the moderate peers subsample. Once again, there is no evidence of complete filtering of common performance in the many peers subsample – CEOs continue to enjoy 8.8 basis points increase in annual compensation when the firm and the peer group both enjoy a 1% annual stock return.

If SIC and GICS industries are poor proxies for the firm's peer group, why do we observe evidence consistent with partial filtering (i.e., weak-form evidence of RPE) using these classifications? And also some weak evidence of monotonicity between the Few and the Moderate peer subsamples? We conjecture that this is due to these proxies also being correlated with product market peers with noise. To examine this possibility, we include peer return variables constructed based on TNIC simultaneously with peer return variables constructed based on these alternative pre-defined industry classifications in the same regression.

Table 5 presents the estimation results comparing peer return variables. In columns 1-3, we first use all peers in the same industry (i.e., not size and book-to-market matched peers) to construct peer return variables. That is, *All Peer Ret*$_t$ is equal-weighted average stock returns of TNIC peers for firm *i* in period *t*. *All SIC Peer Ret*$_t$ (*All GICS Peer Ret*$_t$) is equal-weighted average stock returns of SIC (GICS) peers in period *t*. I n column 1, we include *All Peer Ret*$_t$ and *All SIC Peer Ret*$_t$ simultaneously in the same regression and find that only the coefficient on *All Peer Ret*$_t$ is significantly negative, while the coefficient on *All SIC Peer Ret*$_t$ is statistically insignificant. In column 2, we find a similar result when we replace *All SIC Peer Ret*$_t$ with *All GICS Peer Ret*$_t$. In column 3, we include all three peer return variables in the same regression and find that only *All Peer Ret*$_t$ is significantly negatively correlated with the dependent variable at 1% level while coefficients on both *All SIC Peer Ret*$_t$ and *All GICS Peer Ret*$_t$ are statistically insignificant. This findings support our argument that peer groups based on the product similarity provide a better identification with than traditional industries in RPE studies. Also, this finding mitigates a concern that that the matching using size and book-to-market matching would be the primary factor resulting in better identification of peer group rather than TNIC groupings (i.e., Albuquerque, 2009).

In our main analysis, we use the characteristics-matched peer firms based on size and book-to-market to construct our measure of peer returns. In columns 4-6, we compare those peer return variables. In columns 4 through 6, we also find that that only the coefficient on *Peer Ret*$_t$ remains negative and statistically significant, while those on *SIC Peer Ret*$_t$ and *GICS Peer Ret*$_t$ become statistically insignificant.

Finally, in column 7, we include the peer return variable based on the characteristics-matched TNIC peers (*Peer Ret*$_t$) and the peer return variable based on all TNIC peers (*All Peer Ret*$_t$) simultaneously in the same regression. We find that the coefficient on *All Peer Ret*$_t$ becomes insignificant, while the coefficient on *Peer Ret*$_t$ remains statistically significant at 1% level. This result is consistent with the prior literature and suggests that matching based on firm characteristics in the same peer group also reduce noise in RPE in the setting of CEO pay (Albuquerque 2009).

Overall, the results in Table 5 suggest that peers based on the product market similarity provide a better proxy for common peer group performance than those based on pre-defined industry classifications in the CEO pay setting.

4.4. Dynamic Peer Groupings and RPE in CEO Compensation

As noted earlier, one of the key advantages of using TNIC to identify RPE peers is that TNIC captures the evolving nature of product markets. Therefore, we can examine whether current stock returns of past, current, and future product market peers contain information about common performance. For example, consider *past* peer firm *j* that was the product market peer of firm *i* in period *t-1,* but not in period *t* (i.e., firm *j* exited firm *i*'s product space in period *t-1*). In this case, firm *j*'s current stock return in period *t* is less likely to contain information regarding common demand and supply shocks that firm *i* faces in period *t*. Similarly, if firm *k* is not a product market peer of firm *i* in period *t* but only becomes a peer in period *t+1* (i.e., future peer), then the stock returns of firm *k* in period *t* are also less likely to contain relevant information about common shocks that firm *i* is experiencing in period *t*. In reality, entering new product markets takes time, and hence firm *k* is most likely taking some activities to enter the new product market in the current period *t* (e.g., investments), resulting in firm *k*'s stock returns in period *t* presumably containing information regarding common external shocks. Foucault and Fresard (2014) adopt this approach and show that past (future) peers' stock price is not (weakly) associated with the focal firm's investment, while present peers' stock price is informative to the focal firm's investment.

Similar to Foucault and Fresard (2014), we classify peer observations that are used to construct the *Peer Ret*$_t$ variable into four sets of peer firms: (1) past peers, (2) new peers, (3) current peers, and (4) future peers. We define *Past Peers* as firms that were firm *i*'s product market peers in period *t-1* but are not in the same TNIC group in period *t*. *New Peers* are firm *i*'s product market peers in period *t* but were not in the same TNIC group in period *t-1*. *Current Peers* are firm *i*'s product market peers in period *t-1* as well as in period *t.* Lastly, we define *Future Peers* as firms that will be firm *i*'s product market peers in period *t+1* but are not in the same TNIC group in period *t*. We then calculate equal-weighted stock returns of each set of peers using stock returns in period *t* and replace *Peer* Ret_t in Equation 1 with each of these stock returns.

Table 6 reports the results. Consistent with our expectations, in column 1, the current period stock returns of past peers (*Past Peer* Ret_t) is not statistically significant, suggesting that current stock returns of past peers do not contain information regarding common shocks. In columns 2 and 3, we find that the coefficients on *New Peer* Ret_t and *Current Peer* Ret_t are significantly negative at 1% level, respectively.[15] In column 4, we find that *Future Peer* Ret_t is not statistically significant, suggesting that current stock returns of firms that are expected to enter firm *i*'s product markets in the next period also do not contain information concerning common shocks in period *t*. Overall, this time-series evidence not only corroborates our RPE hypothesis, but also mitigates concerns that we are capturing some mechanical feature linking our focal firm to these product market peers.

4.5. Cross-sectional Tests

To further strengthen our inferences, we perform several cross-sectional tests, and examine situations in which corporate boards might not want to filter out common shocks due to the product market considerations. First, Aggarwal and Samwick (1999b) show that the nature of product market competition affects the extent to which corporate boards use RPE in CEO pay. Specifically, they show that if a firm's product market outputs are strategic complements with rivals, then corporate boards are less likely to use RPE in CEO pay since RPE, in this case, incentivizes managers to take aggressive price strategies which in turn lower shareholders' returns. In contrast, if the firm's output is a strategic substitute with that of its

[15] When we include the two variables simultaneously in the same regression, we find that the coefficient on *New Peer* Ret_t becomes statistically insignificant, while the coefficient on *Current Peer* Ret_t remains statistically significant at 5% level.

competitors, then managers have weaker incentives to maximize own firm value but stronger incentives to increase all other firms' value (i.e., collusion). In this case, corporate boards are more likely to use RPE in CEO pay.

To examine this prediction, we use the Competitive Strategic Measure (CSM) to identify whether the product market competition is described as one of strategic complements or substitutes (Sundaram et al. 1996; Chod and Lyandres 2011). CSM is defined as the coefficient of correlation between the ratio of the change of a firm's profits to the change of its sales, and the change in the combined sales of its rivals. Intuitively, CSM captures the cross-partial derivative of firm value with regards to industry peers' strategic actions (as measured by changes in sales). If the CSM has a positive value, it indicates that the competition is one of strategic complements; otherwise, the competition is one of strategic substitutes.

Specifically, in columns 1 and 2 of Table 7, we divide the full sample into two subsamples based on the sign of CSM: column 1 uses a subsample of firms with positive CSM (strategic complements), while column 2 uses a subsample of firms with negative CSM (strategic substitutes). Consistent with our expectations, we find that the coefficient on $Peer\ Ret_t$ in column 2 is -0.141, and the absolute value of this coefficient is statistically greater at the 5% level than the absolute value of the coefficient on $Peer\ Ret_t$ in column 1 (-0.053). These findings are consistent with Aggarwal and Samwick (1999b) and suggest that firms use less RPE when the product market competition is characterized as one of strategic complements.

To provide further support, we use an alternative competition measure to test this prediction. Specifically, we use sales-based Herfindahl-Hirschman Index (HHI) of TNIC to divide the full sample into two subsample assuming that if a firm's product market is more concentrated, then the competition is more likely to be one of strategic complements, while if a firm's product market is less concentrated, then the competition is more likely to be one of strategic substitutes. In columns 3 and 4, again, we divide the full sample into two subsamples based on the sample median of sales-based HHI. Again, consistent with our expectations, we find that the coefficient on $Peer\ Ret_t$ in column 4 is -0.167, and the absolute value of this coefficient is statistically greater at the 5% level than that column 3 (-0.071). This result corroborates our earlier finding and suggests the nature of product market competition affects the use of RPE in compensation contracts.

Second, we examine the theoretical predictions of RPE in Gopalan et al. (2010). Gopalan et al. propose a model showing that the use of RPE in CEO pay decreases if firms want to provide strategic flexibility to their CEOs. They argue that "the board of directors is not primarily concerned with how hard the CEO is actually working, but whether she has the vision to choose the right strategy for deploying the firm's assets. In doing so, the CEO's concern is with the firm's strategic direction in lieu of its surrounding market environment." Put differently, if the effect of common external shocks on firm performance is not random, but due to specific actions undertaken by the CEO, then the effect of common external shocks should not be excluded in evaluating the CEO's efforts.

To test this prediction, we follow Gopalan et al. and use the following three measures to identify firms that offer greater strategic flexibility to the CEO: peer-adjusted growth option, peer-adjusted stock returns during the previous period, and the asset growth in the next period. First, firms with greater growth options as measured by higher market-to-book ratios are more likely to provide their CEOs with the greater strategic flexibility to allow for more discretion in exercising those options. Therefore, we classify firm-years with peer-adjusted market-to-book ratios above the median as offering greater strategic flexibility to the CEO. Second, RPE is reduced for more talented CEOs due to the decreasing disutility of effort for more talented CEOs. Thus, we classify firm-years with positive peer-adjusted stock returns during period *t-1* as having more talented CEOs because firms managed by more talented CEOs are more likely to exhibit better peer-adjusted stock performance. Third, if less RPE allows CEOs to have greater strategic flexibility, we expect to observe some evidence that CEOs with less RPE exploit the strategic flexibility to a greater extent at the firm level such as greater asset growth. Hence, we classify firm-years with positive asset growth in period *t+1* as exploiting their strategic flexibility to a greater extent and examine whether firms with positive (negative) asset growth in period *t+1* are less (more) likely to use RPE in period *t*. [16]

[16] Gopalan et al. also examine whether multi-segment firms (based on the SIC industry) are less likely to use RPE. We do not examine this variable because segment information in Compustat is only based on SIC industries, which

Table 8 presents the results. In columns 1 and 2, we divide the full sample into two subsamples based on median peer-adjusted market-to-book. Consistent with our expectations, we find evidence of less filtering of common shocks for high market-to-book firms in column 2 and the difference between columns 1 and 2 is statistically significant at the 1% level. This evidence suggests that firms providing their CEOs with greater strategic flexibility use less RPE. In columns 3 and 4, we use the peer-adjusted stock returns as a conditioning variable and find similar results. The absolute magnitude of the coefficient on *Peer Ret*$_t$ in column 4 (positive peer-adjusted returns) is statistically lower at the 5% level relative to that in column 3 (negative peer-adjusted returns). Lastly, in columns 5 and 6, we use the asset growth rate in period $t+1$ to investigate whether CEOs with less RPE in period t exploit their strategic flexibility in the subsequent period to a greater extent at the firm level. Consistent with our expectations, we find that firms with greater asset growth in period $t+1$ filter out common shocks to a lesser extent in period t as evidenced by the significantly lower absolute magnitude of the coefficient on *Peer Ret*$_t$ at 10% level in column 6 (positive asset growth rate) relative to that in column 7 (negative asset growth rate). In sum, the results in Table 8 are consistent with predictions and findings in Gopalan et al. and suggest that the use of RPE is attenuated by the board's desire to promote strategic flexibility on the part of the CEO.

5. Additional Tests – RPE in Forced CEO Turnover Decisions

5.1. RPE Tests for Forced CEO Turnover Decisions

We investigate the evidence of RPE in forced CEO turnover decisions. Even though the replacement decisions are not directly associated with contracting, we expect that corporate boards would use RPE in this setting. If managers are forced to leave the office due to the factors beyond their controls,

we do not rely on in our study. Gopalan et al. also use R&D expenditures to test the theory. In untabulated tests, we find that the extent of RPE in firms with high R&D expenditures is not significantly different from RPE in firms with low R&D expenditures. This result could be attributed to R&D expenditures being a noisier measure of the firm's growth options because a significant portion of firms in Compustat universe does not report R&D expenditures separately. Koh and Reeb (2015) find that approximately 10.5% of firms with missing R&D from Compustat actually have active patenting activities, suggesting that R&D expenditures from Compustat are a noisy measure of growth options.

it would discourage managerial ex-ante efforts, leading to inefficient contracting as well. Hence, in this extreme form of managerial performance evaluation, corporate boards would be more careful in identifying the appropriate peers to isolate idiosyncratic component of firm performance. Also, we expect the filtering would increase as the number of peers increases as we argued in the CEO pay setting. However, prior research finds mixed and even weaker evidence of RPE in CEO turnover decisions (e.g., DeFond and Park 1999; Ali et al. 2009; Jenter and Kanaan 2015).

Consistent with our CEO pay analyses, we examine the RPE hypothesis in forced CEO turnover decisions by identifying peer groups based on TNIC classifications. Following prior studies, we use the following linear probability model with firm and year fixed effects to estimate forced CEO turnover likelihood (e.g., Cornelli, Kominek, and Ljungqvist 2012; Guo and Masulis 2015):

$$Forced_t = \beta_1 Firm\ Ret_{t-1} + \beta_2 Peer\ Ret_{t-1} + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age_t + \beta_9 Age{>}60_t + \beta_{10} Duality_t + \beta_{11} Ownership_{t-1} + \varepsilon_{i,t}. \quad (2)$$

The dependent variable, $Forced_t$, is an indicator variable equal to one if a forced CEO turnover occurs in period *t*, and zero otherwise. We use hand-collected forced CEO turnover data for all ExecuComp CEOs for the period 1996 to 2015. [17] $Firm\ Ret_{t-1}$ is measured as the natural logarithm of one plus annual buy-and-hold stock return in period *t-1*. If a CEO turnover occurs in period *t*, we use trailing annual returns, which are measured over a period that covers the 12 months before the CEO departure (e.g., Peters and Wagner 2014). $Peer\ Ret_{t-1}$ is measured as the natural logarithm of one plus equal-weighted annual average returns based on the characteristics-matched TNIC peers over the same period that $Firm\ Ret_{t-1}$ is measured.

Panel A of Table 9 provides descriptive statistics of CEO turnover. We first note that the mean value of forced CEO turnover in our sample is approximately 2%, which is similar to that found in prior studies (Guo and Masulis 2015; Jenter and Kanaan 2015; Peters and Wagner 2014). Panel B presents

[17] The procedure to classify turnovers as forced follows Parrino (1997) and uses press reports along with an age criterion and further refinements. See Peters and Wagner (2014) for details.

Pearson correlations among main variables. We note that the *Forced*$_t$ variable is negatively correlated with *Firm Ret*$_{t-1}$, suggesting that poor stock performance is associated with forced CEO turnover decisions.

Table 10 demonstrates the estimation results using Equation 2. Similar to the analyses in Table 3, we start with the full-sample results in column 1. Consistent with CEOs fired for the poor performance, the coefficient on *Firm Ret*$_{t-1}$ is negative (coefficient of -0.041) and significant at the 1% level. The coefficient estimate suggests that a one standard deviation decrease in *Firm Ret*$_{t-1}$ is associated with an increase in the forced CEO turnover likelihood of 1.84%, which represents an 92.05% increase relative to the mean. We find that the coefficient on *Peer Ret*$_{t-1}$ is positive (coefficient of 0.023) and also significant at the 1% level, consistent with our first RPE hypothesis. The evidence supports the weak-form version of RPE in the forced CEO turnover decisions, which is consistent with findings in prior research (Jenter and Kanaan, 2015).

We next test our second prediction that the extent of common performance filtering increases with the number of peers by dividing the sample into three subsamples based on the tercile of the number of TNIC peers in period *t-1* and estimate Equation 2 within each subsample. Here again, we find the coefficient on *Peer Ret*$_{t-1}$ to become increasingly more positive as we move from the Few group to the Moderate group to the Many group. The coefficient on *Peer Ret*$_{t-1}$ is 0.007 in the Few peer group and statistically insignificant, 0.028 in the Moderate peer group significant at the 1% level, and 0.045 in the Many peer group significant at the 1% level. The coefficient on *Peer Ret*$_{t-1}$ is significantly different between the Few and the Moderate groups at the 10% level (difference of 0.021) and also between the Few and the Many groups at the 1% level (difference of 0.038). Similar to the pay results in Table 3, the coefficient on *Firm Ret*$_{t-1}$ does not vary significantly across these subsamples (-0.041, -0.046 and -0.042).

In column 4, we find evidence consistent with our third prediction of complete filtering in the forced CEO turnover decisions. The sum of the coefficients on *Firm Ret*$_{t-1}$ and *Peer Ret*$_{t-1}$ is indistinguishable from zero (*F*-statistic = 0.040, *p*-value = 0.842), suggesting that boards completely filter out common performance when deciding on CEO replacement in an environment with many peer firms. Overall, these results support our RPE hypotheses and corroborate the CEO pay results documented in Table 3.

5.2. Alternative Industry Classifications

Similar to Table 4, we replicate our CEO turnover results using alternative industry classifications. Table 11 reports the replication results. In Panel A, we use three-digit SIC codes and calculate *SIC Peer* Ret_{t-1} using the same method as in the construction of our main peer return variable using TNIC, *Peer* Ret_{t-1}. In column 1, we find the same result documented in column 1 of Table 10, i.e., weak-form evidence of RPE in forced CEO turnover decisions. Next, we partition the sample into terciles based on the number of firms in the same SIC industry, and estimate Equation 2 within each subsample. We find evidence consistent with our two predictions. In particular, the coefficient on *SIC Peer* Ret_{t-1} monotonically increases as we move from the Moderate group to the Many group (coefficient difference of 0.025; *p*-value 0.015). We also find evidence consistent with complete filtering in the Many peers subsample -- albeit a bit weaker than with TNIC matched peers. The coefficient on *Firm* Ret_{t-1} is -0.043 and that on *SIC Peer* Ret_{t-1} is 0.032, and the sum of the two coefficients is statistically indistinguishable from zero (*F*-statistic 0.960; *p*-value 0.327).

In Panel B, we use GICS codes to define peers and compute *GICS Peer* Ret_{t-1}. Here again, we find evidence consistent with weak-form RPE in the full sample. In the subsample analysis, the most positive and significant coefficient for the peer return is found in the moderate peers subsample, which is consistent with the results in Panel B of Table 4. However, the absolute value of the coefficient estimate on *GICS Peer* Ret_{t-1} is statistically lower than that of *Firm* Ret_{t-1}, indicating weak evidence of RPE (*F*-statistic 3.020; *p*-value 0.083). In column 4, we find evidence of complete filtering of common performance in forced CEO turnover decisions. The coefficient on *Firm* Ret_{t-1} is -0.033, that on *GICS Peer* Ret_{t-1} is -0.028, and the sum of the two coefficients is statistically indistinguishable from zero (*F*-statistic 0.210; *p*-value 0.644). The result is not driven by increased filtering but primarily driven by the decreased turnover-own-firm-performance sensitivity between the Moderate and Many groups. The coefficient estimate on *Firm* Ret_{t-1} in the Many group is statistically higher than that of the Moderate group (the coefficient difference 0.023 is significantly positive at the 10% level).

Overall, we find some evidence of strong-form RPE in forced CEO turnover decisions when we use alternative industry classifications even though the findings are not as significant as the results using product market peers. As mentioned before, this is not surprising since these alternative proxies might also be correlated with product market peers. Similar to Table 5, we examine this possibility by including peer return variables simultaneously in the same regression.

Table 12 presents the estimation results comparing peer return variables in the forced CEO turnover regressions. First, we use all firms in the same industry group to construct the peer return variable in columns 1-3 (i.e., *All Peer* Ret_{t-1}, *All SIC Peer* Ret_{t-1}, and *All GICS Peer* Ret_{t-1}). Consistent with our CEO pay results, we find that only the coefficient on *All Peer* Ret_{t-1} remains positive and statistically significant at the 1% level, while those on *All SIC Peer* Ret_{t-1} and *All GICS Peer* Ret_{t-1} become statistically insignificant in columns 1-3. Again, this finding is consistent with our argument that pre-defined industry classifications provide noisier proxies of peer groups, and thus TNIC provides a better identification of peers in forced CEO turnover decisions.

In columns 4-6, we use peer return variables constructed based on characteristics-matched peers. In column 4, we include *Peer* Ret_{t-1} and *SIC Peer* Ret_{t-1} simultaneously in the same regression and find that the coefficient on *Peer* Ret_{t-1} is significantly positive at the 1% level while the coefficient on *SIC Peer* Ret_{t-1} is statistically insignificant. In column 2, we replace *SIC Peer* Ret_t with *GICS Peer* Ret_t, and we find that the coefficient on *Peer* Ret_{t-1} is significantly positive at the 1% level and the coefficient on *GICS Peer* Ret_{t-1} is also significantly positive at the 1% level. In column 6, we include all three peer return variables and find that only the coefficient on *Peer* Ret_{t-1} and *GICS Peer* Ret_{t-1} is significantly positive at the 1% level and 5% level, respectively. The coefficient estimate on *Peer* Ret_{t-1} (0.015) is slightly higher than that of *GICS Peer* Ret_{t-1} (0.013), albeit not statistically significant. This would be possible if some peer information are dropped in the process of matching, and those information is captured by GICS peers, leading to both variables get significant coefficients. To check this possibility, in column 7, we include the peer return variables based on the characteristics-matched TNIC peers (*Peer* Ret_{t-1}) and the peer return variable based on all TNIC peers (*All Peer* Ret_{t-1}) simultaneously in the same regression. We find that both coefficients on *All Peer* Ret_{t-1} and *Peer* Ret_{t-1} variables are statistically significant at the 5% level, suggesting that, in the setting of CEO turnovers, some necessary information about common shocks is not fully captured by characteristics-based matching.[18] This finding suggests that corporate boards would use a broader set of peers to more carefully identify peer performance in the CEO replacement decisions even though the peer performance measure might contain more noise.

Overall, the findings in Table 11 and 12 confirm our hypothesis that RPE exists in the setting of forced CEO turnover, and the filtering increases with the number of peers. Findings also suggest that product market peers provide a better identification of peers in the forced CEO turnover setting.

5.3. Dynamic Peer Groupings and Forced CEO Turnover Decisions

In this section, we examine again the dynamic aspects of TNIC peers in the setting of forced CEO turnover decisions. We use the same variables used in Table 6 and examine whether the current stock returns of past, new, current, and future product market peers contain information about common performance, and thus it is filtered out in the managerial retention decisions.

Table 13 reports the results. We find that the coefficient on $\textit{Firm Ret}_t$ is significantly negative in all four columns. More importantly, consistent with our CEO pay results, we find that, the current period stock returns of past peers ($\textit{Past Peer Ret}_t$) and future peers ($\textit{Future Peer Ret}_t$) are not statistically significant, suggesting that current stock returns of past and future peers do not contain information regarding common shocks. In columns 2 and 3, we find that the coefficients on $\textit{New Peer Ret}_t$ and $\textit{Current Peer Ret}_t$ are significantly positive at the 5% level and the 10% level, respectively. These findings are consistent with the findings in the CEO pay setting and suggest that corporate boards also take the dynamic aspect of product markets into account when they make a CEO replacement decisions.

6. Conclusion

This study examines the RPE hypothesis using product-market peers identified by a textual analysis of firms' product descriptions in 10-K filings (Hoberg and Phillip, 2016). In contrast to the mixed evidence

[18] We re-examine results in Table 10 and Table 11 using peer return variables based on all peer firms in each industry classification and find similar results.

of RPE documented in prior studies, we find three pieces of evidence consistent with RPE in both CEO pay and forced CEO turnover decisions – (i) firms on average filter out common shocks to performance measures, (ii) the extent of filtering increases with the number of peers, and (iii) firms completely filter out common shocks in the presence of a large number of peers. We can replicate the first finding but not the other two using the pre-defined industry classifications such as SIC and GICS especially in the CEO pay regressions. We find evidence that product market peers, in general, provide a better identification than pre-defined industry classifications. Overall, our results suggest that a key identification strategy to testing RPE theory lies in accurately defining the peer group.

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Table 1
Descriptive Statistics

This table presents descriptive statistics for our sample. The sample period is between 1996 and 2015. Panel A presents descriptive statistics for main variables. Panel B presents Pearson correlations among main variables. The sample period is between 1996 to 2015. All variables are defined in the Appendix A.

Panel A Descriptive Statistics

	N	Mean	Std	Q1	Median	Q3
$Total\ Comp_t$	26,182	5,453.360	9,884.990	1,495.260	3,188.220	6,458.250
$ln(Total\ Comp_t)$	26,182	8.038	1.058	7.311	8.068	8.773
$Firm\ Ret_t$	26,182	0.046	0.453	-0.151	0.090	0.295
$Peer\ Ret_t$	26,182	0.063	0.318	-0.087	0.094	0.249
$SIC\ Peer\ Ret_t$	25,519	0.055	0.333	-0.101	0.091	0.247
$GICS\ Peer\ Ret_t$	25,842	0.061	0.316	-0.091	0.096	0.250
$Size_{t-1}$	26,182	7.243	1.619	6.137	7.150	8.311
BM_{t-1}	26,182	0.569	0.452	0.284	0.478	0.748
Vol_{t-1}	26,182	0.089	0.055	0.051	0.076	0.111
ROA_{t-1}	26,182	0.050	0.108	0.013	0.049	0.095
$Tenure_t$	26,182	1.909	0.774	1.341	1.911	2.472
Age_t	26,182	55.733	7.291	51	56	60
$Duality_t$	26,182	0.380	0.485	0	0	1
Own_{t-1}	26,182	0.021	0.057	0.001	0.003	0.011
$lnDelta_{t-1}$	26,182	4.994	1.969	4.075	5.191	6.232
$\#\ of\ Peers_t$	26,182	82.159	113.223	16	41	94
$\#\ of\ SIC\ Peers_t$	25,519	87.993	119.849	12	28	121
$\#\ of\ GICS\ Peers_t$	25,842	69.007	93.707	20	42	79
$Peer\text{-}Adjusted\ GO_t$	26,179	0.168	1.001	-0.227	-0.005	0.287
$Peer\text{-}Adjusted\ Return_{t-1}$	26,160	-0.009	0.640	-0.352	-0.053	0.269
$Asset\ Growth_{t+1}$	24,142	1.103	0.277	0.983	1.056	1.154
CSM_t	25,920	0.047	3.200	-0.237	0.000	0.205
HHI_t	26,182	0.176	0.143	0.078	0.129	0.226

Panel B Pearson Correlations

	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	*ln*(*Total Comp$_t$*)													
(2)	*Firm Ret$_t$*	0.08												
		(0.00)												
(3)	*Peer Ret$_t$*	0.04	0.58											
		(0.00)	(0.00)											
(4)	*SIC Peer Ret$_t$*	0.05	0.55	0.74										
		(0.00)	(0.00)	(0.00)										
(5)	*GICS Peer Ret$_t$*	0.04	0.58	0.77	0.78									
		(0.00)	(0.00)	(0.00)	(0.00)									
(6)	*Size$_{t-1}$*	0.61	0.01	0.04	0.03	0.03								
		(0.00)	(0.02)	(0.00)	(0.00)	(0.00)								
(7)	*BM$_{t-1}$*	-0.15	0.08	0.12	0.10	0.11	0.02							
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)							
(8)	*Vol$_{t-1}$*	-0.24	-0.03	-0.02	-0.01	0.00	-0.38	0.06						
		(0.00)	(0.00)	(0.01)	(0.37)	(0.90)	(0.00)	(0.00)						
(9)	*ROA$_{t-1}$*	0.10	0.03	-0.02	-0.02	-0.01	0.13	-0.26	-0.20					
		(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)					
(10)	*Tenure$_t$*	-0.05	0.03	0.02	0.02	0.02	-0.09	-0.04	-0.03	0.08				
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)				
(11)	*Age$_t$*	0.03	0.03	0.04	0.04	0.03	0.12	0.05	-0.13	0.03	0.39			
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
(12)	*Duality$_t$*	0.04	0.00	0.01	0.00	0.00	0.11	-0.04	-0.02	0.05	0.18	0.14		
		(0.00)	(0.92)	(0.18)	(0.45)	(0.43)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
(13)	*Own$_{t-1}$*	-0.23	0.01	-0.01	-0.02	0.00	-0.14	-0.03	0.10	0.06	0.34	0.15	0.09	
		(0.00)	(0.14)	(0.08)	(0.02)	(0.99)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
(14)	*lnDelta$_{t-1}$*	0.37	-0.03	-0.04	-0.04	-0.04	0.33	-0.26	-0.16	0.21	0.36	0.13	0.21	0.23
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 2
Sales / Costs Correlations

Panel A presents estimation results from the regression of firm *i*'s sales (*Sales$_t$*) in period *t* on average sales using all peer firms in TNIC (*Avg Sales TNIC$_t$*), SIC (*Avg Sales SIC$_t$*), or GICS (*Avg Sales GICS$_t$*) in period *t* excluding firm *i*. Panel B presents estimation results from the regression of firm *i*'s operating costs in period t (*Costs$_t$*), which is the sum of cost of goods sold and SG&A expenses on average operating costs using all peer firms in TNIC (*Avg Costs TNIC$_t$*), SIC (*Avg Costs SIC$_t$*), or GICS (*Avg Costs GICS$_t$*) in period *t* excluding firm *i*. In each panel, column (1) reports estimation results using the full sample, and column (2) through (5) present estimation results conditional on time periods denoted in each column. The sample period is between 1996 and 2015. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

Panel A Sales Correlations

	Dependent Variable: *Sales$_t$*				
Independent Variables	(1)	(2)	(3)	(4)	(5)
	Full Sample	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Avg Sales TNIC$_t$	**0.785*** **	**0.816*** **	**0.842*** **	**0.792*** **	**0.634*** **
	(35.982)	**(30.641)**	**(29.983)**	**(22.538)**	**(16.251)**
Avg Sales SIC$_t$	0.249***	0.231***	0.208***	0.235***	0.366***
	(10.813)	(8.267)	(7.191)	(6.759)	(9.543)
Avg Sales GICS$_t$	0.169***	0.152***	0.149***	0.186***	0.218***
	(7.484)	(5.208)	(5.218)	(4.996)	(5.156)
# of observations	74,004	23,428	19,973	16,379	14,224
Adjusted R-squared	0.540	0.518	0.547	0.552	0.550

Panel B Cost Correlations

	Dependent Variable: *Costs$_t$*				
Independent Variables	(1)	(2)	(3)	(4)	(5)
	Full Sample	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Avg Costs TNIC$_t$	**0.933*** **	**0.834*** **	**0.965*** **	**0.958*** **	**0.944*** **
	(50.656)	**(27.850)**	**(38.258)**	**(32.824)**	**(31.083)**
Avg Costs SIC$_t$	0.164***	0.250***	0.113***	0.158***	0.162***
	(9.959)	(8.452)	(5.108)	(6.005)	(7.259)
Avg Costs GICS$_t$	0.133***	0.149***	0.134***	0.133***	0.139***
	(7.866)	(4.685)	(6.385)	(4.779)	(5.440)
# of observations	74,004	18,336	19,973	16,379	14,224
Adjusted R-squared	0.433	0.424	0.443	0.432	0.428

Table 3
Tests of Relative Performance Evaluation Hypothesis in CEO Compensations

This table presents the estimation results from the following regression model.

$$ln(Total\ Comp_t) = \beta_1\ Firm\ Ret_t + \beta_2\ Peer\ Ret_t + \beta_3\ Size_{t-1} + \beta_4\ BM_{t-1} + \beta_5\ Vol_{t-1} + \beta_6\ ROA_{t-1} + \beta_7\ Tenure_t + \beta_8\ Age + \beta_9\ Duality_t + \beta_{10}\ Ownership_{t-1} + \beta_{11}\ lnDelta_{t-1} + \varepsilon_t$$

In column 1, the estimation uses the full sample. In column 2, 3, and 4, the full sample is divided into three subsamples based on the tercile of the number of TNIC peers. Results testing strong-form evidence of RPE and the coefficient differences are summarized toward the bottom of the table. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm-CEO and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent Variable: *ln*(*Total Comp$_t$*)			
Independent Variables	(1)	(2)	(3)	(4)
		# of TNIC Peers		
	Full Sample	Low	Moderate	High
Firm Ret$_t$ (β_1)	0.213***	0.219***	0.227***	0.208***
	(13.877)	(9.594)	(6.849)	(7.151)
***Peer Ret$_t$* (β_2)**	**-0.101*** **	**-0.039**	**-0.107** **	**-0.207*** **
	(-5.067)	**(-1.444)**	**(-2.537)**	**(-4.231)**
Size$_{t-1}$	0.226***	0.258***	0.187***	0.193***
	(8.591)	(6.839)	(3.722)	(4.692)
BM$_{t-1}$	-0.290***	-0.249***	-0.260***	-0.322***
	(-12.728)	(-8.768)	(-5.310)	(-6.596)
Vol$_{t-1}$	-0.171	-0.115	-0.424	-0.006
	(-1.151)	(-0.439)	(-1.505)	(-0.022)
ROA$_{t-1}$	0.409***	0.572***	0.321**	0.410***
	(4.389)	(3.560)	(1.987)	(2.705)
Tenure$_t$	-0.001	0.048	-0.031	-0.035
	(-0.026)	(0.992)	(-0.483)	(-0.538)
Age$_t$	-0.016	0.007	-0.026	-0.033
	(-0.994)	(0.525)	(-0.698)	(-1.080)
Duality$_t$	0.038**	0.063**	0.034	0.009
	(2.090)	(2.192)	(1.138)	(0.226)
Own$_{t-1}$	-0.306	-0.762*	-0.166	0.054
	(-1.199)	(-1.707)	(-0.311)	(0.120)
lnDelta$_{t-1}$	0.005	-0.007	0.010	0.008
	(0.645)	(-0.714)	(0.638)	(0.586)
Strong RPE F-Stat	**32.180**	**43.490**	**8.600**	**0.000**
P-Value ($\beta_1 + \beta_2 = 0$)	**0.000**	**0.000**	**0.003**	**0.971**
# of observations	26,182	8,888	8,621	8,673
Adjusted R-squared	0.763	0.790	0.775	0.739
Coefficient Difference	$\Delta\beta_1$	*P-value*	$\Delta\beta_2$	*P-value*
Low versus Moderate	0.007	(0.829)	-0.067	(0.113)
Moderate versus High	-0.018	(0.618)	-0.100*	(0.069)
Low versus High	-0.011	(0.725)	-0.167***	(0.000)

Table 4
RPE in CEO Compensation and Alternative Industry Classifications

This table presents the estimation results from the following regression model.

$$ln(Total\ Comp_t) = \beta_1 Firm\ Ret_t + \beta_2 Alternative\ Peer\ Ret_t + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age + \beta_9 Duality_t + \beta_{10} Ownership_{t-1} + \beta_{11} lnDelta_{t-1} + \varepsilon_t$$

In Panel A, the *Alternative Peer Ret$_t$* is *SIC Peer Ret$_t$*. In Panel B, the *Alternative Peer Ret$_t$* is *GICS Peer Ret$_t$*. In each panel, column 1 presents estimation resulting using the full sample, and in columns 2-4, the full sample is divided into three subsamples based on the tercile of the number of industry peers that is used in each panel. Results testing strong-form evidence of RPE and the coefficient differences are summarized toward the bottom of the table. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm-CEO and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

Panel A RPE tests in CEO compensation using SIC

	Dependent Variable: *ln*(*Total Comp*)			
Independent Variables	(1)	(2)	(3)	(4)
		# of SIC Peers		
	Full Sample	Low	Moderate	High
Firm Ret$_t$ (β_1)	0.204***	0.244***	0.251***	0.137***
	(13.025)	(10.491)	(9.940)	(4.565)
***SIC Peer Ret$_t$* (β_2)**	**-0.074*** **	**-0.041**	**-0.119*** **	**-0.063**
	(-4.060)	**(-1.539)**	**(-3.192)**	**(-1.619)**
Size$_{t-1}$	0.227***	0.206***	0.222***	0.234***
	(8.490)	(5.768)	(6.088)	(5.063)
BM$_{t-1}$	-0.291***	-0.258***	-0.296***	-0.284***
	(-12.530)	(-8.819)	(-8.440)	(-5.018)
Vol$_{t-1}$	-0.131	-0.422*	-0.287	-0.062
	(-0.861)	(-1.753)	(-0.987)	(-0.224)
ROA$_{t-1}$	0.410***	0.604***	0.574***	0.229
	(4.339)	(3.810)	(3.114)	(1.620)
Tenure$_t$	0.000	0.050	0.093*	-0.113
	(0.013)	(1.131)	(1.912)	(-1.577)
Age$_t$	-0.014	-0.027	-0.008	-0.030
	(-0.889)	(-0.783)	(-0.410)	(-0.852)
Duality$_t$	0.037**	0.058**	0.018	0.026
	(2.007)	(2.059)	(0.638)	(0.656)
Own$_{t-1}$	-0.309	-0.300	-0.556	-0.191
	(-1.180)	(-0.848)	(-1.003)	(-0.422)
lnDelta$_{t-1}$	0.004	-0.004	-0.016	0.014
	(0.526)	(-0.408)	(-1.525)	(1.106)
Strong RPE F-Stat	**48.850**	**57.960**	**14.340**	**4.070**
P-Value ($\beta_1 + \beta_2 = 0$)	**0.000**	**0.000**	**0.000**	**0.044**
# of observations	25,519	8,659	8,424	8,436
Adjusted R-squared	0.762	0.794	0.778	0.737
Coefficient Difference	$\Delta\beta_1$	*P-value*	$\Delta\beta_2$	*P-value*
Low versus Moderate	0.007	(0.812)	-0.077**	(0.050)
Moderate versus High	-0.114***	(0.001)	0.056	(0.233)
Low versus High	-0.107***	(0.001)	-0.022	(0.600)

Panel B RPE tests in CEO compensation using GICS

Independent Variables	Dependent Variable: $ln(Total\ Comp_t)$ (1)	(2)	(3)	(4)
		# of GICS Peers		
	Full Sample	Low	Moderate	High
$Firm\ Ret_t$ (β_1)	0.208***	0.227***	0.231***	0.162***
	(13.577)	(9.085)	(8.567)	(6.325)
GICS Peer $\boldsymbol{Ret_t}$ **(**$\boldsymbol{\beta_2}$**)**	**-0.085*** **	**-0.052***	**-0.124*** **	**-0.074***
	(-4.290)	**(-1.701)**	**(-3.305)**	**(-1.784)**
$Size_{t-1}$	0.228***	0.203***	0.175***	0.256***
	(8.645)	(3.611)	(4.001)	(5.684)
BM_{t-1}	-0.293***	-0.221***	-0.367***	-0.327***
	(-12.801)	(-5.827)	(-9.423)	(-7.307)
Vol_{t-1}	-0.165	-0.485**	-0.734***	0.381
	(-1.111)	(-2.008)	(-2.725)	(1.494)
ROA_{t-1}	0.411***	0.466**	0.385***	0.256*
	(4.403)	(2.464)	(2.602)	(1.937)
$Tenure_t$	0.002	0.008	0.018	-0.005
	(0.075)	(0.142)	(0.349)	(-0.093)
Age_t	-0.013	-0.018	-0.008	0.000
	(-0.776)	(-0.496)	(-0.156)	(0.034)
$Duality_t$	0.036**	0.058**	0.041	0.025
	(2.010)	(2.005)	(1.170)	(0.838)
Own_{t-1}	-0.288	-0.470	-0.497	-0.083
	(-1.132)	(-0.985)	(-1.027)	(-0.186)
$lnDelta_{t-1}$	0.004	0.002	-0.019*	0.004
	(0.555)	(0.128)	(-1.715)	(0.333)
Strong RPE F-Stat	**39.310**	**25.810**	**9.480**	**5.920**
P-Value ($\boldsymbol{\beta_1 + \beta_2 = 0}$**)**	**0.000**	**0.000**	**0.002**	**0.015**
# of observations	25,842	8,744	8,520	8,578
Adjusted R-squared	0.763	0.791	0.771	0.748
Coefficient Difference	$\Delta\beta_1$	*P-value*	$\Delta\beta_2$	*P-value*
Low versus Med	0.003	(0.919)	-0.071*	(0.093)
Med versus High	-0.068**	(0.033)	0.050	(0.300)
Low versus High	-0.065**	(0.036)	-0.021	(0.635)

Table 5
RPE in CEO Compensation: Comparison with Alternative Industry Classifications

This table presents the estimation results from the following regression model.

$$ln(Total\ Comp_t) = \beta_1 Firm\ Ret_t + \beta_2 Peer\ Ret_t + \beta_3 Alternative\ Peer\ Ret_t + \beta_4 Size_{t-1} + \beta_5 BM_{t-1} + \beta_6 Vol_{t-1} + \beta_7 ROA_{t-1} + \beta_8 Tenure_t + \beta_9 Age + \beta_{10} Duality_t + \beta_{11} Ownership_{t-1} + \beta_{12} lnDelta_{t-1} + \varepsilon_t$$

Alternative Peer Ret$_t$ is constructed based on either three-digit SIC or six-digit GICS industries. In columns 1-3, we use all firms in the each industry group to construct peer return variables (i.e., *All Peer Ret$_t$*, *All SIC Peer Ret$_t$*, and *All GICS Peer Ret$_t$*). In columns 4-6, we use characteristics-matched (using size and book-to-market) peers to construct peer return variables (i.e., *Peer Ret$_t$*, *SIC Peer Ret$_t$*, and *GICS Peer Ret$_t$*). The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm-CEO and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent variable: *ln*(*Total Comp$_t$*)						
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm Ret$_t$	0.207***	0.207***	0.208***	0.217***	0.219***	0.221***	0.213***
	(13.107)	(13.172)	(13.015)	(13.648)	(13.961)	(13.788)	(13.754)
All Peer Ret$_t$	**-0.113*** **	**-0.103*** **	**-0.114*** **	**-**	**-**	**-**	**-0.008**
	(-3.576)	**(-3.246)**	**(-3.300)**	**-**	**-**	**-**	**(-0.232)**
All SIC Peer Ret$_t$	0.017	-	0.019	-	-	-	-
	(0.658)	-	(0.609)	-	-	-	-
All GICS Peer Ret$_t$	-	0.012	-0.001	-	-	-	-
	-	(0.390)	(-0.028)	-	-	-	-
Peer Ret$_t$	**-**	**-**	**-**	**-0.088*** **	**-0.082*** **	**-0.080*** **	**-0.096*** **
	-	**-**	**-**	**(-3.642)**	**(-3.465)**	**(-3.183)**	**(-3.273)**
SIC Peer Ret$_t$	-	-	-	-0.028	-	-0.016	-
	-	-	-	(-1.271)	-	(-0.617)	-
GICS Peer Ret$_t$	-	-	-	-	-0.035	-0.028	-
	-	-	-	-	(-1.495)	(-1.016)	-
Size$_{t-1}$	0.226***	0.226***	0.227***	0.228***	0.228***	0.229***	0.226***
	(8.448)	(8.589)	(8.481)	(8.506)	(8.659)	(8.551)	(8.589)
BM$_{t-1}$	-0.292***	-0.296***	-0.294***	-0.288***	-0.292***	-0.290***	-0.290***
	(-12.576)	(-12.913)	(-12.643)	(-12.442)	(-12.753)	(-12.477)	(-12.752)
Vol$_{t-1}$	-0.138	-0.168	-0.141	-0.139	-0.171	-0.142	-0.171
	(-0.912)	(-1.131)	(-0.931)	(-0.916)	(-1.152)	(-0.934)	(-1.148)
ROA$_{t-1}$	0.403***	0.403***	0.401***	0.407***	0.408***	0.406***	0.409***
	(4.263)	(4.317)	(4.244)	(4.317)	(4.376)	(4.302)	(4.387)

Tenure$_t$	0.000	0.002	0.003	0.000	0.002	0.004	-0.001
	(0.000)	(0.049)	(0.101)	(0.011)	(0.062)	(0.120)	(-0.025)
Age$_t$	-0.014	-0.014	-0.013	-0.014	-0.014	-0.012	-0.016
	(-0.899)	(-0.803)	(-0.735)	(-0.909)	(-0.803)	(-0.734)	(-0.992)
Duality$_t$	0.038**	0.036**	0.038**	0.038**	0.037**	0.038**	0.038**
	(2.061)	(2.016)	(2.037)	(2.056)	(2.036)	(2.039)	(2.092)
Own$_{t-1}$	-0.327	-0.311	-0.328	-0.320	-0.303	-0.317	-0.307
	(-1.249)	(-1.218)	(-1.256)	(-1.222)	(-1.188)	(-1.216)	(-1.200)
lnDelta$_{t-1}$	0.004	0.004	0.004	0.004	0.004	0.003	0.005
	(0.551)	(0.602)	(0.479)	(0.522)	(0.566)	(0.439)	(0.645)
# of observations	25,519	25,842	25,220	25,519	25,842	25,220	26,182
Adjusted R-squared	0.762	0.763	0.762	0.762	0.763	0.763	0.763

Table 6
Dynamic Peer Groups and RPE in CEO Compensation

This table presents the estimation results from the following regression model.

$$ln(Total\ Comp_t) = \beta_1 Firm\ Ret_t + \beta_2 Dynamic\ Peer\ Ret_t + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age + \beta_9 Duality_t + \beta_{10} Ownership_{t-1} + \beta_{11} lnDelta_{t-1} + \varepsilon_t$$

Dynamic Peer Ret$_t$ is defined as equal-weighted average stock returns of past peers (*Past Peer Ret$_t$*), new peers (*New Peer Ret$_t$*), current peers (*Current Peer Ret$_t$*), or future peers (*Future Peer Ret$_t$*) for firm *i* as of period *t*. Past peers are firms that were used to construct the *Peer Ret$_t$* variable in the past period *t-1* but are not in the same product market in the current period *t*. New peers are firms that are used to construct the *Peer Ret$_t$* variable in the current period *t* but were not in the same product market in the past period *t-1*. Current peers are firms that are used in both the past period *t-1* and the current period *t* to construct the *Peer Ret$_t$* variable. Future peers are firms that will be used to construct the *Peer Ret$_t$* variable in the future period *t+1* but are not in the same product market in the current period *t*. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm-CEO and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent Variable: *ln*(*Total Comp$_t$*)			
Independent Variables	(1)	(2)	(3)	(4)
Firm Ret$_t$	0.146***	0.195***	0.214***	0.173***
	(4.584)	(5.831)	(8.612)	(4.431)
Past Peer Ret$_t$	**-0.051**	-	-	-
	(-1.232)	-	-	-
New Peer Ret$_t$	-	**-0.117*** **	-	-
	-	**(-2.612)**	-	-
Current Peer Ret$_t$	-	-	**-0.157*** **	-
	-	-	**(-4.626)**	-
Future Peer Ret$_t$	-	-	-	**-0.071**
	-	-	-	**(-1.451)**
Size$_{t-1}$	0.202***	0.197***	0.209***	0.199***
	(3.356)	(3.673)	(5.229)	(3.212)
BM$_{t-1}$	-0.347***	-0.332***	-0.316***	-0.380***
	(-6.278)	(-5.983)	(-7.693)	(-5.866)
Vol$_{t-1}$	0.068	-0.190	-0.080	0.066
	(0.198)	(-0.612)	(-0.350)	(0.192)
ROA$_{t-1}$	0.392*	0.363*	0.304**	0.447*
	(1.882)	(1.895)	(2.426)	(1.923)
Tenure$_t$	-0.070	-0.106	-0.028	-0.051
	(-0.846)	(-1.474)	(-0.536)	(-0.579)
Age$_t$	-0.036	-0.034	-0.029	-0.062
	(-1.199)	(-1.239)	(-1.055)	(-1.194)
Duality$_t$	-0.003	0.035	0.016	0.012
	(-0.059)	(0.789)	(0.575)	(0.237)
Own$_{t-1}$	-0.144	-0.138	0.077	-0.382
	(-0.240)	(-0.260)	(0.227)	(-0.603)
lnDelta$_{t-1}$	0.006	0.016	0.011	0.006
	(0.302)	(1.005)	(0.919)	(0.308)
# of observations	8,460	9,047	14,345	7,580
Adjusted R-squared	0.713	0.727	0.760	0.718

Table 7
Strategic Interactions in Product Markets and RPE in CEO Compensation

This table presents the estimation results from the following regression model.

$$ln(Total\ Comp_t) = \beta_1\ Firm\ Ret_t + \beta_2\ Peer\ Ret_t + \beta_3\ Size_{t-1} + \beta_4\ BM_{t-1} + \beta_5\ Vol_{t-1} + \beta_6\ ROA_{t-1} + \beta_7\ Tenure_t + \beta_8\ Age + \beta_9\ Duality_t + \beta_{10}\ Ownership_{t-1} + \beta_{11}\ lnDelta_{t-1} + \varepsilon_t$$

In column 1 and 2, the full sample is divided into two subsamples based on the Competitive Strategic Measure (CSM). CSM is defined as the coefficient of correlation between the ratio of the change of a firm's profits to the change of its sales, and the change in the combined sales of its rivals. CSM captures the cross-partial derivative of firm value with regards to industry peers' strategic actions as measured by changes in sales. If the CSM has the positive value, it indicates that the competition is strategic complements; otherwise, the competition is strategic substitutes. In column 3 and 4, the full sample is divided into two subsamples based on the median value of the revenue-based Herfindahl-Hirschman Index (HHI) using TNIC peers. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm-CEO and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent Variable: *ln*(*Total Comp$_t$*)			
Independent Variables	(1)	(2)	(3)	(4)
	Competitive Strategic Measure (*CSM*)		*HHI*	
	Complements	Substitute	Concentrated	Competitive
Firm Ret$_t$	0.202***	0.196***	0.207***	0.212***
	(8.681)	(8.110)	(9.060)	(8.814)
Peer Ret$_t$	**-0.053**	**-0.141*** **	**-0.071** **	**-0.167*** **
	(-1.633)	**(-4.602)**	**(-2.570)**	**(-4.480)**
Size$_{t-1}$	0.235***	0.216***	0.199***	0.235***
	(6.749)	(5.653)	(4.732)	(7.253)
BM$_{t-1}$	-0.301***	-0.283***	-0.279***	-0.268***
	(-8.585)	(-8.711)	(-7.987)	(-8.605)
Vol$_{t-1}$	-0.069	-0.052	-0.278	-0.111
	(-0.321)	(-0.232)	(-1.260)	(-0.506)
ROA$_{t-1}$	0.373***	0.368***	0.431***	0.410***
	(2.746)	(2.867)	(2.948)	(3.001)
Tenure$_t$	-0.011	0.005	-0.033	0.064
	(-0.231)	(0.102)	(-0.628)	(1.417)
Age$_t$	-0.016	0.001	-0.024	-0.028
	(-0.658)	(0.028)	(-0.763)	(-1.358)
Duality$_t$	0.045*	0.029	0.080***	0.004
	(1.693)	(1.004)	(3.245)	(0.144)
Ownership$_{t-1}$	-0.066	-0.486	-0.590	0.032
	(-0.198)	(-1.274)	(-1.575)	(0.104)
lnDelta$_{t-1}$	0.004	-0.003	-0.000	0.007
	(0.403)	(-0.350)	(-0.042)	(0.713)
# of observations	13,882	12,300	13,090	13,092
Adjusted R-squared	0.777	0.771	0.771	0.768
Coefficient difference	ΔCoeff.	*P-value*	ΔCoeff.	*P-value*
Firm Ret$_t$	-0.006	(0.821)	0.005	(0.857)
Peer Ret$_t$	-0.088**	(0.018)	-0.096**	(0.015)

Table 8
Strategic Flexibility and RPE in CEO compensation

This table presents the estimation results from the following regression model.

$$ln(Total\ Comp_t) = \beta_1 Firm\ Ret_t + \beta_2 Peer\ Ret_t + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age + \beta_9 Duality_t + \beta_{10} Ownership_{t-1} + \beta_{11} lnDelta_{t-1} + \varepsilon_t$$

In column 1 and 2, the full sample is divided into two groups based on the median value of peer-adjusted market-to-book ratio in period *t*. In column 3 and 4, the full sample is divided into two groups based peer-adjusted annual stock return in period *t-1*. In column 5 and 6, the full sample is divided into two groups based on the median value of the firm's future asset growth rate in period *t+1*. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm-CEO and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent Variable: $ln(Total\ Comp_t)$					
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Peer-Adjusted GO		*Peer-Adjusted Return*		*Asset Growth*	
	Low	High	Negative	Positive	Low	High
$Firm\ Ret_t$	0.214***	0.198***	0.203***	0.276***	0.227***	0.222***
	(8.806)	(6.538)	(7.495)	(6.822)	(9.007)	(7.648)
$Peer\ Ret_t$	**-0.156*** **	**-0.040**	**-0.116*** **	**-0.026**	**-0.139*** **	**-0.066* **
	(-4.535)	**(-1.212)**	**(-3.314)**	**(-0.701)**	**(-3.909)**	**(-1.896)**
$Size_{t-1}$	0.208***	0.285***	0.250***	0.212***	0.212***	0.240***
	(5.445)	(7.979)	(7.175)	(4.994)	(4.629)	(5.714)
BM_{t-1}	-0.275***	-0.321***	-0.341***	-0.267***	-0.269***	-0.343***
	(-9.907)	(-7.873)	(-8.937)	(-7.021)	(-8.807)	(-7.011)
Vol_{t-1}	-0.144	-0.170	-0.032	-0.469*	-0.357	-0.189
	(-0.653)	(-0.677)	(-0.129)	(-1.884)	(-1.494)	(-0.696)
ROA_{t-1}	0.406***	0.396**	0.465***	0.511***	0.455***	0.439***
	(2.978)	(2.447)	(2.984)	(3.405)	(2.656)	(3.240)
$Tenure_t$	0.017	0.007	-0.025	0.028	-0.008	0.057
	(0.406)	(0.148)	(-0.574)	(0.595)	(-0.167)	(1.209)
Age_t	0.005	-0.049*	-0.017	-0.002	-0.041	-0.020
	(0.274)	(-1.940)	(-0.724)	(-0.070)	(-1.137)	(-0.756)
$Duality_t$	0.065**	0.008	0.038	0.032	0.029	0.023
	(2.377)	(0.266)	(1.391)	(1.094)	(0.985)	(0.866)
$Ownership_{t-1}$	-0.190	-0.355	-0.409	-0.180	-0.296	-0.300
	(-0.427)	(-1.066)	(-1.080)	(-0.399)	(-0.538)	(-0.942)
$lnDelta_{t-1}$	-0.004	0.007	0.008	0.015	-0.009	0.012
	(-0.367)	(0.807)	(0.886)	(1.095)	(-0.920)	(0.996)
# of observations	13,091	13,088	14,327	11,855	12,070	12,072
Adjusted R-squared	0.769	0.779	0.759	0.770	0.765	0.774
Coefficient difference	ΔCoeff.	*P-value*	ΔCoeff.	*P-value*	ΔCoeff.	*P-value*
$Firm\ Ret_t$	-0.016	(0.629)	0.073*	(0.057)	-0.005	(0.875)
$Peer\ Ret_t$	0.116***	(0.003)	0.090**	(0.031)	0.073*	(0.069)

Table 9
Descriptive statistics: Forced CEO turnovers

This table reports descriptive statistics for all sample firms with available information for forced CEO turnover tests. The sample period is between 1996 and 2015. Panel A presents descriptive statistics for main variables. Panel B presents Pearson correlations among main variables. The sample period is between 1996 to 2015. All variables are defined in the Appendix A.

Panel A Descriptive Statistics

	N	Mean	Std	Q1	Median	Q3
$Forced_t$	25,757	0.020	0.141	0.000	0.000	0.000
$Firm\ Ret_{t-1}$	25,757	0.063	0.449	-0.137	0.104	0.308
$Peer\ Ret_{t-1}$	25,757	0.072	0.318	-0.077	0.107	0.257
$SIC\ Peer\ Ret_{t-1}$	25,139	0.064	0.332	-0.092	0.100	0.256
$GICS\ Peer\ Ret_{t-1}$	25,530	0.071	0.313	-0.079	0.107	0.258
$Size_{t-1}$	25,757	7.258	1.615	6.152	7.161	8.321
BM_{t-1}	25,757	0.571	0.449	0.286	0.480	0.749
Vol_{t-1}	25,757	0.088	0.053	0.051	0.075	0.110
ROA_{t-1}	25,757	0.050	0.106	0.014	0.049	0.095
$Tenure_t$	25,757	1.913	0.773	1.344	1.922	2.477
Age_t	25,757	55.757	7.282	51.000	56.000	60.000
$Age>60_t$	25,757	0.242	0.428	0.000	0.000	0.000
$Duality_t$	25,757	0.379	0.485	0.000	0.000	1.000
Own_{t-1}	25,757	0.021	0.057	0.001	0.003	0.011
$\#\ of\ Peers_{t-1}$	25,757	83.610	115.895	16.000	41.000	96.000
$\#\ of\ SIC\ Peers_{t-1}$	25,139	88.577	120.122	13.000	28.000	124.000
$\#\ of\ GICS\ Peers_{t-1}$	25,530	71.025	96.323	21.000	44.000	81.000

Panel B Pearson Correlations

	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	*Forced*$_{t}$													
(2)	*Firm Ret*$_{t-1}$	-0.10												
		(0.00)												
(3)	*Peer Ret*$_{t-1}$	-0.02	0.58											
		(0.00)	(0.00)											
(4)	*SIC Peer Ret*$_{t-1}$	-0.02	0.55	0.74										
		(0.00)	(0.00)	(0.00)										
(5)	*GICS Peer Ret*$_{t-1}$	-0.02	0.57	0.77	0.78									
		(0.00)	(0.00)	(0.00)	(0.00)									
(6)	*Size*$_{t-1}$	0.00	0.02	0.05	0.04	0.04								
		(0.82)	(0.00)	(0.00)	(0.00)	(0.00)								
(7)	*BM*$_{t-1}$	0.03	-0.35	-0.16	-0.16	-0.16	0.02							
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)							
(8)	*Vol*$_{t-1}$	0.04	-0.11	-0.11	-0.11	-0.10	-0.38	0.06						
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)						
(9)	*ROA*$_{t-1}$	-0.04	0.28	0.11	0.09	0.10	0.13	-0.27	-0.21					
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)					
(10)	*Tenure*$_{t}$	-0.02	0.06	0.02	0.02	0.02	-0.09	-0.04	-0.03	0.08				
		(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)				
(11)	*Age*$_{t}$	-0.04	0.02	0.04	0.04	0.03	0.12	0.05	-0.13	0.03	0.39			
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
(12)	*Age>60*$_{t}$	-0.04	0.01	0.02	0.02	0.02	0.03	0.03	-0.05	0.01	0.32	0.72		
		(0.00)	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)		
(13)	*Duality*$_{t}$	-0.04	-0.01	-0.03	-0.04	-0.04	0.11	-0.04	-0.02	0.06	0.18	0.14	0.10	
		(0.00)	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	
(14)	*Own*$_{t-1}$	-0.03	0.01	-0.01	-0.01	0.00	-0.14	-0.03	0.09	0.06	0.34	0.16	0.15	0.08
		(0.00)	(0.03)	(0.35)	(0.08)	(0.73)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 10
Tests of Relative Performance Evaluation in Forced CEO Turnover Decisions

This table presents the estimation results from the following regression model.

$$Forced_t = \beta_1 Firm\ Ret_{t-1} + \beta_2 Peer\ Ret_{t-1} + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age + \beta_9 Age{>}60 + \beta_{10} Duality + \beta_{11} Ownership_{t-1} + \varepsilon_t$$

In column 1, the estimation uses the full sample. In column 2, 3, and 4, the full sample is divided into three subsamples based on the tercile of the number of TNIC peers. Results testing strong-form evidence of RPE and the coefficient differences are summarized toward the bottom of the table. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent Variable: $Forced_t$			
Independent Variables	(1)	(2)	(3)	(4)
		# of TNIC Peers		
	Full Sample	Few	Moderate	Many
$Firm\ Ret_{t-1}$ (β_1)	-0.041***	-0.041***	-0.046***	-0.042***
	(-8.488)	(-4.992)	(-4.734)	(-4.424)
$Peer\ Ret_{t-1}$ (β_2)	**0.023*** **	**0.007**	**0.028*** **	**0.045*** **
	(4.750)	**(1.049)**	**(2.661)**	**(4.134)**
$Size_{t-1}$	0.002	-0.004	0.001	0.004
	(0.521)	(-0.662)	(0.165)	(0.693)
BM_{t-1}	-0.010*	-0.013	-0.021**	-0.002
	(-1.828)	(-1.441)	(-2.317)	(-0.188)
Vol_{t-1}	0.055*	0.083	0.085	0.031
	(1.647)	(1.312)	(1.214)	(0.552)
ROA_{t-1}	-0.002	0.001	0.036	-0.012
	(-0.141)	(0.045)	(1.102)	(-0.483)
$Tenure_t$	0.024***	0.021***	0.028***	0.033***
	(9.157)	(4.128)	(4.792)	(6.891)
Age_t	-0.001***	-0.001	-0.001	-0.002**
	(-3.197)	(-0.781)	(-1.228)	(-2.422)
$Age{>}60_t$	-0.014***	-0.014**	-0.022***	-0.011*
	(-4.148)	(-2.330)	(-3.197)	(-1.669)
$Duality_t$	-0.001	-0.001	-0.003	-0.007
	(-0.272)	(-0.156)	(-0.477)	(-1.113)
$Ownership_{t-1}$	-0.034	-0.055	-0.114	-0.072
	(-1.286)	(-1.087)	(-1.268)	(-1.488)
Strong RPE F-Stat	**10.840**	**11.900**	**3.430**	**0.040**
p-value ($\beta_1 + \beta_2 = 0$)	**0.001**	**0.001**	**0.064**	**0.842**
# of observations	25,757	8,665	8,554	8,538
Adjusted R-squared	0.045	0.068	0.088	0.043
Coefficient Difference	$\Delta\beta_1$	*P-value*	$\Delta\beta_2$	*P-value*
Few versus Moderate	-0.005	(0.686)	0.021*	(0.066)
Moderate versus Many	0.004	(0.767)	0.017	(0.218)
Few versus Many	-0.001	(0.931)	0.038***	(0.001)

Table 11
RPE in Forced CEO Turnovers and Alternative Industry Classifications

This table presents the estimation results from the following regression model.

$$Forced_t = \beta_1 Firm\ Ret_{t-1} + \beta_2 Alternative\ Peer\ Ret_{t-1} + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age + \beta_9 Age>60 + \beta_{10} Duality + \beta_{11} Ownership_{t-1} + \varepsilon_t$$

In Panel A, the *Alternative Peer Ret*$_t$ is *SIC Peer Ret*$_t$. In Panel B, the *Alternative Peer Ret*$_t$ is *GICS Peer Ret*$_t$. In each panel, column 1 presents estimation resulting using the full sample, and in columns 2-4, the full sample is divided into three subsamples based on the tercile of the number of industry peers that is used in each panel. Results testing strong-form evidence of RPE and the coefficient differences are summarized toward the bottom of the table. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

Panel A RPE tests in forced CEO turnovers using SIC

	Dependent Variable: *Forced*$_t$			
Independent Variables	(1)	(2)	(3)	(4)
		# of SIC Peers		
	Full Sample	Few	Moderate	Many
Firm Ret$_{t-1}$ (β_1)	-0.040***	-0.044***	-0.038***	-0.043***
	(-8.328)	(-4.977)	(-4.342)	(-5.029)
***Peer Ret*$_{t-1}$ (β_2)**	**0.018*** **	**0.007**	**0.014**	**0.032*** **
	(3.995)	**(1.090)**	**(1.453)**	**(3.627)**
Size$_{t-1}$	0.002	-0.002	-0.003	0.004
	(0.542)	(-0.252)	(-0.534)	(0.796)
BM$_{t-1}$	-0.011**	-0.028***	-0.006	-0.004
	(-2.017)	(-3.076)	(-0.711)	(-0.317)
Vol$_{t-1}$	0.056	0.077	0.111*	0.015
	(1.630)	(1.045)	(1.694)	(0.305)
ROA$_{t-1}$	-0.003	-0.066*	0.037	0.016
	(-0.210)	(-1.873)	(1.121)	(0.681)
Tenure$_t$	0.024***	0.030***	0.023***	0.026***
	(8.977)	(5.359)	(4.985)	(5.224)
Age$_t$	-0.001***	-0.002***	-0.000	-0.001
	(-3.252)	(-2.970)	(-0.183)	(-1.378)
Age>60$_t$	-0.014***	-0.019***	-0.016**	-0.012*
	(-4.025)	(-3.391)	(-2.317)	(-1.710)
Duality$_t$	-0.001	-0.002	-0.000	-0.007
	(-0.215)	(-0.300)	(-0.019)	(-1.213)
Ownership$_{t-1}$	-0.033	-0.042	-0.038	-0.026
	(-1.215)	(-0.819)	(-1.368)	(-0.541)
Strong RPE F-Stat	**16.370**	**13.380**	**4.640**	**0.960**
p-value ($\beta_1 + \beta_2 = 0$)	**0.000**	**0.000**	**0.031**	**0.327**
# of observations	25,139	8,849	7,940	8,350
Adjusted R-squared	0.043	0.050	0.058	0.035
Coefficient Difference	$\Delta\beta_1$	*P-value*	$\Delta\beta_2$	*P-value*
Few versus Moderate	0.006	(0.624)	0.007	(0.518)
Moderate versus Many	-0.005	(0.679)	0.018	(0.132)
Few versus Many	0.001	(0.931)	0.025**	(0.015)

Panel B RPE tests in forced CEO turnovers using GICS

	Dependent Variable: *Forced*$_t$			
Independent Variables	(1)	(2)	(3)	(4)
		# of GICS Peers		
	Full Sample	Few	Moderate	Many
Firm Ret$_{t-1}$ (β_1)	-0.041***	-0.040***	-0.056***	-0.033***
	(-8.402)	(-4.618)	(-5.579)	(-3.843)
***Peer Ret*$_{t-1}$ (β_2)**	**0.023*** **	**0.012**	**0.036*** **	**0.028*** **
	(4.628)	**(1.514)**	**(3.822)**	**(3.137)**
Size$_{t-1}$	0.001	-0.002	-0.000	0.006
	(0.514)	(-0.372)	(-0.071)	(1.163)
BM$_{t-1}$	-0.010*	-0.009	-0.025**	0.001
	(-1.841)	(-0.993)	(-2.334)	(0.052)
Vol$_{t-1}$	0.053	0.063	0.081	0.035
	(1.605)	(0.963)	(1.051)	(0.747)
ROA$_{t-1}$	-0.002	0.005	0.005	-0.009
	(-0.102)	(0.148)	(0.144)	(-0.370)
Tenure$_t$	0.024***	0.024***	0.031***	0.030***
	(9.110)	(4.943)	(5.269)	(5.911)
Age$_t$	-0.001***	-0.001*	-0.002**	-0.002**
	(-3.202)	(-1.835)	(-2.072)	(-2.439)
Age>60$_t$	-0.014***	-0.013**	-0.015**	-0.015**
	(-4.143)	(-2.187)	(-2.021)	(-2.385)
Duality$_t$	-0.001	-0.002	-0.002	-0.001
	(-0.250)	(-0.311)	(-0.329)	(-0.188)
Ownership$_{t-1}$	-0.034	-0.055	-0.010	-0.040
	(-1.283)	(-1.614)	(-0.151)	(-0.730)
Strong RPE F-Stat	**10.760**	**7.790**	**3.020**	**0.210**
p-value ($\beta_1 + \beta_2 = 0$)	**0.001**	**0.005**	**0.083**	**0.644**
# of observations	25,530	8,746	8,313	8,471
Adjusted R-squared	0.047	0.086	0.049	0.035
Coefficient Difference	$\Delta\beta_1$	*P-value*	$\Delta\beta_2$	*P-value*
Few versus Moderate	-0.016	(0.197)	0.023**	(0.040)
Moderate versus Many	0.023*	(0.058)	-0.008	(0.514)
Few versus Many	0.007	(0.513)	0.016	(0.162)

Table 12
RPE in Forced CEO Turnover Decisions: Comparison with Alternative Industry Classifications

This table presents the estimation results from the following regression model.

$$Forced_t = \beta_1 Firm\ Ret_{t-1} + \beta_2 Peer\ Ret_{t-1} + \beta_3 Alternative\ Peer\ Ret_{t-1} + \beta_4 Size_{t-1} + \beta_5 BM_{t-1} + \beta_6 Vol_{t-1} + \beta_7 ROA_{t-1} + \beta_8 Tenure_t + \beta_9 Age + \beta_{10} Age>60 + \beta_{11} Duality + \beta_{12} Ownership_{t-1} + \varepsilon_t$$

Alternative Peer Ret$_{t-1}$ is constructed based on either three-digit SIC or six-digit GICS industries. In columns 1-3, we use all firms in the each industry group to construct peer return variables (i.e., *All Peer Ret$_{t-1}$*, *All SIC Peer Ret$_{t-1}$*, and *All GICS Peer Ret$_{t-1}$*). In columns 4-6, we use characteristics-matched (using size and book-to-market) peers to construct peer return variables (i.e., *Peer Ret$_{t-1}$*, *SIC Peer Ret$_{t-1}$*, and *GICS Peer Ret$_{t-1}$*). The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent variable: *Forced$_t$*						
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm Ret$_{t-1}$	-0.043***	-0.042***	-0.043***	-0.043***	-0.043***	-0.044***	-0.042***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
All Peer Ret$_{t-1}$	**0.027*** **	**0.023*** **	**0.026*** **	-	-	-	**0.016** **
	(0.000)	**(0.000)**	**(0.000)**	-	-	-	**(0.043)**
All SIC Peer Ret$_{t-1}$	0.001	-	-0.000	-	-	-	-
	(0.832)	-	(0.958)	-	-	-	-
All GICS Peer Ret$_{t-1}$	-	0.005	0.003	-	-	-	-
	-	(0.377)	(0.628)	-	-	-	-
Peer Ret$_{t-1}$	-	-	-	**0.020*** **	**0.015*** **	**0.015*** **	**0.012** **
	-	-	-	**(0.000)**	**(0.003)**	**(0.003)**	**(0.047)**
SIC Peer Ret$_{t-1}$	-	-	-	0.007	-	0.003	-
	-	-	-	(0.104)	-	(0.559)	-
GICS Peer Ret$_{t-1}$	-	-	-		0.014***	0.012**	-
	-	-	-		(0.008)	(0.037)	-
Size$_{t-1}$	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	(0.585)	(0.600)	(0.605)	(0.614)	(0.623)	(0.645)	(0.593)
BM$_{t-1}$	-0.011**	-0.009*	-0.011**	-0.011**	-0.010*	-0.011**	-0.009*
	(0.033)	(0.060)	(0.034)	(0.029)	(0.051)	(0.030)	(0.056)
Vol$_{t-1}$	0.059*	0.055*	0.058*	0.057*	0.054*	0.057*	0.056*
	(0.071)	(0.080)	(0.075)	(0.076)	(0.086)	(0.081)	(0.076)
ROA$_{t-1}$	-0.003	-0.002	-0.003	-0.002	-0.001	-0.001	-0.002
	(0.825)	(0.883)	(0.835)	(0.895)	(0.954)	(0.934)	(0.895)
Tenure$_t$	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age$_t$	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age>60$_t$	-0.014***	-0.014***	-0.014***	-0.014***	-0.014***	-0.014***	-0.014***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Duality$_t$	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.749)	(0.769)	(0.740)	(0.733)	(0.764)	(0.731)	(0.776)
Ownership$_{t-1}$	-0.033	-0.033	-0.033	-0.033	-0.033	-0.033	-0.033
	(0.197)	(0.188)	(0.200)	(0.196)	(0.180)	(0.197)	(0.179)
# of observations	25,127	25,520	24,933	25,126	25,520	24,932	25,748
Adjusted R-squared	0.145	0.144	0.146	0.145	0.145	0.145	0.144

Table 13
Dynamic Peer Groups and RPE in Forced CEO Turnover Decisions

This table presents the estimation results from the following regression model.

$$Forced_t = \beta_1 Firm\ Ret_t + \beta_2 Dynamic\ Peer\ Ret_t + \beta_3 Size_{t-1} + \beta_4 BM_{t-1} + \beta_5 Vol_{t-1} + \beta_6 ROA_{t-1} + \beta_7 Tenure_t + \beta_8 Age + \beta_9 Age{>}60 + \beta_{10} Duality + \beta_{11} Ownership_{t-1} + \varepsilon_t$$

Dynamic Peer Ret$_t$ is defined as equal-weighted average stock returns of past peers (*Past Peer Ret$_t$*), new peers (*New Peer Ret$_t$*), current peers (*Current Peer Ret$_t$*), or future peers (*Future Peer Ret$_t$*) for firm *i* as of period *t*. Past peers are firms that were used to construct the *Peer Ret$_t$* variable in the past period *t-1* but are not in the same product market in the current period *t*. New peers are firms that are used to construct the *Peer Ret$_t$* variable in the current period *t* but were not in the same product market in the past period *t-1*. Current peers are firms that are used in both the past period *t-1* and the current period *t* to construct the *Peer Ret$_t$* variable. Future peers are firms that will be used to construct the *Peer Ret$_t$* variable in the future period *t+1* but are not in the same product market in the current period *t*. The sample period between 1996 and 2015. All variables are defined in the Appendix. Firm and year fixed effects are included in the regressions. Standard errors are clustered by firm. ***, **, and * represent significance level at the 1%, 5%, and 10% level, respectively. Robust t-statistics are in parentheses.

	Dependent Variable: *ln*(*Total Comp$_t$*)			
Independent Variables	(1)	(2)	(3)	(4)
Firm Ret$_t$	-0.034***	-0.034***	-0.038***	-0.031***
	(-4.974)	(-5.455)	(-7.203)	(-4.808)
Past Peer Ret$_t$	**0.007**	-	-	-
	(0.986)	-	-	-
New Peer Ret$_t$	-	**0.013****	-	-
	-	**(1.990)**	-	-
Current Peer Ret$_t$	-	-	**0.014***	-
	-	-	**(1.923)**	-
Future Peer Ret$_t$	-	-	-	**0.006**
	-	-	-	**(0.776)**
Size$_{t-1}$	0.007	0.008	0.003	0.003
	(1.121)	(1.563)	(0.807)	(0.595)
BM$_{t-1}$	0.022**	0.017***	0.014**	0.017**
	(2.451)	(2.636)	(2.498)	(2.263)
Vol$_{t-1}$	0.008	0.042	0.026	0.016
	(0.138)	(0.925)	(0.624)	(0.412)
ROA$_{t-1}$	-0.009	-0.040*	-0.041**	-0.014
	(-0.335)	(-1.938)	(-1.976)	(-0.822)
Tenure$_t$	0.031***	0.032***	0.028***	0.024***
	(6.300)	(7.505)	(8.060)	(4.389)
Age$_t$	-0.001*	-0.002***	-0.001**	-0.001
	(-1.762)	(-3.287)	(-2.284)	(-1.134)
Age>60$_t$	-0.013*	-0.013**	-0.015***	-0.016**
	(-1.947)	(-2.132)	(-3.242)	(-2.223)
Duality$_t$	-0.010*	-0.001	-0.007*	-0.009
	(-1.735)	(-0.196)	(-1.649)	(-1.467)
Own$_{t-1}$	-0.012	0.012	-0.033	-0.047
	(-0.259)	(0.189)	(-0.828)	(-1.271)
# of observations	8,460	9,047	14,345	7,580
Adjusted R-squared	0.713	0.727	0.760	0.718

APPENDIX A: Variable Definitions

Variable	**Definition**
Age_t	Age_t is defined as CEO age variable in ExecuComp in period *t*.
$Age>60_t$	$Age>60_t$ is an indicator variable equal to one if the CEO age is greater than 60, zero otherwise.
$Asset\ Growth_{t+1}$	$Asset\ Growth_{t+1}$ is measured as firm *i*'s total assets in period *t+1* divided by total assets in period *t*.
BM_{t-1}	BM_{t-1} is measured as firm *i*'s Book-to-Market ratio as of the beginning of period *t*. Book-to-Market is measured as the book value of equity divided by market value of equity. Book value of equity is measured by shareholders' equity plus deferred tax and investment credit minus preferred stock. The market value of equity is obtained from CRSP and is calculated by the number of common shares outstanding multiplied by share price.
CSM_t	CSM_t is the Competitive Strategic Measure, which is defined as the coefficient of correlation between the ratio of the change of a firm's profits to the change of its sales, and the change in the combined sales of its rivals. CSM captures the cross-partial derivative of firm value with regards to industry peers' strategic actions as measured by changes in sales. If the CSM has the positive value, it indicates that the competition is strategic complements; otherwise, the competition is strategic substitutes.
$Duality_t$	$Duality_t$ is an indicator variable equal to one if the CEO is the chairman of the corporate boards, zero otherwise.
$Firm\ Ret_t$	$Firm\ Ret_t$ is measured as the natural logarithm of one plus firm *i*'s annual buy-and-hold stock return in period *t*.
$Firm\ Ret_{t-1}$	When there is no forced CEO turnover in period *t*, $Firm\ Ret_{t-1}$ is measured as the natural logarithm of one plus annual buy-and-hold stock return in period *t-1*. If a CEO turnover occurs in period *t*, annual returns are measured over a period that covers the 12 months prior to the CEO departure date.
$Forced_t$	$Forced_t$ is an indicator equal to one if a forced CEO turnover occurs in period *t*, zero otherwise. Forced CEO turnover is identified following Parrino (1997) and Peters and Wagner (2014).
$lnDelta_{t-1}$	$lnDelta_{t-1}$ is the natural logarithm of one plus portfolio delta for the CEO at the beginning of the period *t*. Portfolio delta measures the dollar change in wealth experienced by the CEO for a 1% change in the firm's stock price (Core and Guay, 2002; Coles et al., 2006).
$\#\ of\ Peers_t$	$\#\ of\ Peers_t$ is measured as the number of firms in the same TNIC group for firm *i* in period *t*.
$\#\ of\ GICS\ Peers_t$	$\#\ of\ GICS\ Peers_t$ is measured as the number of firms in the same six-digit GICS group for firm *i* in period *t*.
$\#\ of\ SIC\ Peers_t$	$\#\ of\ SIC\ Peers_t$ is measured as the number of firms in the same three-digit SIC group for firm *i* in period *t*.

Own_{t-1}	*$Ownership_{t-1}$* is calculated as the number of shares owned by CEO excluding option divided by the number of shares outstanding for firm *i* at the beginning of period *t.*
Peer-Adjusted GO_t	*Peer-Adjusted GO_t* is measured as market to book ratio of firm firm *i* in period *t* less median market-to-book ratio of TNIC peers in period *t*.
Peer-Adjusted $Returns_{t-1}$	*Peer-Adjusted $Return_{t-1}$* is measured as annual return for firm *i* in period *t-1* less equal-wegithed average return of TNIC peers in period *t-1*.
Peer Ret_t	*Peer Ret_t* is measured as the natural logarithm of one plus equal-weighted annual returns of firm *i*'s characteristics-matched TNIC peers in period *t*. To define characteristics-matched TNIC peers, we choose one-quarter of TNIC peers based on the closeness of the Mahalanobis distance using the market value of equity (i.e., Size) and book-to-market as of the beginning of the fiscal period. We require firm *i* to have a minimum of two peer firms in each period.
Peer Ret_{t-1}	When there is no forced CEO turnover in period *t*, *Peer Ret_{t-1}* is measured as the natural logarithm of one plus equal-weighted annual returns of firm *i*'s characteristics-matched TNIC peers in period *t-1* (see above). If a CEO turnover occurs in period *t*, annual returns are measured over a period that covers the 12 months prior to the CEO departure date.
ROA_{t-1}	*ROA_{t-1}* is return on assets in period *t-1* as measured by income before the extraordinary items divided by the average total assets for firm *i* in period *t-1*.
SIC Peer Ret_t	*SIC Peer Ret_t* is measured as the natural logarithm of one plus equal-weighted annual returns of firm *i*'s characteristics-matched SIC peers in period *t*. To define characteristics-matched SIC peers, we choose one-quarter of firms in the same three-digit SIC industry based on the closeness of the Mahalanobis distance using the market value of equity (i.e., Size) and book-to-market as of the beginning of the fiscal period. We require firm *i* to have a minimum of two peer firms in each period.
SIC Peer Ret_{t-1}	When there is no forced CEO turnover in period *t*, *SIC Peer Ret_{t-1}* is measured as the natural logarithm of one plus equal-weighted annual returns of firm *i*'s characteristics-matched SIC peers in period *t-1* (see above). If a CEO turnover occurs in period *t*, annual returns are measured over a period that covers the 12 months prior to the CEO departure date.
GICS Peer Ret_t	*GICS Peer Ret_t* is measured as the natural logarithm of one plus equal-weighted annual returns of firm *i*'s characteristics-matched GICS peers in period *t*. To define characteristics-matched GICS peers, we choose one-quarter of firms in the same eight-digit GICS industry based on the closeness of the Mahalanobis distance using market value of equity (i.e., Size) and book-to-market as of the beginning of the fiscal period. We require firm *i* to have a minimum of two peer firms in each period.
GICS Peer Ret_{t-1}	When there is no forced CEO turnover in period *t*, *GICS Peer Ret_{t-1}* is measured as the natural logarithm of one plus equal-weighted annual returns of firm *i*'s characteristics-matched GICS peers in period *t-1* (see above). If a CEO turnover occurs in period *t*, annual returns are measured over a period that covers the 12 months prior to the CEO departure date.
HHI_t	*HHI_t* is measured as the revenue-based Herfindahl-Hirschman Index (HHI) using TNIC peers.

$Size_{t-1}$	$Size_{t-1}$ is measured as the natural logarithm of one plus firm *i*'s total revenue in period *t-1*.
$Tenure_t$	$Tenure_t$ is defined as the natural logarithm of one plus the difference between the *BECAMECEO* variable in ExecuComp and the date of fiscal year-end for firm *i* as of the beginning of period *t* divided by 365.
$Total\ Comp_t$	*Total Comp* is *TDC1* in ExecuComp, which is measured by the sum of salary, bonus, long-term incentive payouts, the fair value of stock and option grants, and all other compensation for firm *i* in period *t*.
$ln(Total\ Comp_t)$	*ln*(*Total Comp*) is measured as the natural logarithm of one plus total CEO compensation for firm *i* in period *t*.
Vol_{t-1}	Vol_{t-1} measures idiosyncratic return volatility and defined as the standard deviations of residuals from the regression of firm *i*'s monthly returns on monthly equal-weighted peer firm average returns using preceding past 12 months (a minimum of 6 observations is required).

APPENDIX B: Explicit Peers

We obtain the data on the explicit peers for relative performance evaluation in compensation from the Incentive Lab database. Incentive Lab collects detailed data on compensation plans and structures disclosed in proxy filings for the group of largest 750 firms in terms of the market value of equity for each year. Furthermore, Incentive Lab forward-fills data for firms leaving the group and also back-fills the data for firms entering the group up to 1998, resulting in the collection of detailed compensation data for approximately 1,300 firms in each year between 1998 and 2015 (a total number of 2,056 unique firms as of the end of fiscal year 2015). In our sample. we have 1,477 firm-year observations for 279 unique firms disclosing the explicit peers during the sample period between 1998 and 2015.

Panel A provides descriptive statistics concerning the number of explicit peers and the number of peer firms in other peer group definition referred to as explicit peers. We first note that, on average, firms disclose 14.78 explicit peers, and 59.29% of them (or 7.83 firms) are the TNIC peers. We also find that 53.91% of explicit peers (or 6.68 firms) are firms operating in the same three-digit SIC industry. We note that these statistics are largely similar to that reported in Gong et al. (2011). Gong et al. hand-collect the explicit peers for S&P 1,500 firms in 2006. They find that 232 firms disclose the identity of explicit peers and have on average 14.69 explicit peers (Panel F Table 1 in Gong et al.). Moreover, Gong et al. find that 47.92% of explicit peers are operating in the same three-digit SIC industry.

Panel B demonstrates the RPE results using the explicit peers, and panel C provides results comparing the explicit peers and other peer group definitions. Other than the use of explicit peers, the estimation uses the same regression specification as in our main analyses (Table 3-5).

Panel A Descriptive Statistics

	N	Mean	Std	Median	%
# of Explicit Peers	1,477	14.78	12.20	12.00	
# of TNIC peers classified to as explicit peers	1,477	7.83	6.47	7.00	59.29%
# of SIC peers classified to as explicit peers	1,477	6.68	5.74	6.00	53.91%
# of GICS peers classified to as explicit peers	1,477	7.22	5.08	6.00	59.69%

Panel B RPE tests in CEO compensation using explicit peers

Independent Variables	(1)	(2)	(3)	(4)
	Dependent Variable: *ln*(*Total Comp*)			
		# of Explicit Peers		
	Full Sample	Low	Med	High
Firm Ret$_t$	**0.237*****	**0.064**	**0.283****	**0.236****
	(3.791)	**(0.417)**	**(2.564)**	**(2.035)**
Explicit Peer Ret$_t$	**-0.192****	**-0.076**	**-0.194**	**-0.269***
	(-2.352)	**(-0.618)**	**(-1.086)**	**(-1.745)**
Size	0.226**	0.166	0.314**	-0.270*
	(2.448)	(1.033)	(2.424)	(-1.814)
BM	-0.121	0.033	-0.202	-0.131
	(-1.584)	(0.316)	(-1.233)	(-1.072)
Vol	-0.469	-1.996*	-0.752	1.309*
	(-0.963)	(-1.749)	(-1.019)	(1.689)
ROA	-0.086	0.255	-0.013	0.440
	(-0.324)	(0.599)	(-0.021)	(0.825)
Tenure	-0.099	-0.247	-0.132	0.164
	(-0.903)	(-1.352)	(-0.599)	(0.927)
Age	-0.083	-0.075	0.059	-0.114
	(-0.578)	(-0.374)	(0.264)	(-0.701)
Duality	-0.010	-0.027	0.118	0.003
	(-0.195)	(-0.340)	(1.077)	(0.035)
Own	-19.758**	-12.355	-6.499	-18.450
	(-1.987)	(-0.618)	(-0.403)	(-1.223)
lnDelta	0.008	-0.008	0.006	-0.033
	(0.438)	(-0.156)	(0.132)	(-1.481)
Strong RPE F-Stat	**0.400**	**0.010**	**0.480**	**0.070**
P-Value ($\beta 1 + \beta 2 = 0$)	**0.526**	**0.921**	**0.490**	**0.799**
Firm-CEO FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
# of observations	1,477	499	488	490
Adjusted R-squared	0.784	0.782	0.798	0.842
Coefficient Difference	$\Delta\beta 1$	p-value	$\Delta\beta 2$	p-value
Low versus Med	0.218	(0.167)	-0.118	(0.520)
Med versus High	-0.046	(0.722)	-0.075	(0.687)
Low versus High	0.172	(0.275)	-0.193	(0.233)

Panel C Comparison with other peer group definitions

	Dependent variable: *ln*(*Total Comp*$_t$)						
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm Ret$_t$	0.237***	0.208***	0.200***	0.196***	0.242***	0.243***	0.238***
	(3.791)	(3.210)	(3.322)	(3.205)	(3.745)	(3.827)	(3.728)
***Explicit Peer Ret*$_t$**	**-0.192****	-	-	-	**-0.146**	**-0.167**	**-0.191***
	(-2.352)	-	-	-	**(-1.552)**	**(-1.630)**	**(-1.824)**
***Peer Ret*$_t$**	-	**-0.143***	-	-	**-0.064**	-	-
	-	**(-1.727)**	-	-	**(-0.646)**	-	-
***SIC Peer Ret*$_t$**	-	-	**-0.107**	-	-	**-0.034**	-
	-	-	**(-1.283)**	-	-	**(-0.340)**	-
***GICS Peer Ret*$_t$**	-	-	-	**-0.098**	-	-	**-0.002**
	-	-	-	**(-1.353)**	-	-	**(-0.024)**
Size$_{t-1}$	0.226**	0.222**	0.222**	0.225**	0.224**	0.223**	0.225**
	(2.448)	(2.407)	(2.369)	(2.407)	(2.448)	(2.419)	(2.438)
BM$_{t-1}$	-0.121	-0.122	-0.123	-0.117	-0.121	-0.120	-0.117
	(-1.584)	(-1.532)	(-1.547)	(-1.481)	(-1.567)	(-1.553)	(-1.529)
Vol$_{t-1}$	-0.469	-0.519	-0.479	-0.507	-0.478	-0.467	-0.481
	(-0.963)	(-1.081)	(-0.979)	(-1.057)	(-0.984)	(-0.946)	(-0.989)
ROA$_{t-1}$	-0.086	-0.099	-0.073	-0.080	-0.092	-0.081	-0.081
	(-0.324)	(-0.373)	(-0.279)	(-0.305)	(-0.342)	(-0.304)	(-0.306)
Tenure$_t$	-0.099	-0.103	-0.103	-0.095	-0.099	-0.101	-0.097
	(-0.903)	(-0.945)	(-0.936)	(-0.856)	(-0.910)	(-0.916)	(-0.872)
Age$_t$	-0.083	-0.088	-0.088	-0.078	-0.085	-0.085	-0.082
	(-0.578)	(-0.620)	(-0.618)	(-0.547)	(-0.595)	(-0.596)	(-0.570)
Duality$_t$	-0.010	-0.014	-0.011	-0.013	-0.010	-0.007	-0.009
	(-0.195)	(-0.273)	(-0.209)	(-0.249)	(-0.209)	(-0.148)	(-0.185)
Own$_{t-1}$	-19.758**	-19.988**	-20.092**	-20.177**	-19.732**	-19.774**	-19.808**
	(-1.987)	(-1.998)	(-1.974)	(-2.001)	(-1.988)	(-1.973)	(-1.991)
lnDelta$_{t-1}$	0.008	0.008	0.010	0.010	0.008	0.010	0.010
	(0.438)	(0.390)	(0.525)	(0.518)	(0.396)	(0.537)	(0.518)
# of observations	1,477	1,477	1,460	1,466	1,477	1,460	1,466
Adjusted R-squared	0.784	0.783	0.782	0.783	0.784	0.783	0.783