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Relative Performance Evaluation and Competitive Aggressiveness

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ABSTRACT

We examine the relation between incentive plans based on relative performance and competitive aggressiveness. Using data on executive incentive-compensation contracts in large U.S. firms, we find a positive association between competitive aggressiveness and peer group overlap—that is, the extent to which two firms select each other as peers in these incentive plans. Our findings indicate that managers of such firms take more frequent as well as more complex competitive actions, relative to managers evaluated on relative performance without peer group overlap. Moreover, we show that these competitive tactics are more pronounced when managers compete against: (1) peers with similar grant sizes, (2) peers on similar performance metrics, and (3) peers in the same industry. Collectively, our findings provide evidence

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on how widely used incentive-compensation practices relate to strategic firm decisions.

JEL codes: D22, J33, J41, L1, M4

Keywords: relative performance evaluation; peer group overlap; competitive aggressiveness; strategic interaction; collusion

1. Introduction

The usage of incentive plans based on relative performance in large U.S. firms has grown from 22% to 67% from 2006 to 2019 (e.g., Meridian Compensation Partners LLC. [2019], Equilar [2020]). Given the ubiquity of relative performance plans, it is of paramount interest to investors, regulators, and practitioners to understand how these incentive plans affect firm decisions. However, empirical evidence on the implications of relative performance plans for firm decisions is limited. We address this important void by examining how these incentive-compensation practices relate to competitive actions that aim to directly challenge rivals. In particular, we relate the extent to which firms select each other as peers to their competitive aggressiveness.

A key purpose of relative performance evaluation (hereafter "RPE") is to improve risk-sharing between the principal and the agent by benchmarking the agent's performance against peers that are affected by common shocks. This allows the principal to provide more efficient incentives (e.g., Holmström [1982]). However, basing pay on relative performance at the same time puts the agent in direct competition to its peers. An agent can respond to this competition in two ways, that is, (1) sabotage and (2) collusion (e.g., Gibbons and Murphy [1990]). In terms of competitive aggressiveness, sabotage implies more competitive aggressiveness, whereas collusion implies less competitive aggressiveness. This suggests that RPE incentive plans can increase or decrease competitive aggressiveness. Below we explain the rationale for each scenario in detail.

The reason why RPE incentive plans can *increase* competitive aggressiveness is fairly intuitive. The manager of the focal firm has an incentive to gain an advantage over competitors and improve the firm's relative position, which he/she can achieve by engaging in competitive actions. This intuition is formalized in a simple theoretical framework developed by Aggarwal and Samwick [1999]. This framework predicts that, in a setting with two competing agents, the incentives to act aggressively are greatest if *both* agents are evaluated based on own- and peer performance, because *both* agents then have an incentive to outperform each other. Such "reciprocity" is not necessarily present in relative performance plans of large U.S. firms—a focal firm's peers need not use RPE themselves or, if they use RPE, they need not select the focal firm as their own peer. Throughout the paper, we refer to such an overlapping peer relationship as "peer group overlap." There are no economic forces that either prohibit or require firms to select

each other as peers, and as such there is variation in the degree to which competing firms are evaluated based on each other's performance. As a result, if relative performance plans increase competitive aggressiveness, this increase is proportional to the extent to which two firms select each other as peers in these incentive plans.

The reason why RPE incentive plans can *decrease* competitive aggressiveness is also intuitive but less straightforward. It is typically the case that all firms would be better off when none of them are competitively aggressive compared to when all of them are (e.g., Aggarwal and Samwick [1999]). In the presence of RPE, a necessary condition for the latter is a commitment to abstain from being competitively aggressive. Such commitment can be created through collusion. If firms using RPE incentive plans collude, they are *less* competitively aggressive than firms that do not use these incentive plans. Moreover, if relative performance plans decrease competitive aggressiveness, then this decrease is also proportional to the extent to which two firms select each other as peers in these incentive plans. Because both scenarios are plausible, the goal of this paper is to test which scenario plays out in practice. Strictly speaking, our question is therefore an empirical question.

We empirically examine the relation between peer group overlap in relative performance plans and competitive aggressiveness using a sample of 355 unique U.S. firms (1,623 firm-years) over the period 2006 through 2017. We identify peer group overlap in managers' incentive-compensation contracts based on the Compensation Discussion and Analysis (CD&A) section of the proxy statement. The average peer group overlap is 15%, which implies that approximately one in seven firm-peer relationships is a reciprocal peer relationship. To measure competitive aggressiveness, we follow a rich literature on competitive actions in strategic management, and use structured content analysis of competitive actions identified by news events. Examples of such actions are the introduction of new products in an attempt to steal market share from a peer, the launch of a new marketing campaign, price cuts, and the initiation of a joint venture. Our first measure of competitive aggressiveness is the firm's action *volume*, which captures the number of competitive actions for a given period. On average, our sample firms take about 33 actions per year. Our second measure is the firm's action *complexity*. This measure embraces the idea that not all actions are identical—it exploits variation in firms' competitive repertoires across multiple action types, such as, new products, pricing, marketing, and joint ventures. Our sample firms have, on average, considerable variation in their action repertoires across action types. A key advantage of using these two measures is that they allow us to capture a broad and comprehensive set of relevant and impactful competitive actions. Nevertheless, to ensure that our inferences are not unique to these specific measures of competitive aggressiveness, we triangulate and confirm that our results are robust to using accounting-based input (i.e., advertisement expenditures) and output (i.e., operating margins) measures of competitive aggressiveness.

We test for a relation between peer group overlap and competitive aggressiveness using multiple specifications. In our first set of tests, we examine the relation between peer group overlap and competitive aggressiveness using variation in peer group overlap. Consistent with the sabotage hypothesis, we find that peer group overlap is positively associated with competitive aggressiveness. Our findings suggest that firms with peer group overlap act more aggressively by taking more frequent as well as more complex competitive actions than do firms without peer group overlap. In economic terms, our results show that RPE firms with peer group overlap at the 90th percentile have 36% greater action volume and 19% greater action complexity than RPE firms with peer group overlap at the 10th percentile. These economically relevant differences are corroborated when using advertisement expenditures and operating margins as measures of competitive aggressiveness. That is, RPE firms with peer group overlap at the 90th percentile have 76% higher advertising expenditures and 17% lower operating margins than RPE firms with peer group overlap at the 10th percentile.

In our second set of tests, we estimate a staggered continuous difference-in-differences specification. We exploit the idea that if one of the peers of the focal firm's peer group adds the focal firm to its peer group, there is an increase in peer group overlap in that year that is beyond the control of the focal firm. In this specification, variation in peer group overlap is the result of *peers'* incentive-compensation choices. As such, this design rules out many alternative explanations related to firms' *own* incentive-compensation choices. We find that in the year a focal firm gets added to one of its peers' peer group, the focal firm is more competitively aggressive—both in terms of volume and complexity. In economic terms, for each newly added overlap, the focal firm has an 11% higher action volume and a 7% higher action complexity, relative to firms that have no new overlap triggered by their peers. This finding strengthens our inference that managers consider peer group overlap in shaping their firms' repertoire of competitive actions.

Although our evidence is, on average, consistent with the sabotage hypothesis, in our third set of tests, we explore whether the overlap-aggressiveness association varies with characteristics of relative performance plans. In these tests, we show that the association is more pronounced when managers compete against: (1) peers with similar grant sizes, (2) peers on similar performance metrics, and (3) peers in the same industry. Collectively, these findings indicate that characteristics of relative performance plans matter for competitive aggressiveness. In addition—because these tests link the relation between peer group overlap and competitive aggressiveness to characteristics of managers' incentive-compensation contracts—these findings implicitly strengthen our inference that the relation is attributable to the decisions of managers.

Our paper makes several contributions to distinct streams of literature. First, we provide empirical evidence on the relation between relative performance plans—and, in particular, peer group overlap—and competitive

aggressiveness. In light of the public debate on the structure of executive incentive-compensation contracts, these insights should be of interest to investors, regulators, and practitioners, because they can be used to assess whether these contracts expose firms to material risks. Specifically, there is an ongoing discussion as to whether RPE-related competition among large U.S. firms induces firms to sabotage or collude. For example, in related work, Bloomfield, Marvão, and Spagnolo [2021b] posit that cartel membership increases the likelihood that a firm uses RPE. Through cartel membership, firms could get the risk reduction benefits of RPE without sabotaging each other. Similarly, Ha, Ma, and Žaldokas [2020] show that after four regional offices of Department of Justice closed down, some firms put a positive weight on peer performance in their executive incentive-compensation contracts. Our story is not mutually exclusive to these stories. Whereas these studies focus on how the existence of collusive agreements affects the use of RPE and how firms abstain from using RPE to enter into collusive agreements, our focus is on how explicit RPE plans relate to firms' competitive actions. The evidence we present is in favor of the "sabotage" hypothesis, and—in conjunction with prior studies' findings—highlights the complex nature of the relation between RPE and competitive behavior. Our study thus improves the understanding of the economics of relative performance plans.

Second, we speak to the empirical management accounting literature that examines the composition, determinants, and consequences of incentive-compensation contracts. In terms of RPE contracts, prior research has mainly focused on the adoption and the risk reduction properties of RPE (e.g., Albuquerque [2009, 2014], Carter, Ittner, and Zechman [2009], Gong, Li, and Shin [2011]), as well as the effort consequences of RPE (e.g., Matsumura and Shin [2006], Casas-Arce and Martínez-Jerez [2009]). Our contribution to this literature is the evidence on the economic consequences of RPE in terms of competitive actions. In this regard, our finding that the positive association between peer group overlap and firms' competitive aggressiveness is largely concentrated in the subsample of reciprocal firms—that is, firms with peer group overlap—suggests there are different implications of relative performance plans *with* peer group overlap and relative performance plans *without* peer group overlap. This subtle, yet important distinction provides important insights not only for decision-makers but also for academic researchers, because inferences obtained from within-firm RPE plans (which typically have 100% overlap) might not directly transfer to executive RPE plans (which need not have—and rarely have—100% overlap), and vice versa. As such, future academic studies that examine the determinants and/or consequences of RPE plans benefit from considering the specific characteristics of RPE plans (vis-à-vis pooling all plans into one construct).

Third, we contribute to the literature on peer selection in executive compensation by providing insights into the prevalence and determinants of the reciprocity aspect of RPE peer selection—that is, peer group overlap.

Two distinct—but related—streams of literature have examined the determinants of peer group composition, both for incentive-compensation benchmarking (e.g., DiPrete, Eirich, and Pittinsky [2010], Faulkender and Yang [2010], Cadman and Carter [2013], Pittinsky and DiPrete [2013]) and for explicit RPE (e.g., Gong, Li, and Shin [2011], Drake and Martin [2020], Bizjak et al. [2021]). The former stream of literature shows that reciprocal firms for incentive-compensation benchmarking share similar firm fundamentals (e.g., de Vaan, Elbers, and DiPrete [2019]). We provide added corroboration to this idea, by showing that firms that end up in each other's relative performance peer group similarly tend to have similar firm fundamentals.

Finally, we draw from—and, in doing so, help bridge—the strategic management and accounting literatures. Although accountants have a great interest in understanding how competition affects accounting-related issues (e.g., Harris [1998], Li, Lundholm, and Minnis [2013]), the accounting literature largely ignored the reverse association between accounting-related choices and competitive actions. We bring in the perspective that incentive-compensation choices relate to such competitive actions. Moreover, we introduce measurement techniques from strategic management to measure competitive aggressiveness. To the extent that competitive aggressiveness is an established and validated construct in strategic management (e.g., Ferrier, Smith, and Grimm [1999], Ferrier [2001], Ferrier and Lyon [2004], Connelly et al. [2017], Connelly et al. [2019]), it provides ample opportunity for future accounting research.

The paper proceeds as follows. Section 2 discusses related literature and develops hypotheses. Section 3 discusses variable measurement, sample selection, and descriptive statistics. Section 4 presents our main tests and results. Section 5 discusses our cross-sectional tests. Section 6 discusses an additional test. Section 7 discusses our robustness tests. Section 8 concludes.

2. *Related Literature and Theory Development*

2.1 RELATED LITERATURE ON RPE

In his seminal paper, Holmström [1982] develops an economic theory of RPE, which stipulates it is optimal to use peer performance as an instrument to filter systematic risk from performance. CD&A disclosures in firms' proxy statements reveal that the use of such RPE arrangements in executive incentive-compensation contracts is omnipresent and increasing rapidly. For example, in the period 2006 through 2019, the use of RPE has more than doubled: Nowadays, approximately two-thirds of S&P 500 firms use some form of RPE in their incentive-compensation contracts (e.g., Meridian Compensation Partners LLC. [2019], Equilar [2020], Bizjak et al. [2021]). These CD&A disclosures also detail the award structures of these RPE plans and provide insights into the associated peer groups used as the benchmark to evaluate managers' relative performance.

Importantly, peers used in these RPE plans differ from peers used to *benchmark* managers' compensation levels—there is relatively little overlap between these groups (e.g., Gong, Li, and Shin [2011], Albuquerque, De Franco, and Verdi [2013]).[1]

With the improved ability to assess whether a firm uses RPE, empirical research shifted from identifying RPE in executive incentive-compensation plans (e.g., Antle and Smith [1986], Barro and Barro [1990], Gibbons and Murphy [1990], Janakiraman, Lambert, and Larcker [1992]) toward examining the antecedents of it, among which the determinants of peer selection. For example, consistent with Holmström's [1982] risk reduction argument, Gong, Li, and Shin [2011] show that common risk exposure is an important determinant of firm-level RPE use.[2] They also show that industry composition and firm size play a crucial role in peer selection, which is in line with Albuquerque [2009]. Drake and Martin [2020] add that boards also consider life cycle stages when constructing peer groups. Relatedly, Albuquerque [2014] also finds that the firm's life cycle is an important determinant of whether a firm uses RPE at all and concludes that firms with high growth opportunities often lack the availability of suitable peers—hindering them from using RPE. Taken together, these studies provide evidence that firms construct peer groups with the goal of filtering common shocks. In this regard, Bloomfield, Guay, and Timmermans [2021a] and Ma, Shin, and Wang [2021] show that the self-selected peer groups that firms construct do a good job in filtering systematic performance.[3]

The combined evidence thus suggests that firms construct peer groups with the goal of risk filtration—à la Holmström [1982]. Nevertheless, Holmström [1982, p. 335] also points out that this efficient use of information induces competition between agents. Although he argues that such competition is valueless beyond information extraction purposes, analytical frameworks that model interactions between agents show that RPE incentives can induce strategic interaction (e.g., Vickers [1985], Sklivas [1987], Aggarwal and Samwick [1999]). Thereby, RPE incentives can expose the principal to potentially unintended—and costly—consequences. Below we discuss these costs in more detail.

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[1] In our sample, we similarly find that only about 35% of the peers that are selected as compensation-benchmarking peers are also selected as a relative performance peer in our sample.

[2] In an analytical model, Dikolli et al. [2018] show that CEO power can also influence the use of RPE and the choice of the peer group.

[3] Ma et al. [2021] conclude that firms' self-selected peer groups exhibit a return beta of 1 with the focal firm—on average. Bloomfield et al. [2021a] develop an algorithm that mimics the RPE peer selection process and constructs peer groups with the objective to maximize risk filtration. They find that firms construct self-selected peer groups that filter similar magnitudes of risk (out-of-sample) as their algorithmically constructed peer groups.

2.2 HYPOTHESIS DEVELOPMENT

The two most important costs associated with the use of RPE relate to actions a firm can take to affect performance of the peer group, that is, (1) sabotage and (2) collusion (e.g., Gibbons and Murphy [1990]). Regarding sabotage, RPE puts a firm in direct competition to its peers. To gain an advantage over competitors and improve the relative position, firms engage in competitive actions (e.g., aggressive pricing strategies, the introduction of a new promotional campaign, or the acquisition of another firm in order to gain synergistic benefits). For example, Ferrier [2001] states that: "*As they navigate the competitive landscape, firms often directly and aggressively challenge competitors in an effort to improve relative performance.*" Aggarwal and Samwick [1999] formalize this intuition and show analytically that RPE affects firms' competitive actions. Their model demonstrates that if managers work under a relative performance plan in an imperfect competitive product market, they will act more competitively aggressive than if they would work under an absolute performance plan.

Although these competitive actions can improve relative performance, they are also costly—and potentially value-destroying. In essence, RPE gives managers incentives to engage in competitive actions, as long as these actions destroy peer value relatively more than own value (e.g., Gibbons and Murphy [1990], Bloomfield, Marvão, and Spagnolo [2021b]). In environments where products are strategic complements, competitive aggressiveness is always value-destroying and firms are typically better off not using RPE (e.g., Vrettos [2013]). In environments where products are strategic substitutes, the situation is different: One firm may—individually—be better off using RPE so to commit the manager to competitive actions while shielding him/her from common risk.

But even in the absence of common risk, Aggarwal and Samwick [1999, p. 2012] demonstrate that the use of RPE can be an equilibrium outcome of a prisoner's dilemma problem. Under a relative performance plan, a manager is incentivized to act aggressively and improve the firm's relative position compared to peer firms. However, this implies that a peer firm loses value relative to the focal firm. To counteract this tendency—and improve its own relative position—that peer firm would also be better off to use RPE itself. This in turn increases that peer firm's competitive aggressiveness, leading to an equilibrium where both firms use RPE and act aggressively, even though collectively they would be better off had they commit to not being aggressive (e.g., Aggarwal and Samwick [1999, p. 2012]). Thus, the incentives to act aggressively are greatest when "all agents" are evaluated based on own- and peer performance. However, although having each other as peers is typical for RPE and other tournament-like schemes *within* firms, this need not be the case for RPE schemes *between* firms. A focal firm's peers need not use RPE themselves or, if they use RPE, they need not select the focal firm as their own peer. The extent to which the focal firm's peers use RPE and have the focal firm as a peer, is what we dub "peer group

overlap." The above sabotage discussion implies that if RPE gives managers incentives to act aggressively, economic theory predicts a firm's competitive aggressiveness is increasing in a firm's peer group overlap. We label this prediction the "sabotage hypothesis."

The second commonly discussed consequence from using RPE is the concern that it can give agents incentives to collude (e.g., Dye [1984], Mookherjee [1984]). Although collusion creates its own problems (e.g., potential inefficiencies), it could also create the commitment necessary to escape from the previously discussed prisoner's dilemma problem—in which all firms act aggressively to improve their relative position. When firms collude, they could collectively agree on product market strategies. Thereby, firms avoid the costs of sabotage, but still benefit from risk filtration. Consistent with this argument, Bloomfield, Marvão, and Spagnolo [2021b] find that RPE is used frequently in firms that have been convicted to violate antitrust laws.

Besides these explicit collusive agreements, collusion might also go undetected or take a more tacit form. In the latter case, firms do *not* communicate privately to exchange information and, thus, do not violate antitrust laws. For example, Bourveau, She, and Žaldokas [2020] provide evidence that firms publicly share detailed information about their customers, contracts, and products so to potentially tacitly coordinate actions in product markets with peers. Even though these collusive agreements are more tacit, they still have real effects on firm policies (e.g., Bertomeu and Liang [2015], Bertomeu et al. [2020]).

There is further evidence that suggests that firms coordinate with peers. For example, in a sample of Japanese firms, Joh [1999] tests how peer performance affects the structure of incentive-compensation contracts. She finds that managers' pay is positively related to industry profit, which suggests a commitment to product market collusion. More recently in the U.S. setting, Ha, Ma, and Žaldokas [2020] show that after four regional offices of Department of Justice closed down—and, thus, after collusion oversight weakens—a subset of firms puts a positive weight on peer performance in their executive incentive-compensation contracts. This similarly suggests a commitment to product market collusion.

Although these studies do not explicitly examine firms' choices *after* they adopt RPE, the evidence suggests that a subset of firms motivates managers to collude through their incentive-compensation contracts. Given our focus, the question is whether firms commit to product market collusion through relative performance plans. If RPE gives managers incentives to enter into collusive agreements with peers, then peer group overlap decreases a firm's competitive aggressiveness. We label this prediction the "collusion hypothesis."

Collectively, the above discussion implies that RPE incentives can either: (1) increase competitive aggressiveness—through sabotage—or (2) decrease competitive aggressiveness—through collusion. At the end of the day, it is an empirical question which hypothesis dominates. There are two

important points to highlight regarding our predictions. First, both predictions hinge on the assumption that firms act in markets with *imperfect* competition (e.g., Aggarwal and Samwick [1999]). In a *perfectly* competitive market, actions of one firm do not affect performance of other firms, and consequently, competitive aggressiveness does not impact a firm's relative performance. In contrast, in *imperfect* competitive markets, actions of one firm do influence both own- and peer performance. This implies that the association between peer group overlap and competitive aggressiveness is likely to be stronger in settings with relatively more imperfect competition than in settings with relatively more perfect competition. In our empirical analysis, we explore this point by partitioning our sample into observations operating in relatively imperfect and perfect competitive product markets.

Second, although it is common for firms to compete on the products and services they sell (even against firms in other product markets to deter entry), they do not only compete in product markets. Firms also compete in other markets—the most prominent of which is the labor market where firms compete on attracting and retaining talent.[4] In general, our arguments for an overlap-aggressiveness association also apply to these other dimensions of competition. That is, firm performance, especially relative to peers, is often important for a firm to successfully compete on these other dimensions. For example, the theory of assortative matching implies that the most productive firms can attract the most productive managers and workers (e.g., Lucas [1978], Gabaix and Landier [2008]). In a similar vein, empirical evidence shows that poor firm performance has *negative* consequences for the attraction and retention of human capital (e.g., Brown and Matsa [2016], Baghai et al. [2021]). This interplay between performance and the ability to successfully compete in other markets indicates that managing relative performance, by being more (sabotage) or less (collusion) competitively aggressive, is important for firms even when they compete with peers on dimensions other than the products and services they sell. As a result, the overlap-aggressiveness association is not solely related to overlapping *product market* peers, but also relates to a broader set of overlapping peers that share multidimensional economic fundamentals. In our empirical analysis, we explore this point by examining whether the overlap-aggressiveness association varies with characteristics of the peer group overlap.

3. Variable Measurement and Sample Selection

3.1 MEASUREMENT OF COMPETITIVE AGGRESSIVENESS

One key construct in all our tests is competitive aggressiveness. Following an extensive prior literature in strategic management, we construct

[4] We thank the anonymous referee for pointing out this important observation.

our primary measures of competitive aggressiveness using the firm's competitive action repertoire identified through structured content analysis of news events.[5] In appendix A, we detail all steps to compute our primary measures of competitive aggressiveness as well as their interpretation. Below, we present a synopsis of their computation and interpretation.

To identify competitive actions, we rely on news events identified by RavenPack News Analytics (hereafter "RavenPack"). RavenPack develops proprietary algorithms that identify events (e.g., new product offerings of firms, price actions, strategic alliances) in unstructured text published by reputable content sources, such as the *Dow Jones Newswires*, the *Wall Street Journal*, and over 19,000 other traditional and social media sites. For each news event, RavenPack identifies a "type," a "relevance score," and a "novelty score." The type refers to a class of events that share similar characteristics; the relevance score indicates the relevance of the focal firm in the event, where greater values imply more relevant events; and the novelty score indicates the novelty of a news event and helps to distinguish duplicate events, where greater values imply more unique events. We follow prior literature (e.g., Connelly et al. [2017, 2019]), and examine seven major action types, including: (1) new product actions, (2) pricing actions, (3) marketing actions, (4) acquisitions, (5) equity joint ventures, (6) strategic alliances, and (7) market expansion.[6] Table 1 presents example events for each action type. We limit our analyses to events for which the relevance score is 100 (i.e., the maximum) and the novelty score is 100 (i.e., the maximum), to ensure that we: (1) assign news events to the correct firm and (2) do not double-count events.

Using these competitive actions, we follow the strategic management literature and construct two empirical measures of competitive aggressiveness: (1) action *volume* and (2) action *complexity*. The volume dimension measures how many competitive actions a firm takes. It counts the number of actions for each firm-year, irrespective of the action type. The interpretation of this measure is straightforward: The more actions a firm takes, the greater its competitive aggressiveness. Formally, we define *Action Volume* as follows:

$$Action\,Volume = \sum_{i=1}^{7} a_{ij} = V_j, \tag{1}$$

where a_{ij} is the number of firm j's actions in the ith action type in a given year.

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[5] Although new in accounting, this approach has a long-standing history in the strategic management literature (e.g., Ferrier et al. [1999], Ferrier [2001], Ferrier and Lyon [2004], Chen et al. [2010], Rindova, Ferrier, and Wiltbank [2010], Ndofor, Sirmon, and He [2011], Nadkarni, Chen, and Chen [2016], Connelly et al. [2017, 2019]).

[6] We thank Brian Connelly for providing his decision tree to classify competitive actions into types.

TABLE 1
News Event Examples

Action Type	Firm	Example
New product actions	Barnes & Noble Inc.	*Barnes & Nobel Studio Debuts New Series: Mr. Literary*
Pricing actions	Atmel Corp.	*Atmel Reduces System Cost in Industrial Applications with High-Quality Video Decoding ARM926-based Microprocessor*
Marketing actions	United Parcel Service Inc.	*UPS Racing Unveils Commercials and Online Sweepstakes to Launch 2010 NASCAR Season*
Acquisitions	Bio-Rad Laboratories Inc.	*Bio-Rad Complete the Purchase of Certain Diagnostics Businesses of Biotest AG*
Equity joint ventures	Scientific Games Corp.	*Playtech Signs Joint Venture with Scientific Games*
Strategic alliances	McAfee Inc.	*Brocade and McAfee Enter Strategic Partnership to Deliver Comprehensive Network Security Solutions*
Market expansion	Texas Instruments Inc.	*Texas Instruments to Enter E-Reader Market*

This table presents example events for each action category.

The complexity dimension considers that not all actions are identical (e.g., launching a new marketing campaign is a fundamentally different action than performing an acquisition) and that firms act more aggressively if they spread their actions across multiple dimensions. It thus measures the breadth of competitive actions across different action types. We relate the actions in the different action types to the overall number of actions for each firm-year. The interpretation of this measure is as follows: The more equally distributed the actions are across the different action types, the more complex and, hence, the greater a firm's competitive aggressiveness. Formally, we define *Action Complexity* as follows:

$$Action\ Complexity = 1 - \sum_{i=1}^{7} \left(\frac{a_{ij}}{V_j} \right)^2, \tag{2}$$

where a_{ij} is the number of firm j's actions in the ith action type and V_j is the total number of actions carried out by firm j in a given year (i.e., *Action Volume*).

A key advantage of using these measures of competitive aggressiveness is that they allow us to capture a broad and comprehensive set of relevant and impactful firm actions. Nevertheless, to ensure that our inferences are not unique to one specific measure of competitive aggressiveness—but rather apply to this theoretical construct more generally—we also triangulate our main analyses in robustness tests with more traditional accounting-based input and output measures of competitive behavior, including the firm's advertisement expenditures and operating margin (see subsection 7.2 for details).

3.2 MEASUREMENT OF PEER GROUP OVERLAP

To measure peer group overlap in relative performance plans, we first identify usage of relative performance plans in executive incentive-compensation contracts based on data from the ISS Incentive Lab database. We identify the presence of a relative performance plan if the CD&A section of the firm's proxy statement states that: (1) at least one component of executive compensation is determined based on the firm's performance relative to performance of other firms and (2) the firm uses and explicitly states the self-selected performance peer group. We exclude firms that use an index as peer group from the sample, because we are primarily interested in firms that *explicitly* select their own set of peers to compete with. Appendix B exemplifies the relative performance plan of United Parcel Service Inc. [2019].

We then analyze all firm-peer relationships and record which relationships are "one-sided" and which are "reciprocal." One-sided peer relationships are those relationships whereby the focal firm has another firm selected as a peer, but this peer firm does *not* have the focal firm as an RPE peer (or does not use RPE at all). In a reciprocal peer relationship, the peer firm also has the focal firm selected as peer. Thus, if a relationship is reciprocal, there is a "peer group overlap." We then count the number of overlapping peer relationships per firm-year and scale that by the peer group size for that firm-year. We label this variable *Peer Group Overlap*. The higher the fraction of reciprocal relationships in a relative performance plan, the greater peer group overlap. Figure 1 illustrates the concept of peer group overlap.

3.3 SAMPLE SELECTION AND SAMPLE DESCRIPTIVE STATISTICS

We construct our sample using data from Compustat, CRSP, ExecuComp, RavenPack, ISS Incentive Lab, and the Hoberg-Phillips Data Library. Our sample begins in 2006, when data on relative performance plans and associated peer groups for the largest 750 firms by market capitalization first becomes available in ISS Incentive Lab, and ends in 2017. The final sample contains 1,623 firm year observations with nonmissing values for all required variables.[7]

Table 2 presents descriptive statistics for the primary variables in our design. Table 3 presents the year and industry distribution of *Peer Group Overlap*. In addition, we provide more details about the characteristics of relative performance plans used by firms in our sample in section 4.1. Table 2 shows that the mean (median) of *Action Volume* is 33 (17), which implies that the

[7] We find that, when including non-RPE firms in ISS Incentive Lab in our sample, approximately 25% of the firms in our sample use a relative performance plan with self-selected peers as part of its executive incentive-compensation contract. This statistic is consistent with previous studies that use data from ISS Incentive Lab (e.g., , Gong et al. [2011], De Angelis and Grinstein [2020]).

TABLE 2
Sample Descriptive Statistics

Panel A. Full sample

	Mean	Std. Dev.	10th	50th	90th
Action Volume	33.107	45.698	3.000	17.000	79.800
Action Complexity	0.438	0.233	0.000	0.500	0.690
Peer Group Overlap	0.150	0.181	0.000	0.087	0.400
New Overlap	0.266	0.597	0.000	0.000	1.000
Peer Group Synchronicity	0.480	0.208	0.192	0.497	0.741
Market Value (Rank)	0.510	0.212	0.222	0.500	0.800
Book-to-Market (Rank)	0.512	0.263	0.150	0.500	0.875
Leverage (Rank)	0.517	0.261	0.154	0.500	0.869
Sales Growth (Rank)	0.492	0.270	0.143	0.500	0.875
Return (Rank)	0.519	0.260	0.160	0.526	0.867
H&P Number of Competitors (Rank)	0.501	0.248	0.167	0.500	0.833
H&P Competitor Similarity (Rank)	0.499	0.265	0.143	0.500	0.857
H&P Number of Competitors	63.087	81.822	4.000	25.000	199.800

Panel B. Subsamples

	RPE firms without overlap			RPE firms with overlap		
	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median
Action Volume	27.867	36.570	13.000	35.726	49.444	18.000
Action Complexity	0.443	0.227	0.500	0.436	0.235	0.498
Peer Group Overlap	0.000	0.000	0.000	0.225	0.180	0.179
New Overlap	0.000	0.000	0.000	0.398	0.694	0.000
Peer Group Synchronicity	0.420	0.195	0.429	0.509	0.208	0.537
Market Value (Rank)	0.483	0.218	0.484	0.523	0.208	0.500
Book-to-Market (Rank)	0.505	0.261	0.500	0.515	0.264	0.500
Leverage (Rank)	0.539	0.258	0.548	0.506	0.262	0.500
Sales Growth (Rank)	0.486	0.272	0.476	0.495	0.269	0.500
Return (Rank)	0.511	0.251	0.500	0.524	0.264	0.533
H&P Number of Competitors (Rank)	0.489	0.246	0.500	0.507	0.250	0.500
H&P Competitor Similarity (Rank)	0.487	0.270	0.500	0.505	0.262	0.500
H&P Number of Competitors	56.425	79.146	22.000	66.418	82.964	26.000

This table presents descriptive statistics. Panel A presents descriptive statistics for the full sample. Panel B presents descriptive statistics grouped by RPE firms without and with peer group overlap. The sample contains 1,623 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables. We exclude financial service firms and utilities. *Action Volume* is the total number of competitive actions. *Action Complexity* is the variation in competitive actions across seven types of competitive actions. *Peer Group Overlap* is the number of overlapping peer relationships scaled by the peer group size. *New Overlap* is the number of overlapping peer relationships that were not overlapping peer relationships in the previous year, for which the overlap was initiated by the peer. *Peer Group Synchronicity* is the firm's stock return synchronicity with its peers. *Market Value (Rank)* is the firm's peer group-rank of market value. *Book-to-Market (Rank)* is the firm's peer group-rank of the ratio of book value of total assets to the firm's market value. *Leverage (Rank)* is the firm's peer group-rank of the book value of total long-term debt, scaled by total assets. *Sales Growth (Rank)* is the firm's peer group-rank of growth in annual revenue over the prior year. *Return (Rank)* is the firm's peer group-rank of cumulative stock return. *H&P Number of Competitors (Rank)* is the firm's peer group-rank of number of product market competitors. *H&P Competitor Similarity (Rank)* is the firm's peer group-rank of similarity to its product market competitors. *H&P Number of Competitors* is the firm's number of product market competitors.

TABLE 3

Year and Industry Distribution of Peer Group Overlap

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Overall
Consumer nondurables	0.101	0.227	0.198	0.270	0.200	0.192	0.162	0.167	0.136	0.187	0.137	0.203	0.182
Consumer durables	0.083	0.056	0.036	0.064	0.119	0.087	0.045	0.011	0.048	0.120	0.036	0.107	0.071
Manufacturing	0.050	0.132	0.118	0.145	0.117	0.124	0.150	0.141	0.138	0.199	0.140	0.179	0.139
Oil, gas, and coal extraction	0.102	0.228	0.145	0.122	0.243	0.224	0.242	0.315	0.303	0.302	0.423	0.391	0.273
Chemicals and allied products	0.104	0.061	0.000	0.029	0.049	0.023	0.024	0.044	0.043	0.115	0.075	0.139	0.065
Business equipment	0.039	0.065	0.050	0.075	0.106	0.042	0.102	0.085	0.115	0.081	0.071	0.084	0.078
Telephone and television transmission	0.000	0.067	0.195	0.111	0.056	0.033	0.000	0.035	0.051	0.054	0.029	0.231	0.091
Utilities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wholesale and retail	0.022	0.000	0.000	0.032	0.030	0.051	0.107	0.092	0.078	0.106	0.075	0.075	0.060
Healthcare and medical equipment	0.231	0.209	0.180	0.008	0.097	0.098	0.116	0.073	0.103	0.086	0.109	0.117	0.116
Finance	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other	0.036	0.129	0.087	0.054	0.075	0.090	0.168	0.089	0.130	0.126	0.200	0.206	0.130
Overall	0.081	0.141	0.111	0.104	0.133	0.123	0.150	0.154	0.157	0.170	0.191	0.209	0.150

This table presents mean descriptive statistics on *Peer Group Overlap* across time and industries. The sample contains 1,623 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables. We exclude financial service firms and utilities. The industry classification follows the 12 industry groups identified by Fama and French [1997]. All variables are defined in the caption of table 2.

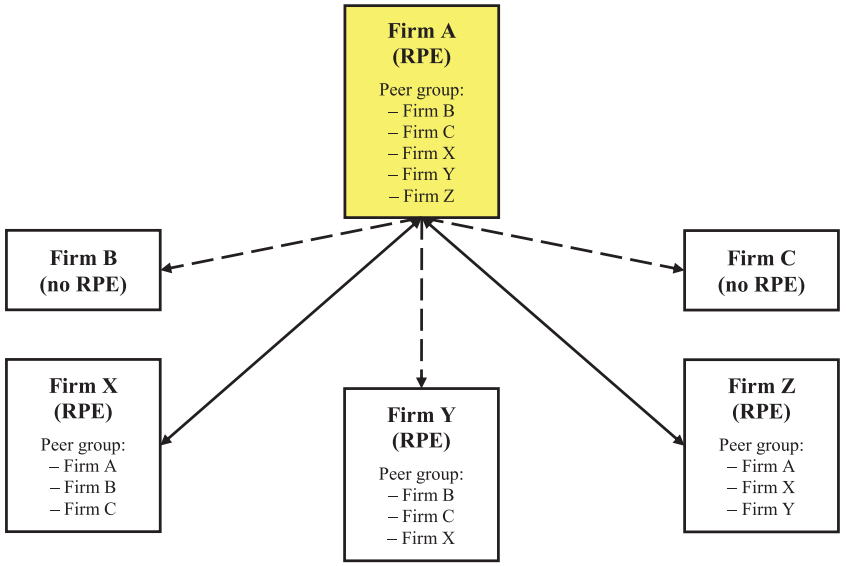

FIG 1.—Peer group overlap. This figure illustrates the peer group overlap concept. The focal firm A has five peers. Of these five peers, two peers (B and C) do not have a relative performance plan themselves and three peers (X, Y, and Z) do have a relative performance plan. Peers X and Z also have firm A selected as their peer, resulting in an overlap in peer selection—as indicated by the solid lines. From firm A's viewpoint, there are thus two (out of five) overlapping peer relations. As such, in this example, peer group overlap for firm A is 40%.

average (typical) firm takes about 33 (17) actions per year. The mean (median) of *Action Complexity* is 0.438 (0.500), which implies that there is considerable variation in firms' action repertoires across action types. In total, the firms in our full sample engage in 53,732 competitive actions. Regarding *Peer Group Overlap*, table 2 shows that the mean is 15%. This implies that on average approximately one in seven firm-peer relationships is a reciprocal peer relationship. Table 3 further shows that the mean peer group overlap has grown from 8% to 21% from 2006 to 2017.

4. *Empirical Analysis*

4.1 WHAT DO RPE PLANS WITH SELF-SELECTED PEERS LOOK LIKE?

Before we test the associations between peer group overlap and competitive aggressiveness, we first provide more details about the characteristics of these relative performance plans. Specifically, in this section, we provide additional descriptive statistics on: (1) the level of relative performance incentives, (2) the performance criteria used in these plans, and (3) the size and dynamics of the peer group. We further test whether these characteristics differ between RPE firms without peer group overlap and RPE firms with peer group overlap. Finally, we examine characteristics that are related

to firm-peer pairs being overlapping (reciprocal) versus not overlapping (one-sided). We tabulate these results in table 4.

Panel A in table 4 presents additional descriptive statistics on the level of relative performance incentives. We estimate the level of incentives by measuring the "risk-neutral value" of the RPE plan—that is, the current dollar amount the manager can maximally receive from his/her RPE plan. For RPE grants with equity awards, the dollar amount equals the maximum number of shares the manager can receive multiplied by the firm's current share price; for RPE grants with cash awards, the dollar amount simply equals the maximum cash the manager can receive. We scale this variable by the manager's previous year's total compensation, so it expresses a percentage of total compensation. We label this variable *Grant Size*. The mean (median) *Grant Size* is 78.5% (60.3%), which implies that the average (typical) RPE plan provides the manager with the possibility to earn an RPE grant worth 78.5% (60.3%) of his/her previous year's total compensation. This indicates that, for firms that use RPE plans, the grants from these plans provide significant incentives to managers. This finding is in line with De Angelis and Grinstein [2020]. Because RPE plans provide significant incentives, an important follow-up question is whether these incentives differ between RPE without overlap and RPE with overlap. We find that the level of incentives does not differ, on average, between RPE without overlap and RPE with overlap (79.3% vs. 78.2%; two-tailed $p = 0.751$ for the difference). The lack of differences in the level of RPE incentives is important because it makes it highly unlikely that any difference in aggressiveness between these two groups can be attributed to the level of incentives.

Panel B in table 4 presents additional descriptive statistics on the performance criteria used in relative performance plans. In our sample, 80.4% of the relative performance plans is price-based whereas 32.8% is accounting-based.[8] These percentages indicate a predominance of price-based criteria (e.g., total shareholder return), which is in line with prior studies (e.g., Gong, Li, and Shin [2011], Gong, Li, and Yin [2019], Bizjak et al. [2021]). Consistent with Bizjak et al. [2021], we also find that the predominance of price-based plans is increasing over time. For example, we find that in 2017 89.1% of the RPE plans is price-based, vis-à-vis 26.3% of RPE plans is accounting-based. When comparing RPE without overlap to RPE with overlap, we find that the use of accounting-based RPE is similar for these two groups (33.8% vs. 32.2%; two-tailed $p = 0.527$ for the difference). In contrast, the use of price-based RPE is significantly (two-tailed $p < 0.001$) higher for RPE with overlap (82.4%) compared to RPE without overlap (76.3%). In line with the increasing predominance of price-based plans, this difference is negligible in more recent years (e.g., 91.4% vs. 88.6% in 2017; two-tailed $p = 0.606$ for the difference).

[8] Note that these percentages add up to more than 100% because some firms use both price-based and accounting-based metrics.

TABLE 4

Additional Descriptive Statistics on Relative Performance Plans and Determinants of Peer Group Overlap

Panel A. Level of incentives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All RPE firms		RPE firms without overlap		RPE firms with overlap		
	Mean	Median	Mean	Median	Mean	Median	(5) – (3)
Grant Size	0.785	0.603	0.793	0.579	0.782	0.616	0.012

Panel B. Performance criteria

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All RPE firms		RPE firms without overlap		RPE firms with overlap		
	Mean	Median	Mean	Median	Mean	Median	(5) – (3)
RPE-price	0.804	1.000	0.763	1.000	0.824	1.000	0.061***
RPE-accounting	0.328	0.000	0.338	0.000	0.322	0.000	−0.016

Panel C. Peer group size and dynamics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All RPE firms		RPE firms without overlap		RPE firms with overlap		
	Mean	Median	Mean	Median	Mean	Median	(5) – (3)
Peer Group Size	14.670	12.000	15.640	12.000	14.180	12.000	−1.461**
Duration Firm-Peer	0.572	0.543	0.593	0.558	0.562	0.530	−0.031***

(*Continued*)

TABLE 4—*(Continued)*

Panel D. Determinants of peer group overlap

	(1)		(2)	
	Dependent variable:			
	$\Pr(\mathbb{1}(Overlap_{ikt+1}))$			
$Market\ Value_{\|i-k\|}$	−0.271***	(0.031)	−0.298***	(0.034)
$Book\text{-}to\text{-}Market_{\|i-k\|}$	−0.155	(0.114)	−0.294**	(0.132)
$Leverage_{\|i-k\|}$	0.008	(0.216)	−0.211	(0.187)
$Sales\ Growth_{\|i-k\|}$	−0.507***	(0.122)	−0.203**	(0.081)
$Return_{\|i-k\|}$	−0.405***	(0.067)	−0.336***	(0.074)
$\sigma\ Return_{\|i-k\|}$	−0.337***	(0.083)	−0.214**	(0.097)
$\mathbb{1}(H\&P_{i\neq k})$	−0.214***	(0.049)	−0.187***	(0.051)
$\mathbb{1}(GICS6_{i\neq k})$	−0.610***	(0.073)	−0.622***	(0.085)
Fixed effects	industry, year		firm, year	
Observations	32,804		32,804	
Pseudo R^2	12.082%		19.710%	

This table presents additional descriptive statistics on relative performance plans and determinants of peer group overlap. Panel A presents descriptive statistics on the level of relative performance incentives. Panel B presents descriptive statistics on the performance criteria used in these plans. Panel C presents descriptive statistics on the size and dynamics of the peer group. Panel D presents results examining the role of firm-peer specific absolute differences in fundamentals in determining peer group overlap. *Grant Size* is the "risk-neutral value" of the RPE plan, scaled by the manager's previous year's total compensation. *RPE-price* restricts *RPE* to firms with price-based metrics. *RPE-accounting* restricts *RPE* to firms with accounting-based metrics. *Peer Group Size* is the total number of firms in the peer group. *Duration Firm-Peer* is the time a firm-peer relationship lasts, expressed as a percentage of the time the focal firm uses RPE. $\mathbb{1}(Overlap)$ is an indicator variable equal to one if a firm-peer relationship is overlapping. The industry indicators follow the 48 industry groups identified by Fama and French [1997]. Standard errors are in parentheses and are adjusted for within cluster correlation by firm and time conform Gow, Ormazabal, and Taylor [2010]. *, **, and *** indicate significance at two-tailed probability levels of 10%, 5%, and 1%, respectively. All (raw versions of the) variables are defined in the caption of table 2.

Panel C in table 4 presents additional descriptive statistics on the size and dynamics of the peer group in relative performance plans. Regarding size, the mean (median) peer group contains 14.7 (12) peers. There is significant variability in peer group size, for example, the 10th percentile being 5 peers and the 90th percentile being 25 peers. The average peer group for RPE firms without overlap is slightly larger than the average peer group for RPE firms with overlap (15.6 vs. 14.2, respectively). The typical peer group, however, is similar in size across RPE firms without overlap and RPE firms with overlap and contains 12 peers. In terms of dynamics, we note that peer groups for RPE are quite sticky over time. For example, in our sample we find that the mean (median) firm-peer relationship lasts for 57.2% (54.3%) of the time the focal firm uses RPE.[9] This statistic implies that, for a firm that uses RPE for, for example, 10 years, the mean and median peer is in the peer group for at least 5.5 of those 10 years. We further find this statistic is fairly right skewed: The first quartile of this statistic is 42.2%. This then implies that for a firm that uses RPE for, for example, 10 years, at least 75% of the mean peer group remains unchanged for at least 4.2 years. We further note that when a new firm is added to an RPE peer group, it typically replaces another firm (e.g., that firm ceased to exist, got acquired, or did not match the focal firm's operations anymore).[10] Thus, even though peer groups are quite sticky over time, firms do change them. We exploit such variation in a staggered continuous difference-in-differences design in subsection 4.3.

Panel D in table 4 presents determinants of peer group overlap in relative performance plans using a dyadic approach, which includes one observation for each firm-peer pairing in a given year (e.g., de Faulkender and Yang [2010], De Vaan, Elbers, and Diprete [2019], Bourveau et al. [2021]).[11] The dependent variable, $\mathbb{1}$ ($Overlap_{ikt}$), is an indicator variable equal to one if a firm *i*-peer *k* relationship is overlapping in year *t*, zero otherwise. We regress this variable on lagged firm *i*-peer *k*-specific characteristics (i.e., absolute differences in firm fundamentals, product market membership based on Hoberg and Phillips [2010, 2016]), and, following Pittinsky and DiPrete [2013], industry membership based on the Global Industry Classification Standard (GICS) and varying fixed effects structures. Across both specifications, we find that a firm-peer pairing is more likely

[9] Note that this statistic is quite difficult to express in—and relatively uninformative when expressed in—actual years, because there is much variation in how long firms themselves use RPE. Hence, it is more convenient to express this statistic as a percentage of the time the focal firm uses RPE.

[10] For example, in their most recent proxy statement, Johnson & Johnson [2020, p. 68] reports that: "*for 2020, the Medical Devices Competitor Composite was updated to more accurately reflect changes in its business mix, the evolution of the competitive landscape, and newly public companies. Alcon Inc. and Intuitive Surgical, Inc. were added while Abbott Laboratories, Becton Dickinson, Edwards Lifesciences, and Roche Holding AG (Diabetes) were removed.*"

[11] Because an overlapping observation occurs twice in such a data set, we exclude these duplicate observations, that is, we include only one observation if there is a peer group overlap.

to be overlapping if differences in several firm fundamentals (i.e., *Market Value*, *Book-to-Market*, *Sales Growth*, *Return*, and σ *Return*) are smaller, as well as when they operate in the same product market and industry (i.e., six-digit GICS code). The finding that GICS membership is informative about firm-peer pairs overlapping, after controlling for product market membership, is consistent with the argument that firms compete with peers also on dimensions other than the products and services they sell. Collectively, these results suggest that firms are more likely to end up in each other's relative performance plans if their underlying fundamentals become more similar.[12]

4.2 PEER GROUP OVERLAP AND COMPETITIVE AGGRESSIVENESS

In this section, we examine the association between peer group overlap and competitive aggressiveness, by estimating the following equation:

$$[Aggressiveness_{it}] = \alpha + \beta_1 Peer\,Group\,Overlap_{it} + \gamma' X_{ij,t-1} + \theta' \mu_j + \phi' \nu_t + \varepsilon_{ijt}, \quad (3)$$

where the indices *i*, *j*, and *t* correspond to firm, industry, and time, respectively.[13] The dependent variable is either *Action Volume* or *Action Complexity* (see subsection 3.1 for details). *X* is a vector that includes a battery of control variables, which we describe below. Lastly, μ_j are industry fixed effects (based on the 48 industry groups identified by Fama and French [1997]), ν_t are year fixed effects, and ε_{ijt} is the firm-year specific error. To correct for any residual cross-sectional and time-series dependence in the firm-year specific error term, ε_{ijt}, we base inferences throughout all our analyses on standard errors clustered by firm and year (e.g., Gow, Ormazabal, and Taylor [2010]).

We control for the "level of risk reduction" in relative performance plans to ensure that *Peer Group Overlap* strictly captures a relative performance plan's competitive incentives, rather than a blend of competitive incentives and risk reduction incentives.[14] We estimate each plan's risk

[12] In this regard, we also document that of the *new* overlapping peer relationships: (1) 41.60% are triggered by the focal firm (and thus 41.60% by the peer firm) and (2) 16.86% are simultaneous. As such, most of the new overlapping peer relationship occur in a sequence.

[13] We do not include firm fixed effects. Although including firm fixed effects would allow us to estimate a within-firm specification, which controls for observable and unobservable time-invariant firm characteristics, there is not a lot of within-firm variation in peer group overlap. To mitigate the concern that other factors might be driving our results, we execute an alternative empirical design in subsection 4.3 and perform robustness tests in section 7.

[14] Peers that are selected for competitive reasons are very likely to have a strong performance correlation with the focal firm. For example, in our sample, the cross-sectional correlation between *Peer Group Overlap* and *Peer Group Synchronicity* is 0.406. Because relative performance plans filter this correlation (i.e., "risk") from performance, we control for these risk reduction incentives to ensure that *Peer Group Overlap* strictly captures competitive incentives.

reduction properties by measuring the focal firm's three-year monthly stock return synchronicity with its actual RPE peers (e.g., Morck, Yeung, and Yu [2000]).[15] We label this variable *Peer Group Synchronicity*. In addition, we control for various firm fundamentals that impact competitive aggressiveness, including the firm's market value of equity, book-to-market ratio, leverage, past sales growth, and returns (e.g., Covin and Covin [1990], Ferrier, Smith, and Grimm [1999], Ferrier [2001]). We also include two measures of competition, because prior literature suggests that competitive environments can shape firms' competitive repertoires (e.g., Covin and Covin [1990], Eisenhardt and Martin [2000]). We measure competition as the number of competitors in the product market and their similarity with the focal firm, as identified by Hoberg and Phillips [2010, 2016]). We measure these fundamentals as a percentile rank relative to the firm's RPE peers at the beginning of the period (suffixed with *(Rank)*). We do so because, for a firm's competitive repertoire of actions, the relative standing to competitors is more important than the firm's absolute fundamentals (e.g., Ferrier, Smith, and Grimm [1999], Ferrier [2001]).

Finally, to account for the notion that both the sabotage and collusion predictions are more likely to be observable in product markets with *imperfect* competition, we split our sample based on the type of competition. Empirically, there is, however, no commonly accepted metric or threshold defining "perfect competition." Conceptually, the most widely used economic models assume that perfect competition is characterized by having a large number of buyers and sellers for any good (e.g., Nicholson and Snyder [2016, p. 407]). The idea behind this characterization is that in such markets (vis-à-vis monopolistic or oligopolistic markets) each firm is a price-taker: The actions and outputs of one *single* firm have no effect on the market price. With a large number of firms in a market this condition is thus more likely to be met compared to markets with only a few number of firms (e.g., Robinson [1934]). With this intuition in mind, we construct our primary proxy for (im)perfect markets based on the number of competitors in the product market. Specifically, we split our sample based on the median number of product market competitors as defined by Hoberg and Phillips [2010, 2016]), and estimate our equation separately for the

[15] We use a three-year period, because the performance period in the vast majority of relative performance plans is three years (e.g., Gong et al. [2011]).

two subsamples.[16,17] Nevertheless, to ensure that our inferences are not unique to one specific measure of competitive environment, we also triangulate our main analyses with two additional measures of competitive environment, including: (1) the sales Herfindahl-Hirschman Index and (2) the maximum similarity score as identified by Hoberg and Phillips [2010, 2016] (see subsection 7.3 for details). We tabulate the results of our main analysis in table 5.

Columns 1 and 2 in table 5 present our main results for the subsample with low number of product market competitors, and columns 3 and 4 present the results for the subsample with high number of product market competitors. In columns 1 and 2, we find that the coefficient on *Peer Group Overlap* is positive and both statistically and economically significant. In economic terms, these coefficients imply that in environments with a low number of product market competitors, RPE firms with peer group overlap at the 90th percentile have 36% greater action volume and 19% greater action complexity than RPE firms with peer group overlap at the 10th percentile.[18,19] We also find that the coefficient on *Peer Group Overlap* is

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[16] Controlling for the Hoberg and Phillips' [2010, 2016] measures of competition *in addition* to our sample split based on the number of competitors in the product market as identified by Hoberg and Phillips [2010, 2016] is a deliberate choice. We split our specifications to "interact" all variables with the type of competition, because economic theory predicts differential relationships between relative performance plans, peer group overlap, and competitive aggressiveness, conditional on the type of competition (i.e., relatively more perfect/imperfect competition). We control for competition in our specifications to estimate the relation between peer group overlap and competitive aggressiveness *over and above* regular product market competition. The split sample analysis additionally allows product market competition to have a differential association with competitive aggressiveness conditional on the number of competitors. For example, the number of competitors might itself be nonlinearly related to competitive aggressiveness.

[17] We rely on the number of product market competitors as identified by Hoberg and Phillips [2010, 2016] as our primary measure of competitive environment, because this measure of competition has several benefits over alternative measures. First, because Hoberg and Phillips [2010, 2016] define competitors using a text-based algorithm that relies on product market descriptions in firms' 10-Ks their classification is a firm-specific measure. As such, their measure more accurately captures a firm's direct product market competitors, compared to industry-based measures (e.g., the Herfindahl-Hirschman Index). Second, their measure takes into account that firms can operate in different competitive environments simultaneously. This is important as firms likely consider their conglomerate structures when acting aggressively.

[18] We calculate the economic magnitudes as follows. For the volume dimension: $\exp(\textit{Peer Group Overlap} \times [Q_{90}^{\textit{Peer Group Overlap}} \mid \textit{H\&P Number of Competitors} = \text{low}]) - 1$. In this case: $[\exp(0.816 \times 0.375) - 1] \approx 36\%$. For the complexity dimension, we compare the magnitude to the (unconditional) mean value of *Action Complexity* for RPE firms with *Peer Group Overlap* at the 10th percentile operating in environments with a low number of product market competitors: $(\textit{Peer Group Overlap} \times [Q_{90}^{\textit{Peer Group Overlap}} \mid \textit{H\&P Number of Competitors} = \text{low}]) / \overline{\textit{Action Complexity}}_{\textit{Peer Group Overlap} = 0 \ \& \ \textit{H\&P Number of Competitors} = \text{low}}$—in this case: $(0.219 \times 0.375) / 0.434 \approx 19\%$.

[19] We also compare the economic magnitudes of peer group overlap to economic magnitudes of other significant control variables using a specification whereby we use the decile

TABLE 5
Peer Group Overlap and Competitive Aggressiveness

	(1)	(2)	(3)	(4)
	Low *H&P Number of Competitors*		High *H&P Number of Competitors*	
	Dependent Variable:		Dependent Variable:	
Variable	log(*Action Volume*)	*Action Complexity*	log(*Action Volume*)	*Action Complexity*
Peer Group Overlap	0.816** (0.276)	0.219***(0.062)	0.504* (0.232)	−0.007 (0.058)
Peer Group Synchronicity	−0.009 (0.215)	−0.029 (0.050)	0.100 (0.202)	−0.005 (0.045)
Market Value (Rank)	0.940***(0.241)	0.176***(0.049)	1.024***(0.236)	0.103 (0.061)
Book-to-Market (Rank)	0.231 (0.230)	0.104** (0.037)	0.333 (0.204)	0.092** (0.041)
Leverage (Rank)	0.022 (0.214)	0.048 (0.054)	0.509***(0.151)	0.078* (0.035)
Sales Growth (Rank)	−0.341** (0.131)	−0.100***(0.032)	−0.010 (0.094)	−0.059 (0.034)
Return (Rank)	−0.129 (0.137)	−0.017 (0.030)	−0.055 (0.151)	−0.030 (0.024)
H&P Number of Competitors (Rank)	−0.338* (0.186)	−0.051 (0.038)	−0.018 (0.154)	0.045 (0.048)
H&P Competitor Similarity (Rank)	0.173 (0.108)	0.036 (0.021)	−0.207 (0.195)	−0.023 (0.042)
Year and industry indicators	Yes	Yes	Yes	Yes
Observations	795	795	828	828
Adjusted R^2	53.505%	24.731%	54.819%	25.360%

This table presents results examining the association between peer group overlap and competitive aggressiveness, split by the number of product market competitors identified by Hoberg and Phillips [2010, 2016]. The sample contains 1,623 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables. The industry indicators follow the 48 industry groups identified by Fama and French [1997]. Standard errors are in parentheses and are adjusted for within cluster correlation by firm and time conform Gow, Ormazabal, and Taylor [2010]. *, **, and *** indicate significance at two-tailed probability levels of 10%, 5%, and 1%, respectively. All variables are defined in the caption of table 2.

positive and significant in column 3, which implies an association between peer group overlap and action volume for firms operating in environments with a high number of product market competitors. This finding may seem counterintuitive at first glance. However, additional analyses discussed in section 6 reconcile these findings; there we show that these actions are primarily related to acquisitions—actions that distort perfect competition.

Collectively, these findings are consistent with the sabotage hypothesis and indicate that peer group overlap in relative performance plans is positively associated with competitive aggressiveness. Our findings suggest that managers of such firms take more frequent as well as more complex competitive actions compared to managers not facing peer group overlap.[20]

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ranks of each independent variable to ensure all variables are of similar scale. In these comparisons, we find that the economic magnitude of moving from the bottom decile to the top decile of peer group overlap is of similar magnitude as moving from the bottom decile to the top decile of the firm's relative size—that is, *Market Value (Rank)*.

[20] We also examine the association between relative performance plans, peer group overlap, and competitive aggressiveness, in a broader sample of firms using RPE and firms not using

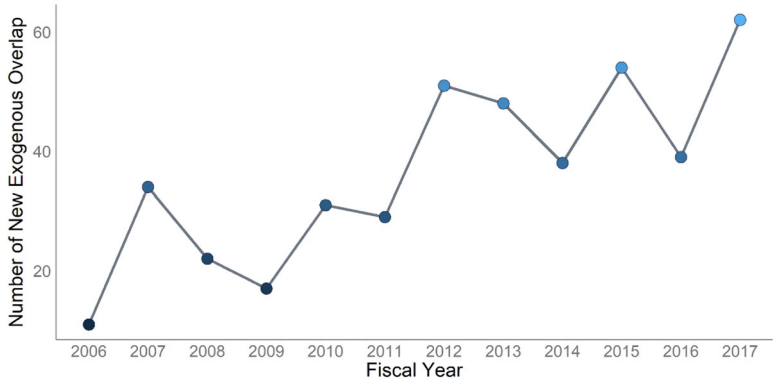

FIG 2.—New overlapping peer relationships. This figure plots the total new overlapping peer relationships that are triggered by peers for each fiscal year.

4.3 PEER GROUP OVERLAP AND COMPETITIVE AGGRESSIVENESS: NEW OVERLAP TRIGGERED BY PEER

In this section, we examine the association between peer group overlap and competitive aggressiveness using variation in peer group overlap that is the result of *peers'* incentive-compensation choices. Specifically, we layer a staggered continuous difference-in-differences design on top of equation (3) (e.g., Atanasov and Black [2016, pp. 253–54]). We do so to reduce concerns that our earlier findings are driven by firms' endogenous choices regarding managers' incentive-compensation contracts.

Our difference-in-differences design exploits the idea that if one of the peers of the focal firm's peer group adds the focal firm to its peer group, the focal firm receives a new peer group overlap in that year that is beyond its own control. Although this overlap requires that the focal firm heretofore endogenously chose that peer, the initiation of an overlapping peer relationship in this way is not a choice of the focal firm—it is plausible to assume that the focal firm *cannot* manipulate its peers' peer selection. Thus, the variation in peer group overlap is identified from variation in *peers'* incentive-compensation choices. As such, we eliminate part of the endogenous variation associated with firms' *own* incentive-compensation practices. We acknowledge that this test is not a panacea for resolving all issues of endogeneity, but it certainly narrows the set of plausible alternative explanations for our story.

Figure 2 plots the total new overlapping peer relationships that are triggered by peers for each fiscal year. This figure shows a linear trend in the

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RPE. In these analyses, we continue to find that the association with competitive aggressiveness is concentrated in the subsample of firms using RPE with peer group overlap (see table OA1 in the online appendix for details). These findings corroborate the notion that peer group overlap—and not plain-vanilla RPE—is associated with competitive aggressiveness.

TABLE 6

New Peer Group Overlap and Competitive Aggressiveness

	(1)	(2)	(3)	(4)
	Low *H&P Number of Competitors*		High *H&P Number of Competitors*	
	Dependent Variable:		Dependent Variable:	
Variable	log(*Action Volume*)	*Action Complexity*	log(*Action Volume*)	*Action Complexity*
Post	0.007 (0.120)	−0.002 (0.033)	−0.091 (0.160)	−0.019 (0.038)
Post × *New Overlap*	0.106** (0.052)	0.028* (0.017)	−0.020 (0.047)	0.001 (0.017)
Peer Group Synchronicity	−0.250 (0.252)	−0.096 (0.063)	−0.024 (0.268)	−0.011 (0.071)
Market Value (Rank)	0.505* (0.300)	0.045 (0.062)	1.221*** (0.266)	0.199*** (0.070)
Book-to-Market (Rank)	0.292 (0.275)	0.084 (0.053)	0.506** (0.242)	0.183*** (0.049)
Leverage (Rank)	−0.032 (0.189)	0.069 (0.047)	0.369* (0.221)	0.081 (0.053)
Sales Growth (Rank)	−0.479*** (0.136)	−0.090** (0.037)	−0.009 (0.137)	0.002 (0.037)
Return (Rank)	−0.189* (0.112)	−0.038 (0.034)	0.100 (0.135)	0.038 (0.037)
H&P Number of Competitors (Rank)	−0.254 (0.203)	−0.098** (0.043)	−0.144 (0.242)	0.059 (0.052)
H&P Competitor Similarity (Rank)	0.152 (0.151)	0.042 (0.036)	0.011 (0.204)	−0.080* (0.047)
Year and industry indicators	Yes	Yes	Yes	Yes
Observations	519	519	545	545
Adjusted R^2	67.086%	33.535%	62.557%	38.086%

This table presents staggered continuous difference-in-differences results examining the association between peer group overlap triggered by peers and competitive aggressiveness, split by the number of product market competitors identified by Hoberg and Phillips [2010, 2016]). The sample contains 1,064 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables that are at least once treated. *Post* is an indicator variable equal to one for years after the first treatment. *New Overlap* is the number of overlapping peer relationships that were not overlapping peer relationships in the previous year, for which the overlap was initiated by the peer. The main coefficient on *New Overlap* is omitted, because it has a perfect correlation with its interaction with *Post*. The industry indicators follow the 48 industry groups identified by Fama and French [1997]. Standard errors are in parentheses and are adjusted for within cluster correlation by firm and time conform Gow, Ormazabal, and Taylor [2010]. *, **, and *** indicate significance at two-tailed probability levels of 10%, 5%, and 1%, respectively. All variables are defined in the caption of table 2.

number of total new overlapping peer relationships across time. Note that because firms receive a new overlap at different points in time and there are cases with multiple overlap additions in the year, the resulting variable, *New Overlap*, is staggered as well as continuous. We then use this variable in a difference-in-differences analysis. In this analysis, *Post* is an indicator variable equal to one for years after the first new overlap, and *New Overlap* is the *number* of overlapping peer relationships that were not overlapping peer relationships in the previous year, for which the overlap was initiated by the peer. Note that in this analysis, the main coefficient on *New Overlap* is omitted, because it has a perfect correlation with its interaction with *Post*. The primary variable of interest is *Post* × *New Overlap*. We tabulate these results in table 6. [21]

In columns 1 and 2 of table 6, we find that the coefficient on *Post* × *New Overlap* is positive and both statistically and economically significant. This finding implies that in the year a focal firm gets added to one of its *peers'* peer group, the focal firm—if operating in environments with a low number of product market competitors—has higher competitive aggressiveness on both dimensions of aggressiveness. In economic terms, these coefficients imply that for *each incremental* addition to a peers' peer group, the focal firm has an 11% higher action volume and a 7% higher action complexity, relative to firms that are not added to their peers' peer group. The statistically insignificant coefficient on *Post* × *New Overlap* in columns 3 and 4 of table 6 suggests that additions for firms operating in environments with relatively more perfect competition are not associated with changes in competitive aggressiveness.

To shed more light on the dynamics of new overlap additions and competitive aggressiveness, we illustrate levels of competitive aggressiveness around the time firms receive a new peer group overlap in their incentive-compensation contracts in figure 3. Panel A displays the volume dimension of aggressiveness and shows that the difference in action volume is immediate and quite sustainable. Panel B displays the complexity dimension of aggressiveness and shows that the difference in action complexity is immediate but less sustainable. The combined pattern displayed in figure 3 suggests: (1) that these first-year actions are one-time actions that deviate from the firm's typical repertoire of actions and thus that (2) these actions are indeed "new" competitive actions toward peer firms.

Finally, we examine whether *past* peer group overlap moderates the association between *new* peer group overlap and competitive aggressiveness. To do so, we repeat our new peer group overlap test and interact the key variables of interest with lagged peer group overlap. In these analyses, we find weak support for a concave relation between new peer group overlap and competitive aggressiveness, conditional on past peer group overlap (see table OA2 in the online appendix for more details). That is, the impact of a new peer group overlap is strongest for firms with zero prior peer group overlap, and increases (for the complexity dimension) at a diminishing rate—consistent with many "diminishing returns" patterns documented in the incentive-compensation literature.

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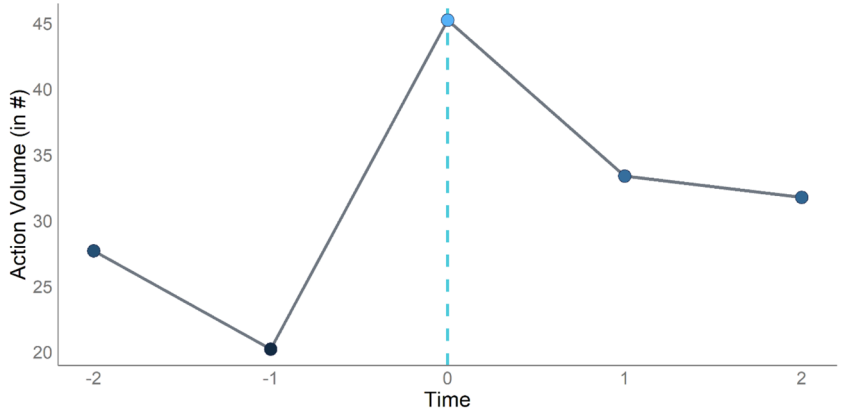
[21] To further control for observable contextual differences in covariates between "treated" firms and "control" firms and mitigate concerns regarding nonparallel trends, we also use an entropy balancing approach (e.g., Atanasov and Black [2016, pp. 258–59]; see table OA2 in the online appendix for more details). Specifically, we balance on the first and second moments of the distributions of all control variables of equation (3) (for more details, see figure OA1, which illustrates a love plot that visualizes the covariate balance between firms in the preperiod and firms in the postperiod after entropy balancing the first and second moments of the distributions of all covariates). After balancing, all differences between the two groups are insignificant (i.e., all two-tailed p-values > 0.999). Most importantly, we find that our inferences are robust to using this approach.

Panel (a) *New peer group overlap action volume*



Panel (b) *New peer group overlap action complexity*

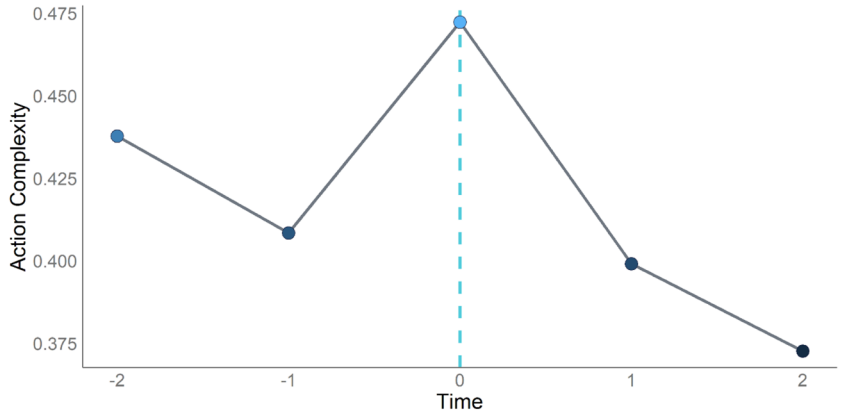


FIG 3.—New peer group overlap and competitive aggressiveness. (Panel A) New peer group overlap action volume. (Panel B) New peer group overlap action complexity. This figure illustrates levels of competitive aggressiveness around the time firms receive a new peer group overlap in their incentive-compensation contracts that is triggered by peers' incentive-compensation choices. Panel A displays the volume dimension of aggressiveness. Panel B displays the complexity dimension of aggressiveness. In this figure, $t = 0$ refers to the year in which managers receive a new peer group overlap in their incentive-compensation contracts. Each data point represents the time-average level of competitive aggressiveness in the cross-section of firms that receive a new peer group overlap.

Collectively, the results of our staggered continuous difference-in-differences estimation strengthen our inferences in two ways. First, this test allows us to isolate the association between competitive aggressiveness and peer group overlap that is triggered by peers. The results provide evidence consistent with managers considering peer group overlap in shaping

their firm's repertoire of competitive actions. Second, these findings help to alleviate concerns that a correlated omitted variable is behind our main results—for example, that our results are an artifact of firms' *own* incentive-compensation choices.

5. Cross-Sectional Variation in the Overlap-Aggressiveness Association

Although the previous analyses show that there is, on average, a positive association between peer group overlap and competitive aggressiveness, we expect that this association varies in the cross-section. We specifically conjecture that the association varies with other characteristics of relative performance plans. In this section, we therefore examine whether and how the overlap-aggressiveness association is affected by the following characteristics of relative performance plans: (1) the level of relative performance incentives, (2) the performance criteria used in these plans, (3) the size of the peer group, and (4) the type of overlapping peers. For each of these characteristics, we reestimate an adjusted version of equation (3) (see below for details about the measurement of these variables). We tabulate these results in table 7. Below we discuss each test in turn.

5.1 THE LEVEL OF INCENTIVES

We examine whether the overlap-aggressiveness association varies with the level of RPE incentives. In this regard, economic theory predicts that the incentive to act aggressively does not only depend on the level of incentives of the focal manager, but also depends on peer managers' incentives. That is, the more homogenous the RPE "tournament," the greater the competitive equilibrium (e.g., Lazear and Rosen [1981]). Intuitively, if managers indeed take competitive actions to target firms in the peer group, then we expect the association between peer group overlap and competitive aggressiveness to be stronger in settings where the tournament between firm-peer pairs is relatively "more homogenous" than in settings where the tournament is relatively "less homogenous." With this intuition in mind, we examine whether the overlap-aggressiveness association is moderated by the similarity in the level of incentives across firms facing peer group overlap. We measure the similarity in the level of incentives using *Grant Size Distance*, with larger values corresponding to less similar incentive structures. *Grant Size Distance* is the Euclidean distance between *Grant Size* of the focal firm and each of its overlapping peers, setting this variable to zero for firms with no overlapping peers.

Panel A in table 7 presents results from allowing the overlap-aggressiveness association to vary with the similarity in the level of incentives. We find that the actions managers take are moderated by the similarity with peer managers' incentives. The results show that more homogenous tournaments are associated with more homogeneity in the type of competitive actions—firms act highly competitive (i.e., higher action volume),

TABLE 7

Peer Group Overlap and Competitive Aggressiveness—Cross-Sectional Variation

Panel A. Incentive strength similarity

	(1)		(2)		(3)		(4)	
	Low *H&P Number of Competitors*				High *H&P Number of Competitors*			
	Dependent Variable:				Dependent Variable:			
Variable	log(*Action Volume*)		*Action Complexity*		log(*Action Volume*)		*Action Complexity*	
Peer Group Overlap	0.970***	(0.237)	0.158**	(0.070)	0.676**	(0.224)	−0.045	(0.064)
Grant Size Distance	0.014*	(0.006)	−0.003	(0.002)	0.009	(0.013)	0.001	(0.003)
Peer Group Overlap × *Grant Size Distance*	−0.049***	(0.013)	0.010**	(0.005)	−0.009	(0.029)	0.003	(0.010)
Controls	Yes		Yes		Yes		Yes	
Year and industry indicators	Yes		Yes		Yes		Yes	
Observations	795		795		828		828	
Adjusted R^2	59.182%		28.966%		56.547%		32.627%	

(*Continued*)

TABLE 7—*(Continued)*

Panel B. Performance criteria similarity

	(1)		(2)		(3)		(4)	
	Low *H&P Number of Competitors*				High *H&P Number of Competitors*			
	Dependent Variable:				Dependent Variable:			
Variable	log(*Action Volume*)		*Action Complexity*		log(*Action Volume*)		*Action Complexity*	
Peer Group Overlap	1.142***	(0.280)	0.308***	(0.063)	0.631**	(0.272)	0.005	(0.069)
Criteria Distance	0.213	(0.135)	0.016	(0.039)	−0.053	(0.180)	−0.019	(0.040)
Peer Group Overlap × *Criteria Distance*	−0.984**	(0.366)	−0.184	(0.112)	−0.353	(0.496)	−0.016	(0.089)
Controls	Yes		Yes		Yes		Yes	
Year and industry indicators	Yes		Yes		Yes		Yes	
Observations	795		795		828		828	
Adjusted R^2	53.946%		25.212%		54.956%		25.290%	

(*Continued*)

TABLE 7—*(Continued)*

Panel C. Peer group size

	(1)		(2)		(3)		(4)	
	Low *H&P Number of Competitors*				High *H&P Number of Competitors*			
	Dependent variable:				Dependent variable:			
Variable	log(*Action Volume*)		*Action Complexity*		log(*Action Volume*)		*Action Complexity*	
Peer Group Overlap (#)	0.083**	(0.028)	0.022***	(0.007)	0.033	(0.032)	−0.002	(0.005)
Peer Group Size	−0.015	(0.010)	0.002	(0.002)	−0.001	(0.004)	−0.001	(0.001)
Peer Group Overlap (#) × *Peer Group Size*	0.004	(0.005)	−0.001	(0.001)	−0.001	(0.003)	0.000	(0.001)
Controls	Yes		Yes		Yes		Yes	
Year and industry indicators	Yes		Yes		Yes		Yes	
Observations	795		795		828		828	
Adjusted R^2	53.894%		24.682%		54.546%		25.313%	

(*Continued*)

TABLE 7—*(Continued)*

Panel D. Overlapping peers from same six-digit GICS industry

	(1)		(2)		(3)		(4)	
	Low *H&P Number of Competitors*				High *H&P Number of Competitors*			
	Dependent Variable:				Dependent Variable:			
Variable	log(*Action Volume*)		*Action Complexity*		log(*Action Volume*)		*Action Complexity*	
Peer Group Overlap in GICS6	0.734**	(0.285)	0.220***	(0.070)	0.460*	(0.256)	−0.014	(0.060)
Peer Group Overlap not in GICS6	1.321	(0.832)	0.161	(0.133)	1.304	(1.292)	0.141	(0.196)
Controls	Yes		Yes		Yes		Yes	
Year and industry indicators	Yes		Yes		Yes		Yes	
Observations	795		795		828		828	
Adjusted R^2	53.426%		24.530%		54.804%		25.305%	

This table presents results examining cross-sectional variation in the association between peer group overlap and competitive aggressiveness, split by the number of product market competitors identified by Hoberg and Phillips [2010, 2016]. Panel A presents results examining cross-sectional variation in the similarity of the strength of incentives. Panel B presents results examining cross-sectional variation in the similarity of performance criteria. Panel C presents results examining cross-sectional variation in the size of the peer group. Panel D presents results examining cross-sectional variation in the industry-type of overlapping peers. *Grant Size Distance* is the Euclidean distance between the "risk-neutral value" of the RPE plan, scaled by the manager's previous year's total compensation (i.e., *Grant Size*) of the focal firm and each of its overlapping peers. *Criteria Distance* is the Euclidean distance between the performance criteria of the RPE plan (i.e., *RPE-price*) of the focal firm and each of its overlapping peers. *Peer Group Overlap (#)* is the number of overlapping peer relationships (i.e., not scaled by the peer group size). *Peer Group Size* is the total number of firms in the peer group (mean centered). *Peer Group Overlap in GICS6* is the number of overlapping peers that operate in the same six-digit GICS industry as the focal firm, scaled by the peer group size. *Peer Group Overlap not in GICS6* is the number of overlapping peers that operate in a different six-digit GICS industry as the focal firm, scaled by the peer group size. The industry indicators follow the 48 industry groups identified by Fama and French [1997]. Standard errors are in parentheses and are adjusted for within cluster correlation by firm and time conform Gow, Ormazabal and Taylor [2010]. *, **, and *** indicate significance at two-tailed probability levels of 10%, 5%, and 1%, respectively. All variables are defined in the caption of table 2.

but focus on fewer dimensions (i.e., lower action complexity). Collectively, these findings indicate that homogeneity in RPE incentives across firms matters for competitive aggressiveness.

5.2 THE PERFORMANCE CRITERIA

We examine whether the overlap-aggressiveness association varies with performance criteria in relative performance plans. Descriptive statistics discussed in subsection 4.1 reveal variation in the measures used in relative performance plans. Although there is a predominance of price-based metrics, there is also a significant portion that is based on accounting numbers. Following the tournament homogeneity intuition from subsection 5.1, we examine whether a manager's incentive to act aggressively is moderated by the similarity in performance criteria across firms facing peer group overlap. We measure the similarity in performance criteria using *Criteria Distance*, with larger values corresponding to less similar performance criteria. *Criteria Distance* is the Euclidean distance between *RPE-price* of the focal firm and each of its overlapping peers.[22]

Panel B in table 7 presents results from allowing the overlap-aggressiveness association to vary with performance criteria similarity. We find that the actions managers take are indeed moderated by the similarity with peer managers' performance criteria. Consistent with the findings in panel A in table 7, we find that more homogenous tournaments are associated with more competitive aggressiveness. Collectively, these findings corroborate the notion that homogeneity in RPE plans across firms matters for competitive aggressiveness.

5.3 THE SIZE OF THE PEER GROUP

We examine whether the overlap-aggressiveness association varies with the size of the peer group, as it might require more aggressiveness to outperform a larger group of peers than a smaller group of peers. We measure the size of peer group using *Peer Group Size*. Given that *Peer Group Overlap* is scaled by *Peer Group Size*, an interaction between these two variables would simply result in unscaling our overlap measure and not test for cross-sectional variation driven by the size of the peer group. As an alternative,

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[22] Strictly speaking, we empirically observe three categories of criteria: (1) only price-based measures, (2) only accounting-based measures, and (3) both price-based and accounting-based measures. Given the predominance of price-based measures and the last category being relatively small, we use *RPE-price*, which captures (1) and (2), to measure *Criteria Distance*. The relevance of using *RPE-price* is also revealed in an analysis in which we allow the overlap-aggressiveness association to vary with *RPE-price* (reported in table OA3 in the online appendix). Here we find that managers indeed take more actions under price-based RPE, compared to only accounting-based RPE, but with similar complexity. To the extent that price-based metrics reflect valuation implications of competitive actions more quickly than do accounting-based metrics, this finding suggests that the faster actions are reflected in performance, the more managers are inclined to act aggressively in the presence of peer group overlap.

we therefore replace *Peer Group Overlap* by *Peer Group Overlap (#)* (i.e., the *number* of overlapping peers) and interact this variable with *Peer Group Size*, where *Peer Group Size* is centered around the mean.

Panel C in table 7 presents results from allowing the overlap-aggressiveness association to vary with peer group size. Although we find that *Peer Group Overlap (#)* is positive and significant for both action volume and complexity, that is, there is a positive association between competitive aggressiveness and peer group overlap for average-sized peer groups, we do not find any significant interaction effects. This finding implies that the number of overlapping peers in the peer group matter for competitive aggressiveness irrespective of the size of the peer group.

5.4 THE TYPE OF OVERLAPPING PEERS

We examine whether the overlap-aggressiveness association varies with the composition of the overlapping portion of the peer group. As discussed in subsection 2.2, it is common for firms to compete not only in product markets, but also in other markets (e.g., the labor market where firms compete on attracting and retaining talent). Although it is difficult to convincingly determine all dimensions on which firms compete, we examine whether overlapping peers that are more likely to share multidimensional economic fundamentals give managers a differential incentive to act aggressively. Following Pittinsky and DiPrete [2013], as well as our evidence in panel D of table 4, we rely on the GICS to identify peers that are more likely to share multidimensional economic fundamentals.[23]

Specifically, we split our main measure of peer group overlap in two new measures based on the GICS "industry" (i.e., six-digit GICS code): (1) *Peer Group Overlap in GICS6* is the number of overlapping peers that operate in the same six-digit GICS industry as the focal firm, scaled by the peer group size and (2) *Peer Group Overlap not in GICS6* is the number of overlapping peers that operate in a different six-digit GICS industry as the focal firm, scaled by the peer group size.[24] We then reestimate equation (3) and replace *Peer Group Overlap* with these variables.

Panel D in table 7 presents results from allowing the overlap-aggressiveness association to vary with the composition of the overlapping portion of the peer group. We find that managers' competitive aggressiveness (both dimensions) are increasing in the overlapping portion of the peer group that comes from the same six-digit GICS industry. Collectively, these findings suggest that primarily overlapping peers that are more likely

[23] The GICS is especially relevant, because it assigns companies to a specific industry (i.e., six-digit GICS code) that best defines its *business operations*.

[24] For firms with at least some peer group overlap, we find that roughly one in five (i.e., 19%) of those overlapping relationships are with peers outside the six-digit GICS code. In the full sample, we find that 16% of the observations have at least one overlapping relationship with a peer outside the six-digit GICS code, and that 7% of the observations *only* have overlapping relationships with peers outside the six-digit GICS code.

to share multidimensional economic fundamentals give managers an incentive to act aggressively.

6. Additional Analysis: Competitive Action Types

In this section, we examine the association between peer group overlap and the types of competitive actions. To do so, we split our aggregated volume measure into its underlying action types and provide insights into which competitive actions managers take. Specifically, we reestimate equation (3) and replace the dependent variable with the action volume *within* each of the following types: (1) new product actions (*New Products*), (2) pricing actions (*Pricing*), (3) marketing actions (*Marketing*), (4) acquisitions (*Acquisitions*), (5) equity joint ventures (*Joint Ventures*), (6) strategic alliances (*Strategic Alliances*), and (7) market expansion (*Market Expansion*). We tabulate these results in table 8.

Panel A in table 8 presents results for the subsample with low number of product market competitors. These results show that the association between peer group overlap and competitive aggressiveness is primarily driven by actions related to the release of new products, acquisitions, joint ventures, and strategic alliances. Panel B in table 8 presents results for the subsample with high number of product market competitors. Here we only find an association between peer group overlap and acquisitions. The overall association between peer group overlap and action volume for this subsample, reported in column 3 of table 5, thus seems to be driven by acquisitions. This suggests that peer group overlap triggers actions that distort perfect competition when the firm operates in a more competitive environment.

Collectively, these findings provide more insights into which competitive actions firms take. We interpret these findings as follows. In settings with relatively less perfect competition, any action could in principle have an impact on performance. Consistent with this notion, we find that firms' competitive action repertoire consists of an extensive set of actions. In contrast, in settings with relatively more perfect competition, only competitive actions that distort perfect competition—such as acquisitions—likely have an impact on performance. Consistent with this notion, we find that firms with peer group overlap primarily rely on this type of actions.

7. Robustness of Main Result

In this section, we examine the robustness of our key finding—the peer group overlap-competitive aggressiveness association. In particular, we examine the robustness of this finding to: (1) assessing the impact of unobservable factors by applying the bounding technique put forward by Oster [2019]; (2) using two alternative measures of competitive aggressiveness; (3) using two alternative measures of competitive environment; controlling for a (4) common time and (5) common industry trend in compet-

TABLE 8

Peer Group Overlap and Competitive Action Types

Panel A. Low *H&P number of competitors*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent Variable:						
	New Products	*Pricing*	*Marketing*	*Acquisitions*	*Joint Ventures*	*Strategic Alliances*	*Market Expansions*
Peer Group Overlap	0.911*** (0.266)	0.026 (0.141)	0.388 (0.318)	0.613** (0.202)	0.194* (0.099)	0.918*** (0.252)	0.210 (0.137)
Peer Group Synchronicity	0.064 (0.246)	−0.197 (0.141)	−0.259 (0.204)	0.103 (0.236)	−0.042 (0.113)	−0.045 (0.233)	−0.082 (0.113)
Market Value (Rank)	1.064*** (0.234)	0.341** (0.122)	0.122 (0.315)	1.096*** (0.239)	0.172 (0.129)	0.765** (0.262)	0.151* (0.082)
Book-to-Market (Rank)	0.329 (0.239)	0.082 (0.109)	0.293 (0.267)	0.167 (0.217)	0.059 (0.107)	0.169 (0.181)	0.124* (0.057)
Leverage (Rank)	−0.136 (0.253)	0.212** (0.082)	0.015 (0.193)	0.200 (0.179)	0.044 (0.069)	−0.147 (0.169)	0.025 (0.040)
Sales Growth (Rank)	−0.425*** (0.089)	−0.249*** (0.057)	−0.244 (0.110)	−0.222* (0.122)	0.058 (0.063)	−0.310** (0.111)	−0.013 (0.057)
Return (Rank)	−0.231 (0.148)	−0.007 (0.060)	0.189 (0.145)	−0.060 (0.137)	−0.103 (0.061)	−0.310** (0.119)	−0.003 (0.038)
H&P Number of Competitors (Rank)	−0.515** (0.182)	−0.052 (0.106)	−0.064 (0.211)	−0.202 (0.178)	−0.113 (0.108)	−0.150 (0.184)	−0.107 (0.067)
H&P Competitor Similarity (Rank)	0.249* (0.119)	0.139** (0.063)	0.223 (0.162)	−0.106 (0.117)	0.018 (0.058)	0.276* (0.131)	0.018 (0.035)
Year and industry indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	795	795	795	795	795	795	795
Adjusted R^2	54.056%	20.202%	23.463%	59.382%	4.326%	43.516%	19.992%

(*Continued*)

TABLE 8—*(Continued)*

Panel B. High *H&P number of competitors*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent Variable:						
	New Products	*Pricing*	*Marketing*	*Acquisitions*	*Joint Ventures*	*Strategic Alliances*	*Market Expansions*
Peer Group Overlap	−0.094 (0.198)	0.140 (0.121)	0.049 (0.233)	0.643** (0.249)	0.047 (0.113)	0.232 (0.251)	0.057 (0.086)
Peer Group Synchronicity	−0.049 (0.212)	−0.005 (0.132)	0.151 (0.283)	0.140 (0.276)	0.036 (0.119)	−0.068 (0.244)	−0.062 (0.039)
Market Value (Rank)	0.855*** (0.219)	0.112 (0.084)	0.163 (0.209)	0.895*** (0.257)	0.199*** (0.061)	0.851*** (0.264)	0.007 (0.043)
Book-to-Market (Rank)	0.308 (0.189)	−0.097 (0.065)	0.087 (0.198)	0.322 (0.188)	0.081 (0.068)	0.051 (0.182)	−0.037 (0.044)
Leverage (Rank)	0.332** (0.151)	0.193* (0.092)	0.295 (0.191)	0.381 (0.175)	0.118 (0.082)	0.342* (0.157)	0.051 (0.039)
Sales Growth (Rank)	−0.222 (0.130)	−0.048 (0.039)	0.033 (0.088)	−0.023 (0.126)	−0.018 (0.043)	−0.163 (0.110)	0.026 (0.035)
Return (Rank)	−0.045 (0.128)	−0.080 (0.072)	−0.085 (0.130)	−0.036 (0.174)	−0.031 (0.069)	−0.211 (0.141)	−0.002 (0.031)
H&P Number of Competitors (Rank)	−0.120 (0.211)	0.119 (0.112)	0.397* (0.215)	−0.216 (0.202)	−0.154* (0.073)	0.101 (0.197)	0.113 (0.071)
H&P Competitor Similarity (Rank)	−0.085 (0.221)	−0.131 (0.091)	−0.330 (0.230)	−0.306 (0.187)	0.059 (0.075)	0.015 (0.200)	−0.056 (0.057)
Year and industry indicators	yes	Yes	yes	yes	yes	yes	yes
Observations	828	828	828	828	828	828	828
Adjusted R^2	67.461%	25.848%	21.602%	51.377%	4.218%	45.234%	10.375%

This table presents results examining the association between peer group overlap and the types of competitive actions, split by the number of product market competitors identified by Hoberg and Phillips [2010, 2016]. The sample contains 1,623 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables. All dependent variables are measured in natural logarithms. The industry indicators follow the 48 industry groups identified by Fama and French [1997]. Standard errors are in parentheses and are adjusted for within cluster correlation by firm and time conform Gow, Ormazabal, and Taylor [2010]. *, **, and *** indicate significance at two-tailed probability levels of 10%, 5%, and 1%, respectively. All variables are defined in the caption of table 2.

itive aggressiveness using Fama and MacBeth [1973] regressions; and (6) controlling for manager's equity incentives. Below we discuss each test in more detail in turn. For parsimony, all results are tabulated in the online appendix.

7.1 OSTER BOUNDS: THE IMPACT OF UNOBSERVABLES

Our empirical strategy is designed to minimize the threat that a correlated omitted variable explains our results. For example, we base our inferences on a staggered continuous difference-in-differences estimation. Strictly speaking, we cannot completely rule out the possibility that an omitted correlated variable is behind our results. Nevertheless, we can formally assess the impact of unobservable factors on our main findings by applying the bounding technique put forward by Oster [2019], which builds on the intuition by Altonji, Elder, and Taber [2005].

This technique is a form of partial identification and can be used in two ways.[25] First, it provides an estimate for the bounds on the coefficient of interest, based on estimated coefficients, R^2 values, and *assumptions* related to the omitted variable bias. Here we follow Altonji, Elder, and Taber [2005] and Oster [2019], consider $R^2_{\max} = min(1.3\tilde{R}^2, 1)$ and $\delta = 1$, which implies that we assume: (1) that our equations are misspecified by 30% and (2) a situation in which unobservable factors have a similar effect on our results as do observable factors. We also consider $\delta = -1$, which implies a situation in which the impact of unobservable factors is of similar magnitude, but correlates in the opposite way as do observable factors. Second, this technique allows us to estimate how large the impact of unobservable factors relative to observable factors—that is, δ—needs to be to drive our coefficients of interest to zero.

We apply this technique to our key finding—the peer group overlap-competitive aggressiveness association in table 5. In this regard, the Oster bounds indicate that if unobservable factors have a similar effect on the association between peer group overlap and competitive aggressiveness as do observables (i.e., $\delta = 1$), the estimated coefficient on *Peer Group Overlap* on *Action Volume* for the subsample with low number of product market competitors in column 1 of table 5 *increases* by approximately 5%—from 0.816 to

[25] Partial identification techniques treat identification (of causal effects) as a continuum rather than a binary phenomenon. This framework—pioneered by Manski [1989, 1990, 1993, 2003] and Horowitz and Manski [1995, 1998, 2000]—took shape in the 1990s, and its use has since grown rapidly in fields such as economics, political science, and sociology. These techniques ask how much we can learn from a regression of observed outcomes on observed conditioning variables under additional assumptions (e.g., in our case, assumptions related to the structure of unobservables). Instead of traditional point estimates, we then obtain a credible range of values in which the parameter of interest lies. The credibility of inference in this regard decreases with the strength of the assumptions maintained (e.g., Manski [2003]). Also see, for example, Armstrong [2013] for a brief discussion of partial identification in accounting.

0.855.[26] If we assume that unobservable factors have the opposite effect as do observable factors, this coefficient decreases to 0.777. This implies that a reasonable range in which the "true" coefficient lies, is the interval [0.777, 0.855]. A similar exercise with respect to *Action Complexity* reveals that such a reasonable interval is [0.163, 0.274]. Most importantly, these bounds do not include zero. Thus, unobservable factors need to have a *larger* impact on the observed relationship between RPE and competitive aggressiveness than observable factors for the *Peer Group Overlap* coefficients to be zero. To be more precise, the Oster [2019] bounds indicate that the impact of unobservable factors needs to be *at least* 20 (four) times the impact of observable factors to drive the coefficient on *Peer Group Overlap* to zero in the volume (complexity) specification.[27]

7.2 ALTERNATIVE MEASURES OF COMPETITIVE AGGRESSIVENESS

In our main analyses, we identify competitive actions through news events. The main advantage of using these competitive actions is that they allow us to capture a broad and comprehensive set of relevant and impactful firm actions. In this robustness check, we triangulate our analyses with more traditional accounting-based input and output measures of competitive behavior, using the firm's advertisement expenditures and operating margin.[28] In terms of aggressiveness, greater advertisement expenditures and smaller operating margins imply greater competitive aggressiveness (e.g., Fombrun and Ginsberg [1990], Vilcassim, Kadiyali, and Chintagunta [1999]). In addition to being a robustness check, these tests also help us to interpret the economic significance of the peer group overlap-competitive aggressiveness association more clearly.

Specifically, we reestimate equation (3) and replace the dependent variable with the firm's advertisement expenditures, scaled by average total assets (*Advertisement*), and the firm's average revenue minus cost of goods sold and selling, general and administrative expenditures, scaled by average revenue (*Operating Margin*). We tabulate these results in the online appendix (see panel A in table OA4 for details).

We find that peer group overlap is positively associated with firms' annual advertisement expenditures, and negatively associated with firms'

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[26] The coefficient increases because if we estimate a univariate regression between log(*Action Volume*) and *Peer Group Overlap*, the coefficient on *Peer Group Overlap* is 0.689 (compared to 0.816 with controls). Hence, if unobservable factors are correlated in the same direction as observable factors, then the coefficient increases further.

[27] Even if we increase the degree to which our equations are misspecified—for example, by assuming that the theoretical maximum R^2 is twice that of our equations—the impact of unobservable factors still needs to be *at least* five times (one time) the impact of observable factors to drive the coefficient on *Peer Group Overlap* to zero in the volume (complexity) specification.

[28] We focus on these accounting-based measures as they represent competitive actions and are readily available for a large sample of firms. In contrast, price and quantity measures are not readily available for a large sample of firms. Moreover, price and quantity measures are difficult to interpret without knowing the nature of the strategic game between firms.

operating margins within the subsample with low number of product market competitors. In economic terms, the coefficients imply that in environments with a low number of product market competitors, RPE firms with peer group overlap at the 90th percentile have 76% higher advertising expenditures and 17% lower operating margins than RPE firms with peer group overlap at the 10th percentile.[29] These magnitudes reveal economically relevant differences in competitive behavior between firms with low and high peer group overlap. Moreover, these tests alleviate concerns that our findings are driven by specific measurement choices related to competitive aggressiveness, but rather apply to the theoretical construct more generally.

7.3 ALTERNATIVE MEASURES OF COMPETITIVE ENVIRONMENT

We assess the robustness of our main results to using alternative measures of competitive environment: (1) the sales Herfindahl-Hirschman Index and (2) the maximum similarity score as identified by Hoberg and Phillips [2010, 2016]. We do so to mitigate concerns with respect to our empirical proxy for the firm's competitive environment. We partition our sample into observations with relatively low and high values of these characteristics, and reestimate equation (3) separately for each subsample. We tabulate these results in the online appendix (see panels B and C in table OA4 for details).

We continue to find results in line with our main results. Specifically, we find that in environments with relatively more imperfect competition (i.e., high *Herfindahl-Hirschman Index* and low *H&P Competitor Similarity*), the coefficient on *Peer Group Overlap* is positive and significant. Hence, we conclude that our main results are robust to using alternative measures of competitive environment.

7.4 CONTROLLING FOR A COMMON TIME TREND

We assess the robustness of our main results to controlling for a common time trend in competitive aggressiveness, because firms likely operate in different economic cycles, which may impact their aggressiveness decisions. Although our main specifications include year fixed effects, we now reestimate equation (3) using Fama and MacBeth [1973] regressions, which allows the coefficients on all variables to vary for each year. Specifically, we estimate equation (3) on an annual basis, and compute coefficients and standard errors based on the distributions of the year-specific cross-sectional regressions. We tabulate these results in the online appendix (see

[29] We calculate the economic magnitudes in the same way as the economic magnitudes for the complexity dimension of competitive aggressiveness. That is, we compare the magnitude to the (unconditional) mean value of *Advertisement* and *Operating Margin* for RPE firms with *Peer Group Overlap* at the 10th percentile operating in environments with a low number of product market competitors. In *absolute* terms, the 76% higher advertising expenditures and 17% lower operating margins imply 1% higher advertising expenditures (as a percentage of total assets) and 3% lower operating margins, respectively.

panel D in table OA4 for details), for which we report the time-series average of the estimated coefficients and the corresponding standard errors, which are based on the standard deviation of the error in the time-series average estimated coefficients. We continue to find that the coefficient on *Peer Group Overlap* is positive and significant in environments with relatively more imperfect competition. Hence, we conclude that our main results are robust to rigorously controlling for a common time trend.

7.5 CONTROLLING FOR A COMMON INDUSTRY TREND

To address concerns that industry characteristics are behind our results, we assess the robustness of our main results to controlling for a common industry trend in competitive aggressiveness. Although our main specifications include industry fixed effects, we now reestimate equation (3) using Fama and MacBeth [1973] regressions, which allows the coefficients on all variables to vary for each industry. Specifically, we estimate equation (3) on an industry basis, and compute coefficients and standard errors based on the distributions of the industry-specific time-series regressions. We tabulate these results in the online appendix (see panel E in table OA4 for details), for which we report the industry average of the estimated coefficients and the corresponding standard errors, which are based on the standard deviation of the error in the industry average estimated coefficients. We continue to find that the coefficient on *Peer Group Overlap* is positive and significant in environments with relatively more imperfect competition (albeit at attenuated significance levels for the complexity specification). Hence, we conclude that our main results are robust to rigorously controlling for a common industry trend.

7.6 CONTROLLING FOR EQUITY INCENTIVES

We assess the robustness of our main results to controlling for managers' equity incentives, because prior literature documents an interdependence between relative performance plans and equity incentives (e.g., Park and Vrettos [2015]). We measure the manager's equity incentives through portfolio delta and vega. *Delta* is the sensitivity of the risk-neutral value of the CEO's portfolio of stock and stock options to a 1% change in the price of the underlying stock. *Vega* is the sensitivity of the risk-neutral value of the CEO's portfolio of stock options to a 0.01 change in the volatility of the underlying stock (e.g., Guay [1999], Core and Guay [2002]). We estimate the risk-neutral value of the manager's option portfolio using the Black and Scholes [1973] model, as modified by Merton [1973] to account for dividend payouts. We then reestimate equation (3) and include *Delta* and *Vega*. We tabulate these results in the online appendix (see panel F in table OA4 for details). We continue to find that the coefficient on *Peer Group Overlap* is positive and significant in environments with relatively more imperfect competition. Hence, we conclude that our main results are not an artifact of equity incentives in executive incentive-compensation contracts.

In sum, across this collective set of robustness tests, we find that our main result is robust. Although we cannot completely rule out the possibility that a correlated omitted variable is behind our results, we argue—based on our main tests, robustness checks, and the Oster [2019] bounds—that the likelihood that such a correlated omitted variable exists is negligible. Taking all tests together, for an omitted variable to explain our results, it would need to: (1) be correlated with all dimensions of competitive aggressiveness; (2) *differentially affect* firms using RPE with peer group overlap and firms using RPE without peer group overlap, *conditional on* the firm's competitive environment; (3) *differentially affect* firms using RPE with a new peer group overlap triggered by peers and firms using RPE without such new overlap, *conditional on* the firm's competitive environment; (4) be *unexplained* by common time and industry trends; *and* (5) impact the peer group overlap-competitive aggressiveness association more than all observable factors combined in our research design. We assess the likelihood of all these conditions being present as low and, therefore, conclude that it seems implausible that a correlated omitted variable is behind our results.

8. Conclusion

This study examines the relation between incentive plans based on relative performance and competitive aggressiveness. Theoretically, RPE puts agents into direct competition with each other, which can either increase or decrease competitive aggressiveness. On the one hand, direct competition can give managers an incentive to act aggressively toward peers, because managers can gain an advantage over competitors and improve their firm's relative position by engaging in competitive actions. We label this prediction the "sabotage hypothesis." On the other hand, because being aggressive can be costly to the firm, direct competition can give managers an incentive to collude so to commit to abstain from being competitively aggressive. We label this prediction the "collusion hypothesis."

We empirically examine the relation between direct competition, which we label peer group overlap, and competitive aggressiveness using a large sample of U.S. firms over the period 2006 through 2017 and using a variety of tests that exploit various forms of variation in peer group overlap. Across all specifications, we present evidence consistent with the sabotage hypothesis. That is, we find a positive association between peer group overlap and competitive aggressiveness. This evidence is robust to a battery of tests designed to mitigate concerns that correlated omitted variables explain our results.

Collectively, our study contributes to both practice and academia. For example, our study provides investors, regulators, and practitioners with insights into how contemporaneous incentive-compensation contracts impact firm decisions. The finding that peer group overlap is positively associated with competitive aggressiveness provides investors, regulators, and practitioners with additional dimensions to consider in assessing whether

incentive-compensation contracts expose firms to material risks. Moreover, to the extent that peer group overlap is not directly observed from one firm's proxy statement—as this requires a set of proxy statements—one important takeaway from our study is that solely relying on information in one firm's proxy statement may yield an incomplete picture of the incentive properties of executive incentive-compensation contracts. With respect to academia, we draw from—and, in doing so, help bridge—related literatures. For example, we bring measurement techniques from strategic management to the accounting literature so to clearly answer our research question. These measurement approaches have a long-standing history in that field and are easily implemented for a large sample of firms. Our hope is that this approach sparks much future research in accounting.

APPENDIX A

DISCUSSION OF COMPETITIVE AGGRESSIVENESS MEASURES

This appendix discusses in more detail our measures of competitive aggressiveness. In particular, this appendix discusses: (1) the construction of these measures and (2) the interpretation of these measures as well as each underlying dimension.

A1. CONSTRUCTION

Following an extensive prior literature in strategic management, we measure competitive aggressiveness using the firm's competitive actions (e.g., Ferrier, Smith, and Grimm [1999], Ferrier [2001], Ferrier and Lyon [2004], Rindova, Ferrier, and Wiltbank [2010]). To identify these competitive actions, we use structured content analysis of news events identified by RavenPack. A key advantage of using these news events is that they allow us to capture relevant and impactful firm decisions. Such actions are typically difficult to quantify when strictly relying on accounting-based measures.

RavenPack develops proprietary algorithms that identify events in the unstructured text published by reputable content sources, such as the *Dow Jones Newswires*, the *Wall Street Journal*, and over 19,000 other traditional and social media sites. The database records an entry any time one of these sources reports on a company. RavenPack covers over 36,000 companies (e.g., Connelly et al. [2017]). The database identifies the first mention of any given competitive action in order to eliminate duplication (e.g., Drake, Guest, and Twedt [2014]).

The first step in constructing the measures of competitive aggressiveness is to download the news events from RavenPack. For each news event, RavenPack identifies a "type"—that is, a class of events that share similar characteristics. For our study, we follow prior literature and examine seven major "types" of competitive actions (e.g., Connelly et al. [2017, 2019]). These types include: (1) new product actions, (2) pricing actions, (3) marketing actions, (4) acquisitions, (5) equity joint ventures, (6) strategic al-

liances, and (7) market expansion. Table 1 presents example events for each action type.

The second step in constructing the measures of competitive aggressiveness is to structure the news events data. To precisely categorize each news event, RavenPack assigns "relevance" and "novelty" scores to each news event. The relevance score indicates the relevance of the focal firm in the event, where greater values imply more relevant events. The novelty score indicates the novelty of a news event and helps to distinguish duplicate events, where greater values imply more unique events. Both scores are measured on a scale from 0 to 100. Consistent with prior literature, we filter events based on the relevance and novelty scores assigned by RavenPack (e.g., Connelly et al. [2017, 2019]). In particular, we limit our analyses to events for which the relevance score is 100 (i.e., the maximum) and the novelty score is 100 (i.e., the maximum). This constraint ensures that we: (1) assign news events to the correct firm and (2) do not double-count events.

The third step in constructing the measures of competitive aggressiveness is to link each news event to a firm in our sample. The firm identifier in RavenPack is the International Securities Identification Number (ISIN) code. We use Compustat's Capital IQ database to transform ISIN codes to Compustat's GVKEY codes. After linking all news events to GVKEY codes, we link the news events to our sample (using the GVKEY code). Using the above relevance and novelty constraints, the firms in our full ISS Incentive Lab sample (i.e., firms using RPE and firms not using RPE) engage in a total of 264,597 competitive actions from 2006 to 2017. In the sample of firms using RPE, this statistic equals 53,732 competitive actions.

The final step in constructing the measures of competitive aggressiveness is to transform the individual news events into empirical measures. Following an extensive and long-standing prior literature in strategic management (e.g., Ferrier, Smith, and Grimm [1999], Ferrier [2001], Ferrier and Lyon [2004]), we construct two empirical measures of competitive aggressiveness: "action volume" and "action complexity."

The volume dimension captures the number of actions a firm takes in one year. In terms of aggressiveness, the more actions a firm takes, the greater its competitive aggressiveness. However, not all actions are identical; distinct actions can be classified into different action types (e.g., launching a new marketing campaign is a fundamentally different action than performing an acquisition). And to the extent that taking actions from various types can be more harmful for competitors than merely focusing on one action type, another commonly used measure of competitive aggressiveness is complexity. The complexity dimension captures the breadth of a firm's repertoire of competitive actions across different action types. In terms of aggressiveness, the greater a firm's action complexity, the greater its competitive aggressiveness.

To measure the volume dimension of competitive aggressiveness, we count the number of actions for each firm-year. To measure the complexity dimension of competitive aggressiveness, we exploit variation in the different "types" of action types—that is, (1) new product actions, (2) pricing actions, (3) marketing actions, (4) acquisitions, (5) equity joint ventures, (6) strategic alliances, and (7) market expansion. In particular, we relate the actions in the different types to the overall number of actions. Formally, both measures are defined as follows:

$$Action\,Volume = \sum_{i=1}^{7} a_{ij} = V_j, \tag{A1}$$

$$Action\,Complexity = 1 - \sum_{i=1}^{7} \left(\frac{a_{ij}}{V_j} \right)^2, \tag{A2}$$

where a_{ij} is the number of firm j's actions in the ith action type and V_j is the total number of actions carried out by firm j in a given year (i.e., *Action Volume*).

A2. DESCRIPTIVE STATISTICS, CORRELATIONS, AND INTERPRETATION

To improve the interpretation of our measures, we first report extensive descriptive statistics for all measures. Table A1 presents descriptive statistics for the competitive aggressiveness measures. Panel A in table A1 presents mean statistics across time. This panel shows that there exists a significant time trend in firms' competitive aggressiveness. For example, the average firm takes 15 actions in 2006, whereas nowadays the average firm takes over 74 actions per year. Furthermore, this panel shows that this increase in the number of actions goes hand in hand with a decrease in the complexity of actions. In other words, nowadays firms take relatively more similar actions than in 2006.

Panel B in table A1 presents mean statistics across industries. This panel shows that there also exist significant industry effects in firms' competitive aggressiveness. For example, firms operating in more technology-heavy industries (e.g., "Business Equipment" and "Telephone and Television Transmission") are much more aggressive than firms operating in nontechnology industries (e.g., "Manufacturing" and "Oil, Gas, and Coal Extraction"). And even though firms operating in more technology-heavy industries take more actions, these firms also take more complex actions than their counterparts in nontechnology industries (e.g., more new products, more strategic alliances, and more market expansions).

We next report correlation coefficients between all measures. Table A2 presents Pearson (above diagonal) and Spearman (below diagonal) correlation coefficients between the competitive aggressiveness measures. This table shows that the correlation between *Action Volume* and *Action Complexity* is positive (e.g., Pearson correlation coefficient is 0.170). This suggests that, in the cross-section, firms that take more actions also take more

TABLE A1

Descriptive Statistics on Competitive Aggressiveness Measures

Panel A. Year distribution

Year	*Action Volume*	*Action Complexity*	*New Products*	*Pricing*	*Marketing*	*Acquisitions*	*Joint Ventures*	*Strategic Alliances*	*Market Expansions*
2006	14.800	0.411	6.070	0.194	2.220	3.940	0.167	2.210	0.014
2007	23.600	0.469	10.100	0.495	2.390	6.580	0.369	3.590	0.058
2008	23.300	0.442	10.300	0.541	3.170	5.700	0.387	3.130	0.090
2009	21.200	0.433	9.230	0.830	3.420	4.440	0.348	2.830	0.098
2010	25.600	0.466	10.600	0.575	4.140	6.470	0.333	3.390	0.117
2011	26.200	0.503	10.100	0.906	3.120	7.680	0.471	3.820	0.065
2012	26.800	0.492	11.200	0.500	3.410	6.830	0.507	4.240	0.127
2013	26.500	0.498	11.000	0.394	3.810	6.490	0.256	4.380	0.156
2014	28.900	0.460	12.200	0.321	3.270	7.460	0.259	5.220	0.080
2015	31.100	0.482	12.700	0.366	3.320	8.130	0.323	5.990	0.256
2016	48.800	0.363	5.920	0.282	4.830	33.400	0.250	3.920	0.218
2017	74.000	0.265	4.890	0.286	5.220	58.500	0.303	4.430	0.377

(*Continued*)

TABLE A1—*(Continued)*

Panel B. Industry distribution

Industry	*Action Volume*	*Action Complexity*	*New Products*	*Pricing*	*Marketing*	*Acquisitions*	*Joint Ventures*	*Strategic Alliances*	*Market Expansions*
Consumer nondurables	27.600	0.467	4.890	0.450	2.600	15.800	0.212	3.460	0.199
Consumer durables	37.200	0.427	13.000	0.578	3.340	14.900	0.297	4.660	0.469
Manufacturing	19.300	0.426	4.770	0.189	2.640	9.740	0.343	1.550	0.060
Oil, gas, and coal extraction	19.100	0.367	1.220	0.197	3.570	12.700	0.442	0.933	0.016
Chemicals and allied products	24.000	0.421	2.450	1.530	2.560	15.400	0.360	1.690	0.027
Business equipment	50.300	0.504	24.000	0.295	3.650	13.900	0.176	8.100	0.214
Telephone and television transmission	157.000	0.518	69.700	4.820	10.300	48.700	0.675	22.000	0.850
Utilities	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wholesale and retail	21.500	0.452	4.770	0.204	3.100	9.300	0.044	3.880	0.204
Healthcare and medical equipment	50.000	0.554	7.570	0.330	7.800	24.700	0.311	9.170	0.126
Finance	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other	38.000	0.423	12.900	0.437	3.370	16.200	0.463	4.380	0.221

This table presents descriptive statistics for the competitive aggressiveness measures. Panel A presents mean statistics across time. Panel B presents mean statistics across industries. The sample contains 1,623 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables. We exclude financial service firms and utilities. The industry classification follows the 12 industry groups identified by Fama and French [1997]. *Action Volume* is the total number of competitive actions. *Action Complexity* is the variation in competitive actions across seven types of competitive actions. *New Products* is the total number of competitive actions in the new product actions type. *Pricing* is the total number of competitive actions in the pricing actions type. *Marketing* is the total number of competitive actions in the marketing actions type. *Acquisitions* is the total number of competitive actions in the acquisitions actions type. *Joint Ventures* is the total number of competitive actions in the equity joint ventures actions type. *Strategic Alliances* is the total number of competitive actions in the strategic alliances actions type. *Market Expansions* is the total number of competitive actions in the market expansion actions type.

TABLE A2

Correlations Between Competitive Aggressiveness Measures

		A	B	C	D	E	F	G	H	I
Action Volume	A		0.170	0.793	0.524	0.496	0.751	0.266	0.816	0.470
Action Complexity	B	0.261		0.249	0.181	0.259	-0.089	0.264	0.323	0.155
New Products	C	0.582	0.545		0.549	0.321	0.225	0.225	0.776	0.416
Pricing	D	0.308	0.269	0.270		0.253	0.202	0.213	0.468	0.306
Marketing	E	0.473	0.303	0.183	0.120		0.327	0.083	0.348	0.203
Acquisitions	F	0.786	0.088	0.191	0.218	0.232		0.137	0.381	0.275
Joint Ventures	G	0.227	0.325	0.193	0.201	0.047	0.181		0.262	0.187
Strategic Alliances	H	0.628	0.548	0.675	0.299	0.232	0.310	0.236		0.431
Market Expansions	I	0.336	0.162	0.289	0.232	0.162	0.250	0.125	0.305	

This table presents Pearson (above diagonal) and Spearman (below diagonal) correlation coefficients between the competitive aggressiveness measures. The sample contains 1,623 observations for all RPE firms with self-selected peers in ISS Incentive Lab from 2006 to 2017 with nonmissing values for all required variables. We exclude financial service firms and utilities. All correlation coefficients are significant at the 1%. All variables are defined in the caption of table A1.

complex actions. Furthermore, the strong correlation coefficients between *Action Volume* and, for example, *New Products*, *Acquisitions*, and *Strategic Alliances*, suggest that those firms that take many actions do so via these dimensions. This is consistent with the pattern that we observed in table A1 for firms operating in more technology-heavy industries. We also observe some noteworthy—and intuitive—correlation coefficients between the underlying action dimensions. For example, the strong correlation between *New Products* and *Pricing* suggests that new products go hand in hand with pricing strategies. Another intuitive correlation is between *New Products* and *Strategic Alliances*, which suggests that new products stem from strategic alliances.

APPENDIX B

EXAMPLE RELATIVE PERFORMANCE PLAN

The following text is an excerpt from the DEF 14a filing of United Parcel Service Inc. [2019, pp. 36–38], where the firm describes its RPE plan.

> *Relative Total Shareowner Return*
>
> Relative TSR is measured by covering our TSR to the TSR a peer group of companies during a three-year performance period. The Compensation Committee evaluates the peer group annually to determine if the companies included in the group are the most appropriate comparators for measuring the success of our executives in delivering shareowner value.[30]

Three-Year TSR Compared to Peer Group	**Percentage of Target Earned forTSR Portion of LTIP Award)**
Greater than 75th Percentile	200%
Median	100%
25th Percentile	50%
Less than 25th Percentile	0%

[30] The peer group considered by the Compensation Committee for 2018 compensation purposes (the "2018 Peer Group") is unchanged from the peer group used for 2017 compensation, and consisted of the companies below:

The Boeing Company,	The Procter & Gamble Company,
Caterpillar Inc.,	Sysco Corporation
The Coca-Cola Company	Target Corp.
Costco Wholesale Corporation	Lowe's Companies, Inc.,
FedEx Corporation	McDonald's Corp.,
The Home Depot, Inc.	PepsiCo, Inc.,
Johnson & Johnson	United Technologies Corporation,
The Kroger Co.	Walgreen Boots Alliance, Inc.
Lockheed Martin Corporation.	

The maximum payout for the TSR portion of the award is capped at 200% of target. If our TSR over the three-year measurement period is negative, even if it exceeds the median of the peer group, the maximum payout percentage for the TSR portion of LTIP awards is capped at 100% of target.

2018 LTIP Awards

The performance measures selected by the Compensation Committee for the 2018 LTIP awards are:

- Growth in Adjusted Consolidated Revenue;
- Adjusted Operating Return on Invested Capital ("ROIC"); and
- Relative Total Shareowner Return ("TSR").

Each goal is measured independently and applied equally in determining final payouts.

The Compensation Committee approved the following target values as a percent of base salary for the 2018 LTIP awards:

Executive Officers	LTIP Target (% Base Salary)	Base Salary
Chief Executive Officer	700	1,234,992
Chief Operating Officer	575	693,676
Chief Financial Officer	450	552,654
Chief Strategy Officer	450	613,500
Other executive officers	350	

Target values are based on internal pay comparison considerations and market data regarding total compensation of comparable positions at similarly sized companies. Differences in the target award values are based on increasing levels of responsibility among the executive officers.

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