Do peer firms influence innovation?*

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Abstract

Using a large sample of 4,545 US firms over the period 1968–2018 (i.e. 51,990 firm-year observations), we examine whether peer firms influence corporate innovation. We find robust and significant positive peer influence on both the decision and the amount of R&D spending. Consistent with the need to keep ahead or abreast of rivals, we find that peer influence on R&D increases with product market competition. There are significant leader–follower interactions with firms adopting the innovation policy of those perceived or likely to have superior information. These findings suggest that information theory is a dominant channel of peer effects. Importantly, adopting peers' innovation exhibit an inverted-U relationship with firm value, indicating that following rivals' R&D policy is beneficial up to a threshold for both firm value and performance. Beyond this threshold, peer effects reduce firm value and performance. Overall, we find evidence that peer effects are a critical determinant of corporate innovation in addition to other factors so far considered in the literature.

Keywords: Innovation, peer effects, product market competition, heterogeneity effects.

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1 Introduction

Research and development (hereafter R&D) has increased more than fourfold over the last three decades due to economic-wide shift from the manufacturing towards technology and service-based sectors.[1] This change is occurring against a backdrop of rapid technological advancement and intensified product market competition, which has further incentivised firms to innovate.[2] While the existing literature identifies several factors that drive R&D (see, Aghion et al., 2013; Atanassov, 2015; He and Wintoki, 2016), the interplay of industrial dynamics, more specifically, how peer firms influence R&D is an open empirical question. Yet, the literature on other corporate decisions, such as capital structure (Leary and Roberts, 2014; Francis et al., 2016), dividend policy (Adhikari and Agrawal, 2018; Grennan, 2019), cash holdings (Chen and Chang, 2012), and investment decisions (Frydman, 2015) show that peer effects matter. Motivated by this research gap, we examine whether peer effects matter for R&D or corporate innovation.[3]

However, it is not *a priori* clear whether a firm imitates its peers' R&D for two counteracting reasons. On the one hand, a firm has to monitor and respond to peer firms, in particular their investments in innovation, as this affects its competitive position. These far-reaching effects of innovation on the firm arises due to the ever-increasing pressure to reduce production costs, enhance growth, and competitiveness (see, Hart, 1983; Aghion et al., 2001, 2005). Hence, mimicking peer firms can be an effective way of achieving competitive parity or market dominance (Lieberman and Asaba, 2006). On the other hand, investments in R&D are irreversible, capital intensive, risky and require a

[1]For example, Borisova and Brown (2013) report that US young and mature firms recorded a fourfold and a twofold increase in R&D between 1980 and 2001, respectively. Similarly, Brown and Petersen (2011) note R&D increases of 2% over the period 1970–1981 compared to 6.3% between 1982 and 1993, and 10.3% from 1994 to 2006.

[2]According to Bates et al. (2009), the incentive to innovate in order to keep abreast of the competition is increasing over time.

[3]Throughout our paper, we interchangeably use the terms R&D and innovation.

significant commitment of resources over a long period, which should reduce or discourage imitation. Therefore, peer effects should be less pronounced for small or young firms relative to large and mature firms that can more readily absorb the risks and costs of undertaking innovation. Besides, the prohibitive costs of R&D expenditure can crowd it other firms from the industry or force them to pursue a different strategic path instead of following their peers. The above two opposing or counteracting forces make it unclear whether peer influence matters for corporate innovation.

In this paper, we examine whether peer firms influence corporate innovation using a large sample of 4,545 firms in the US over the period 1968–2018. Prior literature routinely controls for industrial influences using industry-fixed effects, which does not allow for an in-depth analysis of how and why peer effects might influence R&D (see, Brown et al., 2009, 2012; He and Wintoki, 2016). Using instrumental variable regressions, which address endogeneity concerns in line with Leary and Roberts (2014), we find significant peer influence on corporate innovation.[4] Specifically, a one standard deviation increase in peer firms' R&D spending produces, on average, a 1.108 increase in the log odds of investing in R&D. This average log odds translate into a 75% probability of a firm's R&D spending following peers' corporate innovation. Similarly, the average firm increases the amount spent on R&D by about 4% in response to a one standard deviation increase in peers' R&D. These findings show that peer firms significantly influence the focal firm's decision to invest in R&D and how much they spend.

We next examine whether or not firms mimic their peers to achieve competitive parity within the product market. Despite the prohibitive costs of innovation, firms that innovate can pull ahead of the competition. Hence, the rivalry theory emphasises that

[4]We estimate IV-Probit and IV-Tobit models to examine the decision to invest and the level of investment in R&D, respectively. For our instruments, we use the peer firms' idiosyncratic stock return shocks. Our results are robust to using both the peer firms' idiosyncratic stock return shocks and idiosyncratic stock return risk as instruments for the endogenous peer firms' R&D.

firms adopt similar policies of their successful rivals to catch up with competition (Lieberman and Asaba, 2006; Leary and Roberts, 2014). Thus, we predict that increasing R&D spending becomes critical for firms operating in more competitive markets. Using several alternative definitions of competition, we find results consistent with the hypothesis that peer effects on R&D increase in markets with competitive threats. Our results suggest that firms operating in markets with intense competition are more responsive to the R&D investments of their rivals. The results affirm the findings of Aghion et al. (2005) that direct competition only generates incremental profits for firms in neck-and-neck industries if they innovate. Our findings indicate that competition is an important channel through which peer firms affect both the decision to innovate and the amount spent on innovation.

We then explore heterogeneity effects driving how a firm responds to its peers. This analysis is premised on the information theory that firms tend to follow the policies of those that are perceived to possess superior information (Leary and Roberts, 2014; Adhikari and Agrawal, 2018). We conjure that the high-information asymmetry associated with R&D is likely to make mimicking unidirectional rather than bidirectional. Thus, we predict that mimicking is more pronounced for followers rather than leaders within a product market. To test this prediction, we classify firms as followers/leaders based on several firm characteristics, such as sales, profit margin, and analyst followings. We find significant heterogeneity in peer effects on R&D, firms reporting lower sales, profit margins and fewer analysts being more responsive to their peers than those reporting high sales, profit margins, and more analyst followings.

Our results further show that firms with lower sales and profit margins do not only respond to peers with similar characteristics but also to those reporting high sales and profit margins. We find a similar response to peers associated with firms that generate high sales, profit margins, and have more analyst followings. While we establish a bidirectional effect for both followers and leaders, our results indicate that the response to peer R&D spending is more pronounced for followers relative to leader firms. These results highlight the extent to which leaders perceived to possess superior information about the market influence the financial policy of their followers. By adopting the R&D policy of the leader peers, followers can avoid some of the risks associated with asymmetric information surrounding corporate innovation. Thus, our findings suggest that information theory, by which firms learn from those with superior information, dominate the peer effects associated with corporate innovation.

Finally, we explore whether the peer effects of innovation are beneficial or not for the focal firms. We run cross-section regressions and use the coefficient of peer firms' R&D to test the implications of peer effects on corporate outcomes. Using several measures of corporate outcomes, we find that peer effects of innovation increase firm value, the number and the value of patents, and firm risk. However, adopting the R&D spending of rivals might be detrimental to short-term firm performance. Importantly, the effects of innovation adoption show a non-linear inverted-U relationship and are different between crisis and non-crisis periods, suggesting that there is a limit to the beneficial impacts of R&D spending, beyond which firm value diminishes. Furthermore, in terms of follower–leader interactions, the benefits increase linearly when followers adopt the innovation of leaders up to a threshold and diminish beyond this point. The results are consistent with Fairhurst and Nam (2018), who argue that mimicking might be distracting especially during critical periods when firms experience shocks and lose focus on their core strategic direction.

This study is related to two strands of the literature. First, we contribute to the growing literature examining peer effects on corporate decisions. Prior studies find evidence of peer effects on capital structure (Leary and Roberts, 2014; Francis et al., 2016), dividend policy (Adhikari and Agrawal, 2018; Grennan, 2019), cash holdings (Chen and Chang, 2012), investment decisions (Frydman, 2015), and trade credit (Gyimah et al., 2018). Our paper examines whether peer effects matter for corporate innovation. Second, we provide evidence on the channels through which peer effects drive investment in R&D. The only paper exploring this phenomenon is a contemporaneous study by Bui et al. (2019). However, our paper differs from Bui et al. (2019) by exploring the channel of the peer effects and conclude that information theory dominates the feedback theory as the driver of peers effects. More importantly, our analyses establish non-linear beneficial effects of peer influence on corporate innovation as a whole and for the follower–leader interactions. We also show that the global financial crisis affects the implications of peer effects of corporate innovation.

Our analyses emphasise the prediction that peer effects matter for innovation. R&D is essential for the long-term survival of firms, providing a competitive edge to penetrate new markets to ensure sustained superior profitability. As such, we further show that factors such as competitive industry pressures and cash holdings moderate peer effects on innovation. For example, Aghion et al. (2005) argue that competition encourages innovation when firms are competing closely. Also, studies such as Brown and Petersen (2011), He and Wintoki (2016), and Acharya and Xu (2017) all argue that cash holdings positively affect investment in R&D. Our study not only affirms the significant role of competitive pressures and cash holdings in shaping a firm's innovation policies, but it also shows that these factors affect how a firm responds to its industry peers. This study asserts that peer effects explain innovation beyond the factors already examined in the literature.

The rest of our paper is organised as follows. Section 2 reviews the relevant literature and formulates the testable hypotheses. Section 3 describes the data, whereas Section 4 presents the methodology. Next, Section 5 presents and discusses the empirical results. Section 6 presents the robustness tests and Section 7 concludes the paper.

2 Related Literature and Hypotheses

Theory suggests that rational decision makers mimic successful rivals to avoid expending effort or search costs involved in finding the optimal solution. In other words, there is a herd behaviour associated with most economic decisions, especially during periods of uncertainty or market imperfections. Recent empirical studies document significant peer influence on corporate decisions. For example, Leary and Roberts (2014) and Francis et al. (2016) find significant peer effects on capital structure, whereas Adhikari and Agrawal (2018) and Grennan (2019) report similar peer effects on dividend policy. These studies show that peer firms significantly influence a firm's decisions beyond the factors so far examined in the literature.

Two main theories explain the imitation or mimicking phenomenon associated with corporate decisions. The rivalry theory posits that firms mimic their peers to limit competitive threats. Lieberman and Asaba (2006) argues the rivalry motive results in significant peer effects if firms compete in the same market, are of similar size and financial resources, and they operate in an uncertain information environment. On the other hand, the information theory asserts that firms imitate peers perceived to possess superior information. Several empirical studies find supporting evidence on the importance of information and competition in shaping how a firm responds to its peers (e.g., Leary and Roberts, 2014; Francis et al., 2016; Adhikari and Agrawal, 2018; Grennan, 2019). Against this background, we formulate and test the following hypothesis:-

Hypothesis 1 (H1): *Firms increase R&D in response to their industrial peers.*

The relationship between competition and innovation is not clear. Whereas theories in industrial organisation predict an inverse relationship (Schumpeter, 1947; Grossman and Helpman, 1991), the empirical evidence suggests that competition drives innovation (Nickell, 1996; Blundell et al., 1999; Aghion et al., 1999). Thus, there are two opposing arguments for the effects of competition on innovation. First, because competition destroys monopoly rents, firms will only innovate if they can appropriate the returns arising from innovation (Schumpeter, 1947). In other words, intense competition reduces the overall share of industrial profits discouraging firms from investing in R&D. Second, competition acts as a disciplinary tool that reduces managerial slack and encourages innovation and growth. In line with this reasoning, Aghion et al. (2005) argues that increased competition provides incentives for firms in neck-and-neck industries to invest in R&D as a way of "escaping competition".

The significance of valuable innovation is that it ensures sustained superior profits, especially when it serves new and unmet consumer demands (Roberts, 1999). Whereas firms can still achieve high profitability by avoiding competition, innovation provides the tool that facilitates the staunching of competitive pressures. This effect is especially true for firms operating in established industries, in which the first to introduce new innovation generates greater market share and profitability (Geroski et al., 1993; Banbury and Mitchell, 1995). These findings reinforce the importance of corporate innovation to business survival, with the increased competitive edge stemming from innovation bringing in new customers, generating new and increased sales and profitability, and cash holdings. Thus, innovation creates opportunities for growth and enhances the firm's competitive position.

Even though competition is a related concept to peer effect, the two concepts are significantly distinct (Bird et al., 2018). A firm derives its market power from its ability to influence product prices and the quality and nature of its products (Kubick et al., 2015). According to Aghion et al. (2005) and Lieberman and Asaba (2006), firms operating in industries with intense competition have more incentives to innovate to keep abreast with the competition and achieve competitive parity. This argument is consistent with Grossman and Helpman (1991) and Aghion et al. (1997), who assert that a firm must adopt a step-by-step innovation to achieve a similar status as the leaders before pursuing cost-leadership status in the future through increased innovation. Thus, faced with intense competition, firms innovate to pull ahead of the competition and generate incremental profits at the expense of non-innovating rivals (Aghion et al., 2001). As rivals innovate, the incentive to imitate peer firms' innovation to maintain competitive parity and preserve profit potential becomes larger. The effects of competitive pressures on innovation are subject to debate. Therefore, we test the hypothesis that competitive industry pressures drive firms to imitate their peers.

Hypothesis 2 (H2): *Peer effects on R&D increase with industrial competition.*

Why firms adopt the policies of their peers can be attributed to two main motives. First, the learning motive implies that firms learn from their successful rivals by following their policies (Scharfstein and Stein, 1990; Leary and Roberts, 2014). Second, the feedback theory, which is akin to the theory of predation, emphasises that firms with surplus cash adopt similar financial policies as their cash-constrained competitors to drive them out of business (Brander and Lewis, 1986; Bolton and Scharfstein, 1990). This channel of peer effects becomes apparent in a competitive industry, where there is an increased need to consolidate competitive positions. We consider *Leaders* as firms reporting high sales, profit margins, and more analyst followings. *Followers* are those firms generating relatively lower sales, profit margins, and fewer analyst followings. Thus, leader–firms can adopt the innovative policy of their followers to weaken competitive pressures. Whether or not a firm can imitate its peers might also depend on the financial capacity of the firm. The factors that limit a firms' investments in innovation include high costs, uncertain outcomes and significant moral hazard associated with innovation (Hall, 2010). However, empirical findings suggest that recent significant increases in cash holdings have culminated in increases in R&D (Bates et al., 2009; Falato and Sim, 2014; He and Wintoki, 2016). Thus, we derive our third hypothesis:

Hypothesis 3 (H3): *Followers are more likely to adopt the R&D policy of the leader-peer firms.*

The beneficial effects of corporate innovation on firm value have been explored in the literature. Innovation generates positive stock market response and firm growth (Kogan et al., 2017), and positively predict future stock returns (Hirshleifer et al., 2013, 2018; Mama, 2018). This positive predictive effect of innovation on stock returns stems from the post-innovation patent counts and citations. Ehie and Olibe (2010) argue that the positive effect of R&D investment on firm market value is more pronounced for firms in the manufacturing sector than those in the service sector. Thus, whether or not innovation proves beneficial might depend on the type of firm and its sector. For example, technology firms that depend on R&D for growth and competitive positioning might generate substantial benefits from innovation than would an otherwise non-technology firm. Kallunki et al. (2009) find that technology acquirers are more successful in converting their R&D spending into increase current market value and positive future profitability than non-technology acquirers.

However, whether or not firms adopt the R&D spending policy of their rivals for a strategic reason will depend on the subsequent corporate outcomes. Bui et al. (2019) establish a linear relationship between a firm's R&D spending and firm value and risk. This evidence suggests that there is no limit to the effect of innovation on corporate outcomes, contrary to Hartmann et al. (2006) who argue that R&D spending yields reward up to a cut-off point beyond which additional investment in innovation does not generate commensurate returns. In other words, there is a possible inverted-U relationship between corporate innovation and firm value. On the one hand, a firm may play safer or learn from more information when it pays more attention to its peers. On the other hand, it may neglect its information or competitive advantages, which may lead to its over- or under-investment. Mimicking peers innovation might redirect resources to over-invest in R&D and distract managers from focusing on their value-enhancing strategies (Fairhurst and Nam, 2018). Therefore, we test the implications of peer effects of corporate innovation on firm value.

Hypothesis 4 (H4): *There is a non-linear relationship between R&D investment and firm value.*

3 Data and summary statistics

3.1 Data

Our sample is drawn from the Compustat North America Database over the period 1968–2018. Data availability restricts the sample period of our analysis. We apply several filters to the data as is standard in the literature. We exclude firms in the utility, financial, and public sectors. We also exclude firms with negative equity, missing data on key Variables, and asset growth in excess of 100%. We winsorise all Variables at the upper and bottom 1% in order to reduce the effects of outliers. We augment our dataset with product market concentration, product similarity, and product fluidity data from Hoberg and Phillips's data library (see, Hoberg and Phillips, 2010, 2016; Hoberg et al., 2014).[5] These filtering results in 51,990 firm-year observations for 4,545 firms.

3.2 Variables

Our primary measure of innovation is R&D expenditure (He and Wintoki, 2016; Acharya and Xu, 2017) since it accounts for more than 50% of corporate innovation (Hall, 2010). According to Hall (2010) and Mairesse et al. (2005), R&D is the only measure of innovation that is frequently used over a long period of time, and has higher predictive

[5]The data is available from http://hobergphillips.usc.edu/industryconcen.htm

power for firm performance relative to other proxies. The R&D dummy (RDD) is equal to one if a firm reports R&D during a particular year and zero otherwise. Following He and Wintoki (2016), we define the ratio of R&D expenditure to total assets (RD/TA) as R&D intensity.

We use other alternative measures, R&D to net assets (RD/NA) and change in R&D to total assets ($\Delta RD/TA$). Since it is possible for firms to report some R&D expenditure in the item of selling, general and administrative expenses (SG&A), we measure R&D spending as the sum of R&D expenditure and SG&A (Banker et al., 2011; Lévesque et al., 2012). These alternative proxies (($RDSGA/TA$ and ($RDSGA/Sales$) are used to re-estimate the baseline results as robustness checks. In line with prior studies, we set R&D to zero for firms with missing R&D on their annual reports (Hirschey et al., 2012; He and Wintoki, 2016). We then estimate peer averages by defining peer firms as those that fall within the same three-digit SIC code, where three-digit SIC code is the definition of an industry. Several alternative definitions of the industry are used in the robustness tests. We describe in detail the construction of the other Variables used in Appendix A.

3.3 Summary statistics

Table 1 summarises the basic statistics for all Variables used and these are comparable to prior studies. Firms that invest in R&D constitute 77% (40,059) of the sample. The mean (median) RD/TA is 0.045 (0.000) and is within the ranges that are reported by Brown and Petersen (2011) and He and Wintoki (2016). The mean (median) of the control Variables; cash, market to book ratio (Mtbv), debt, size, and return on assets (ROA) are 0.152 (0.030), 1.685 (1.005), 0.193 (0.044), 5.620 (4.142) and 0.079 (0.051), respectively. The basic statistics for the other measures of research and development (R&D), RD/NA, $\Delta RD/TA$, $RDSGA/TA$, and $RDSGA/Sales$, and those of control Variables are in line with the literature.

PLEASE INSERT TABLE 1 HERE

PLEASE INSERT FIGURE 1 HERE

The time series plots in Figure 1 show that R&D (RD/TA) has been increasing from an average of 0.7% in the 1960s to a peak of 4.9% in the late 2000s, and thereafter, decreasing to 4.5% in the 2010s. This shows the increasing significance of R&D as a form of corporate investments (see, Brown et al., 2009; Borisova and Brown, 2013; Falato and Sim, 2014; He and Wintoki, 2016).

4 Methodology

4.1 Estimation model

We investigate peer effects on R&D using the baseline model of Leary and Roberts (2014), which is specified as follows:[6]

$$y_{ijt} = \alpha + \beta \overline{y}_{-ijt} + \gamma' \overline{X}_{-ijt-1} + \lambda' X_{ijt-1} + \phi' \nu_t + \epsilon_{ijt} \tag{1}$$

where Y_{ijt} is the either R&D or R&D dummy (RDD) for firm i in industry j at time t, α is a constant, β, γ' and λ' are the vectors of coefficients to be estimated, $\overline{y}_{-ijt}$ is peer firm average excluding firm i, $\overline{X}_{-ijt-1}$ and X_{ijt-1} are vectors of peer firm averages and firm-specific characteristics, respectively. ν_t are year fixed effects. Finally, ϵ_{ijt} is the firm-year specific error term. In line with Leary and Roberts (2014), we assume that ϵ_{ijt}

[6]Several other studies which examine peer effects on corporate decisions use the same model (see, among other, Chen and Chang, 2012; Francis et al., 2016; Bustamante and Frésard, 2017; Park et al., 2017; Adhikari and Agrawal, 2018).

is correlated within firms and heteroskedastic. The vectors $\overline{X}_{-ijt-1}$ and X_{-ijt-1} include cash, market-to-book, leverage, size and profit.[7] We estimate the empirical models using several approaches for robustness and to allow for comparisons with previous studies.

4.2 Instruments for 2SLS estimation

A potential endogeneity problem associated with studies of peer effects is the "reflection problem" (Manski, 1993). This problem arises due to the difficulty of disentangling the peer effects on R&D spending from common industry effects when the characteristics of the industry dictate individual corporate innovation policies. That is, endogeneity arises in an attempt to infer whether the average group behaviour influences the behaviour of an individual who belongs to the group. Leary and Roberts (2014) stress that this endogeneity issue also arises from the selection of firms into peer groups or an omitted common factor and identifying whether the response to peer effects operates through their actions or characteristics. We address the endogeneity concerns by estimating IV Probit and IV Tobit models using appropriate instruments. By dealing with endogeneity issues, we are better able to analyse the extent to which the actions stemming from peer firms' policy choices influence a focal firm's corporate innovation policy beyond the effects of the firm characteristics.

Following Leary and Roberts (2014), and Adhikari and Agrawal (2018), we use idiosyncratic stock returns and risks of peer firms as our instruments for IV Probit and IV Tobit estimations. The instruments are relevant for the following reasons. First, idiosyncratic stock returns and risks are unique to a specific firm, and as such, are less likely to affect the innovation decisions of an individual firm directly. Second, stock returns are widely available for all firms and are not easy to manipulate, unlike accounting-based

[7] These factors are informed by the literature (e.g., Aghion et al., 2004; Brown et al., 2009, 2012; Borisova and Brown, 2013; Brown and Petersen, 2015).

measures of performance.[8] Third, several studies find a significant relationship between innovation and stock returns (Hirshleifer et al., 2013; Gu, 2016; **?**). Hence, we estimate the likelihood and extent of the peer influence on R&D using the peer firms' idiosyncratic stock returns and risks as instruments.

We estimate the idiosyncratic stock returns and risks using the augmented Carhart (1997) model with four factors (size, book-to-market, and momentum) as follows:[9]

$$\begin{aligned} R_{ijt} =& \alpha_{ijt} + \beta_{ijt}^{M}(RM_t - RF_t) + \beta_{ijt}^{SMB} \times SMB_t + \beta_{ijt}^{HML} \times HML_t \\ &+ \beta_{ijt}^{MOM} \times MOM_t + \beta_{ijt}^{IND}(\overline{R}_{-ijt} - RF_t) + \eta_{ijt} \end{aligned} \tag{2}$$

where R_{ijt} is the total stock return for firm i in industry J over the month t, $RM_t - RF_t$ is the excess market return, SML_t is the size factor, HML_t is the book-to-market factor, MOM_t is the momentum factor, $\overline{R}_{-ijt} - RF_t$ is the excess return on an equally weighted industry portfolio (where the industry is defined at the three-digit SIC code), excluding firm i's return, and η_{ijt} is the error term.

We estimate Equation (2) on a rolling annual basis using monthly stock returns. At a minimum, we require that each firm should have at least 24 months of historical returns data and use up to 60 months of data for the estimations. Using the estimated coefficients from Equation (2) for the previous year (*t-1*) and the monthly factors returns for the current year (t), we use Equation (3) to compute the expected return and Equation

[8] This reduces concerns about the external validity and reliability of our empirical tests. While we do not claim that the instruments are the best possible for this estimation, we assert that the instruments are supported by the literature and have predictive power for corporate innovation.

[9] Our approach is in line with Adhikari and Agrawal (2018), who examine peer effects on dividends pay-out policies.

(4) for the idiosyncratic return and risk as follows:-

$$
\begin{aligned}
\textit{Expected Return} \equiv \widehat{R}_{ijt} = \widehat{\alpha}_{ijt} + \widehat{\beta}_{ijt}^{M}(RM_t - RF_t) + \widehat{\beta}_{ijt}^{SMB} \times SMB_t \\
+ \widehat{\beta}_{ijt}^{HML} \times HML_t + \widehat{\beta}_{ijt}^{MOM} \times MOM_t \\
+ \widehat{\beta}_{ijt}^{IND}(\overline{R}_{-ijt} - RF_t)
\end{aligned} \tag{3}
$$

$$
\textit{Idiosyncratic Return} \equiv \widehat{\eta}_{ijt} = R_{ijt} - \widehat{R}_{ijt} \tag{4}
$$

We compute the annual idiosyncratic return as the geometric average of the monthly idiosyncratic returns from Equation (4). Consistent with Adhikari and Agrawal (2018), the annual idiosyncratic risk is the standard deviation of the idiosyncratic returns from Equation (4). Our instruments, the average peer idiosyncratic return and average peer idiosyncratic risk, are calculated analogously as discussed above for the peer-firm averages in Equation (1).

PLEASE INSERT TABLE 2 HERE

Table 2 presents the summary statistics of the factor loadings estimated using Equation (3). The average (median) number of months for the regressions is 57 (60), and the R^2 is 0.343 (0.334). Consistent with Adhikari and Agrawal (2018), our factors load positively on the market (β_{ijt}^{M}), size (β_{ijt}^{SMB}), book-to-market (β_{ijt}^{HML}) and industry (β_{ijt}^{IND}), while they load negatively on momentum (β_{ijt}^{MOM}). The mean (median) β_{ijt}^{SMB} for our sample is 0.414 (0.359), which is relatively lower than 0.945 (0.922) for Adhikari and Agrawal (2018), but similar to Leary and Roberts (2014) who report 0.399 (0.422). All the other factor loadings are consistent with the literature.

We first discuss the model diagnostics as our results largely depend on the validity of our instruments. We conduct an overidentifying restrictions test and F tests to assess the appropriateness of the instruments. We include a formal test of the validity of the instruments using the Hansen's overidentification J test. According to the Hansen's J test, a small J-statistic indicate that instruments are valid and appropriate for the estimations (Sargan, 1958; Baum et al., 2007; Barth et al., 2013). For all our models in Table 3, the F-test is large and significant, and the significance of the Wald test of exogeneity differs across the models. Moreover, the reported J values are small in almost all the models, suggesting that the null is not rejected and the overidentification restrictions are valid. In short, the statistical tests provide sufficient confidence that our instruments deal with any potential endogeneity issue and significantly predict the peer average R&D. Hence, the instruments used in the estimations are valid insofar as the regression outputs explain our predictions in the paper. Hence, the IV Probit and IV Tobit regressions are robust estimations for our empirical analyses.

5 Empirical Results

5.1 Peer influence on corporate innovation

We first discuss our main results of peer effects on innovation, focusing on the coefficient of peer average R&D. In this section, we test Hypothesis 1 (H1), which posits that a firm's peers influence its R&D expenditure. Table 3 presents the IV Probit and Tobit estimations for the different specifications. The dependent variable is the R&D dummy (RDD) for Columns (1)–(6) and R&D expenditure (R&D) for Columns (7)–(12). The second stage regressions for IV Probit are given in Columns (2), (4), and (6), whereas those of the Tobit estimations are shown in Columns (8), (10), and (12). In our regressions, we control for both peer and firm-specific characteristics such as cash ratio, market-to-book ratio, debt, firm size, and return on assets. The literature informs our choice of the control Variables.

PLEASE INSERT TABLE 3 HERE

Columns (2), (4), and (6) of Table 3 show that the coefficient of peer average R&D is consistently positive and significant across the three different specifications. Specifically, the result in Column (2) (for the model excluding firm-factors and peer averages) suggests a 77% probability of investing in R&D in response to peer firms R&D. Similarly, Columns (4) and (6) show a 76% and 73% probability of investing in R&D even after controlling for firm-specific factors only, and both firm-specific factors and peer averages, respectively. Consistent with Hypothesis 1 (H1), the estimates suggest that industrial dynamics significantly influence the decision to initiate investments in R&D in addition to other factors so far examined in the literature.

Next, we examine peer effects on the amount invested in R&D. An analysis of peer influence on corporate innovation is interesting and important because R&D has now surpassed physical investments as economies are increasingly shifting from manufacturing to technology and services sectors. To accomplish the above objective, we estimate Tobit regressions in Columns (7)–(12) of Table 3 and interpret the results of the second stage regressions as shown in Columns (8), (10), and (12). The results show that, on average, peer influence increases R&D expenditure between 3% and 5%. These significant and positive peer effects are in line with Hypothesis 1 (H1) and corroborate studies documenting significant peer influence on other corporate decisions (Chen and Chang, 2012; Francis et al., 2016; Bustamante and Frésard, 2017; Park et al., 2017; Adhikari and Agrawal, 2018, e.g.,). The peer effects that we document are particularly significant due to the unique features of R&D - high irreversibility, information asymmetry and asset substitution concerns, and long investment horizons and low-collateral values - that makes it difficult or less desirable for firms to mimic.[10] We conclude that our results provide more rigorous tests and stronger evidence of peer influence on corporate decisions.

We find that other peer average factors have a lower or insignificant effect on the likelihood of the firm investing in R&D, except for peer-size, which is negative. However, on RD/TA, we find that the peer averages are significant and of the opposite sign compared to the firm-specific factors. We further find that the coefficients of cash, market-to-book ratio, and size are consistently significant and positively related to RDD and RD/TA. The effect of cash and market-to-book ratio on RD/TA is in line with Brown et al. (2009, 2012) and Borisova and Brown (2013), who find that most of the R&D is attributable to cash-rich and high-growth firms. Similarly, Brown and Petersen (2011) finds that firms tend to hoard cash to smooth the R&D expenditure. Recently, He and Wintoki (2016) also links the increase in cash holdings to the surge in R&D. These studies collectively show that cash and R&D are positively correlated in line with Table 3. We find that debt and profitability are negatively correlated with RDD and RD/TA as is consistent with prior literature (e.g., Hall, 2002; Hall et al., 2009; Aghion et al., 2004; Hall and Lerner, 2010). For brevity, we do not further discuss the results on control Variables as they are of the expected sign, magnitude and in line with the literature.

To summarise, we find that peer effects significantly influence both the probability and amount invested in R&D. These findings suggest that peer effects documented in the literature on other corporate decisions also influence corporate innovation beyond the traditional determinants.

[10] These unique or special features of R&D investments are well documented in the literature (see, Brown et al., 2009; Brown and Petersen, 2011; Borisova and Brown, 2013).

5.2 Competition and peer firm effects on corporate innovation

In this section, we test Hypothesis 2 (H2), which posits that peer influence on R&D increases with product market competition. Hypothesis 2 (H2) is premised on (Hart, 1983) and Aghion et al. (1999), who contend that competition drives innovation by acting as a disciplinary tool that spurs managerial action. According to Aghion et al. (2001), firms innovate to keep abreast of competition and enhance their growth prospects in highly competitive product markets. This implies that peer firm influence increases with competition. However, the traditional Schumpeterian model posits that competition harms innovation as it decimates monopoly rents (Schumpeter, 1947; Hart, 1983; Grossman and Helpman, 1991; Aghion et al., 1999). Following on this prediction, peer influence should decrease rather than increase with competition. Against this background, it is not clear how competitive threats moderate peer influence.

To examine the above opposing predictions, we partition the sample into high (low) competition in each year based on whether the firm is below (above) the median Herfindahl–Hirschman index (Herfindahl index), Concentration index, and Lerner index. Similar proxies and approaches were used by Giroud and Mueller (2011) and Adhikari and Agrawal (2018) to examine the effects of product market competition on equity prices and peer effects on dividends, respectively. Using this approach enables us to test Hypothesis 2 (H2), which is premised on the predictions of the rivalry theory that firms respond by matching or exceeding their peers in order to maintain or enhance competitive positions in the product market (Lieberman and Asaba, 2006). Table 4 summarises the results.

PLEASE INSERT TABLE 4 HERE

Column (1) and (2), which are for sub-samples based on the Herfindahl index of assets (HHI-Assets), show that peer effects on R&D are more pronounced and significant for firms in very competitive markets (low HHI-Assets) relative to those in less competitive markets (high HHI-Assets). Specifically, we find that the average firm in very competitive industries increases R&D investments by 5% for a one standard deviation increase in peer firms' R&D. This effect is statistically and economically significant at 1%. We find a similar response based on the Herfindahl index of sales (HHI-Sales), with peer effect of innovation in competitive industries (low HHI-Sales) increasing by 5% for a one standard deviation increase in peer firms' R&D. However, we do also find a significant peer influence for firms in less-competitive markets (an average increase of 2.5%) with a positive coefficient for peer firms' R&D. The χ^2 statistic for the difference in the coefficients for low and high HH–Assets and HHI-Sales are respectively 4.51 and 32.80. This indicates that even though the coefficients of peer firms' R&D are positive and significant for both sub-samples, the coefficients are indeed statistically different. These differences suggest that mimicking peer firms is most beneficial for firms in highly competitive markets. This result collaborates Aghion et al. (2001) and (Aghion et al., 2005) who find a positive link between product-market competition and corporate innovation. Our results extend these prior studies by showing that product market competition not only motivates firms to innovate but also to follow peer firms so as to remain competitive.

Next, we use alternative measures of competition, such as the Concentration index and the Lerner index to test the robustness of our results to using alternative proxies of product market competition. Further comparisons using the Concentration index (Columns 5 and 6) and the Lerner index (Columns 7 and 8) show similar differences (as those based on the Herfindahl index), with peer effects being more pronounced for firms in more competitive industries relative to those in less-competitive industries. Specifically, the coefficient of peer average R&D is positive and significant at the 1% level in Column (5) for high-competition and in Column (6) for low-competition. Again, the χ^2 statistic of 18.69 indicates the coefficients are statistically different between high and low competition. Even though the coefficients of peer average R&D are positive for both high-competition (Column 7) and low-competition (Column 8) based on the Lerner index, the magnitude of the coefficient is higher for firms subject to high-competition relative to those that face low-competition. Based on this analysis, we conclude that our results are robust to how we measure or define market competition.

Overall, our results suggest that peer effects increase (decrease) with product market competition (concentration). This confirms the predictions of the rivalry theory (Lieberman and Asaba, 2006), which posits that mimicking increases with product market competition. For R&D, matching or exceeding peer firms is important for two reasons. First, technological laggards need to catch up with the leaders and enhance their profitability (Aghion et al., 2001, 2005). Second, innovation reduces production costs and avert potential liquidation for firms operating in highly competitive industries (Nickell, 1996; Blundell et al., 1999). Moreover, innovation allows firms to avoid competitive pressures and generate sustained superior profitability. Thus, in line with our predictions in Hypothesis 2 (H2), firms are more responsive to their peers when they face high product market competition.

5.3 Which firms are mimicked?

For our final analysis, we test Hypothesis 3 (H3) predicting that firms subject to information asymmetry mimic those perceived to have superior information. This hypothesis is based on the information theory and implies significant heterogeneity in how firms respond to their peers. To test this prediction, we use three firm-specific variables (sales, profit margins and analyst coverage) that are widely used to proxy for information asymmetry (see, Leary and Roberts, 2014; Bustamante and Frésard, 2017; Adhikari and Agrawal, 2018). Thus, firms are defined as *Followers* if they report low sales, profit margins, and few analysts, whereas *Leaders* generate high sales, profit margins, and greater analysts coverage. We define low (high) sales, low (high) profit margins, and low (high) analyst followings for firms reporting below (above) the median sales, profit margin, and analyst followings in each year, respectively. Following the information theory, we expect *Followers* (*Leaders*) to be more (less) responsive to their peers. Table 5 summarises the results estimating Equation (1) for the sub-samples. In Columns (1)–(4), (5)–(8), and (9)–(12), we examine whether sales, profit margin, and analyst followings influence how a firm responds to its peers, respectively.

PLEASE INSERT TABLE 5 HERE

Table 5 shows significant heterogeneity in peer influence. The results show that a firm is not only influenced by peers within its sub-group based on sales, profit margin and analyst following, but also by the peers in the other sub-groups. For example, in Column (1), a firm with low sales increases R&D by 6% in response to low sales peer firms (those within its sales group), while it also increases R&D by 3% (Column 2) in response to high sales peers. In Columns (3) - (12), we observe similar bidirectional responses for cohorts based on sales, profit margins and analyst followings, with high sales, profit margins, and analyst followings firms having more effects on their low sales, profit margins and analyst coverage peers. These asymmetric and bidirectional cross-cohort peer effects, which are on average relatively higher for *Followers* than (*Leaders*), are in line with the information-based theory. The results are also consistent with the feedback theory by which leaders copy the policy of their followers to undercut and drive them out of business. This predatory response to follower peers policy undermines any strategic inroads to dampen competitive pressures in the market. Thus, firms with low sales, profit margins, and few analysts are not only more responsive to peers within their sub-groups, but also to peers in other sub-groups perceived to have superior information.

The reported χ^2 statistics suggest that the coefficients between the different cohorts are statistically different from one another.

To summarise, our results show that peer effects are bidirectional and asymmetric between cohorts or subgroups. The incentive to innovate is higher for follower firms which are still seeking to establish themselves within the product markets. As our results show, peer influence significantly drives innovation in addition to other factors identified in the literature.

5.4 The implications of mimicking corporate innovation

While the previous sections show significant peer effects, it remains an empirical question of whether peer effects on innovation are beneficial or not. Hypothesis 4 (H4) tests the prediction about the implications of peer effects of corporate innovation. We estimate the following models to tackle this under-research yet important area as peer effects amplify firm-specific shocks across and within industries:

$$y_{ijt} = \lambda_0 + \lambda_1 \overline{RD/TA}_{-ijt-1} + \boldsymbol{\theta} \boldsymbol{Z}_{ijkt-1} + \mu_j + \mu_t + \xi_{ijt} \tag{5}$$

$$y_{ijt} = \lambda_0 + \lambda_1 \overline{RD/TA}_{-ijt-1} + \lambda_2 \overline{RD/TA}^2_{-ijt-1} + \boldsymbol{\theta} \boldsymbol{Z}_{ijkt-1} + \mu_j + \mu_t + \xi_{ijt} \tag{6}$$

where y_{ijkt} is corporate outcome (firm value and performance, patents counts and value, citations, product similarity and fluidity) of firm i in industry j at time t, λ_0 is a constant. λ_1, λ_2 and $\boldsymbol{\theta}$ are the vectors of coefficients to be estimated. $\overline{RD/TA}_{-ijt-1}$ and $\overline{RD/TA}^2_{-ijt-1}$ are the lagged peer effects and squared term of the lagged peer effects, respectively. $\boldsymbol{Z}_{ijkt-1}$ is a vector of lagged sales growth (*Sales Growth*), cash (*Cash*), debt (*Debt*), property, plant and equipment (*PPE*), firm-size (*Size*) and the logarithm of firm-age (*LogAge*). μ_k and μ_t are industry and year-fixed effects, respectively. Finally, ξ_{ijkt} is the error term. Table 6 summarises the results for the multivariate analyses of the implications of mimicking peer firms.

PLEASE INSERT TABLE 6 HERE

Table 6 presents the estimates of the implications of mimicking on stock market valuation using Tobin's q (Q) and market value divided by equity (QE), firm performance (ROE), risk, innovation outputs, such as patent counts (LOGPATS) and patent value (LOGTCW and LOGTSM), market concentration (CONCE), novelty of products (SIMILARITY and FLUIDITY). Innovation output data is extracted from the website of Kogan et al. (2017).[11] LOGPATS is the log of the number of patent counts, LOGTCW is the citation-weighted value of patents, and LOGTSM is the stock market value of patents. Product novelty is the Hoberg and Phillips (2016) measure of product similarity.

Panel A shows the results after estimating Equation (5) of the linear relationship between R&D spending and corporate outcomes. We find that mimicking R&D has a significant positive effect on corporate outcomes, such as on stock market value (Q and QE), risk, innovation outputs, and product novelty. The results indicate a positive stock market response to news about patents as a result of innovation. The results underscore the argument that current managerial decisions regarding R&D investment can create future opportunities that influence the viability, growth, and competitiveness of an organisation in future periods (Morbey, 1988; Ehie and Olibe, 2010). Moreover, Kallunki et al. (2009) find positive effects of R&D spending on stock valuation following technology-oriented M&As. Innovation is also associated with positive increases in patent counts, patent value and product novelty. This result indicates that innovation

[11] Data is available from https://iu.app.box.com/v/patents and the NBER website at https://data.nber.org/patents/

portends future firm growth stemming from the economic value associated with R&D investment (Harford, 1999; Cockburn and MacGarvie, 2011; Kogan et al., 2017). However, the positive and negative coefficients of $\overline{RD/TA}$ in Columns (3) and (4), respectively, indicate that following a rival's innovation policy increases risk but does not generate immediate superior performance. Thus, peer effects of innovation lower current earnings and exacerbate firm risks. These results are largely in line with Bui et al. (2019), who report value-enhancing effects of peer influence on corporate innovation.

In Panel B, we further extend the analysis by examining whether mimicking is non-linear. Hartmann et al. (2006) argue that R&D spending does not necessarily generate benefits as there must be some threshold beyond which investing does not yield proportional rewards. In other words, there is an inverted-U relationship between R&D expenditure and firm value. For this analysis, we estimate Equation (6), which includes a squared term of the lagged peer effects ($\overline{RD/TA}^2_{-ijt-1}$). The negative coefficients of $\overline{RD/TA}^2_{-ijt-1}$ for firm value (Q, QE, LOGPATS, LOGTCW, and LOGTSM) show that our results exhibit significant non-linearities; that is mimicking is beneficial up to a threshold for firm value and performance. Beyond the threshold, mimicking is detrimental as it reduces firm value and performance. We interpret this result as consistent with Fairhurst and Nam (2018), who find that mimicking is distracting especially during critical periods when firms experience a significant shock as mimickers will be less focused on their own fundamentals.

In Figure 2, we also examine whether firms mimic for constructive reasons. To accomplish this objective, we sub-divide firms based on the median within each industry-year and compare the results across the sub-groups. We then plot the margins for the effect of peer firms on corporate outcomes from $follower - leader$ sub-samples formed based on LogSales, Gross Profit and Analyst Followings. This analysis builds on Panel B of Table 6 and Table 5, which document the implications of peer effects and the $follower - leader$

interactions associated with peer effects of innovation, respectively.

INSERT FIGURE 2 HERE

The plots reveal several interesting patterns on the implications of responding to peer firms: (1) the benefit of mimicking appear to increase linearly not only if *follower* firms mimic firms in a similar cohort, but also when they mimic *leader* firms and (2) mimicking is only beneficial up to a maxima, beyond which it diminishes for *leader* firms irrespective of whether they respond to *follower* firms or counterparts of a similar size. We link the diminishing benefits of mimicking beyond the maxima to the adverse effects of the prohibitive costs of R&D intensity. Moreover, the intensity of the mimicking behaviour might prove counterproductive with mounting costs and diversion of resources that would otherwise be used to undertake other value-enhancing core business of the firm.

Finally, the timing of R&D expenditure, including adopting the innovation of rivals, explain the impact on firm value. Figure 3 shows that firm value increases more during pre-crisis period compared to crisis-period. This effect is consistent using both research and development (RD/TA) and selling, general and administrative expenses adjusted R&D measure ($RDSGA/TA$). In summary, these further analyses show two important implications of mimicking: (1) mimicking peers' R&D is beneficial in good states as it reduces the search costs involved when firms want to optimise their decisions, and (2) it could lead to sub-optimal decisions in bad states due to diverted attention as mimickers are likely to focus more on the activities of rival firms rather than their own fundamentals. These findings offer several new empirical insights on an unexplored question of whether and the extent to which peer effects are beneficial to firms.

6 Robustness

We implement several robustness tests. First, we re-examine our main results using five sub-samples based on broad industrial sector categorisations namely; Others (industries except mining and manufacturing), mining (1000 $\leq$ SIC code $\leq$ 1499), manufacturing (2000 $\leq$ SIC code $\leq$ 3999), durables (2400 $\leq$ SIC code $\leq$ 2500 and 3200 $\leq$ SIC code $\leq$ 3800) and non-durables (2000 $\leq$ SIC code $\leq$ 2300 and 2600 $\leq$ SIC code $\leq$ 3100). Table 7 presents the results estimating Equation (1) for the five sub-samples.

PLEASE INSERT TABLE 7 HERE

The results in Columns (1)–(10) of Table 7 show that peer effects vary significantly across the four main industrial sectors. In Columns (1) and (2), we find that peer influence on R&D is significant for firms in the manufacturing sector, but not for those in the non-manufacturing sectors. This result is consistent with Figure A.1, which shows similar differences with firms in the manufacturing (durables) sectors having significantly higher R&D than those in the non-manufacturing (non-durables) sectors, except for Figure A.1e. Overall, the results for the sub-samples are qualitatively similar to our main findings in Table 4.

PLEASE INSERT TABLE 8 HERE

In order to address concerns that our results may be driven by how we measure corporate innovation and classify firms into industries, we re-estimate our baseline model using four other definitions: R&D to net assets (RD/NA), a change in R&D to total assets ($\Delta RD/TA$), and the sum of R&D and selling, general and administrative expenses SG&A to total assets ($RDSGA/TA$), to sales ($RDSGA/Sales$). Using the summation of R&D and SG&A addresses the concern that some firms attempt to hide their R&D

expenses by reporting it as part of selling, general and administrative expenses (Banker et al., 2011; Lévesque et al., 2012). Consistent with Table 3, the results in Table 8 show that peer effects are significant across the different definitions of innovation. Our results hold in the alternative definitions of innovation, highlighting the prediction that peer innovation has a significant influence on the R&D spending of the focal firms.

PLEASE INSERT TABLE 9 HERE

In addition to using the three-digit SIC code as the primary definition of an industry, we perform several analyses with six alternative definitions of an industry. Specifically, an industry is defined using the one-digit SIC code (SIC1), two-digit SIC code (SIC2), Fama and French 48 industrial classifications (FF48), the North America Industry Classification System (NAICS), FC100, and FC200. Similarly, Table 9 shows that our results are robust to changing the level or way we define an industry. Based on these tests, we conclude that our results are robust to using different methods of selecting peers, sub-sampling, and defining corporate innovation, and the choice of the estimation technique.

7 Conclusion

We extend the literature on peer effects on corporate decisions by examining whether peer firms influence corporate innovation in the US over the past five decades. This period is interesting as it is marked by a surge in R&D to levels that exceed physical or tangible investments. To the best of our knowledge, we make the first attempt at testing whether peer effects matter for corporate innovation. We argue that focusing on peer effects on corporate innovation provides sharper tests as mimicking is difficult or less desirable given that corporate innovation is susceptible to high-asymmetric information problems, asset substitution issues, low-collateral values, irreversibility and long-investment horizons.

Our results, which are robust to a battery of tests, suggest that peer effects matter for corporate innovation. Specifically, we find that firms are more responsive to peers in highly competitive product markets. More important, firms learn from one another in defining their corporate policy choices. The information theory underpins such a learning process by which firms follow peers that are perceived to have superior information about the market. Even though we find bidirectional peer effects, the analyses emphasise that *leaders* more significantly influence their *followers* compared to the effects of *followers* on their *leaders*.

The empirical analysis explores the implications of peer effects of innovation on corporate outcomes. There is evidence that adopting the innovation policy of rivals can generate increases in market value and innovation outputs. However, we find a limit to this beneficial effects of R&D spending on corporate outcomes. Thus, the non-linear relationship between mimicking R&D and measures of firm value indicates that mimicking becomes sub-optimal beyond a cut-off point. Finally, the post-R&D effects on firm value also depend on the timing; it pays off during non-crisis periods compared to a crisis period. Overall, our findings suggest that peer influence is an important determinant of corporate innovation in addition to other factors so far considered in the literature. The intensity of such a mimicking strategy needs to be tempered to derive optimum benefits. This highlights the need for future research on the drivers of mimicking behaviour in corporate decisions.

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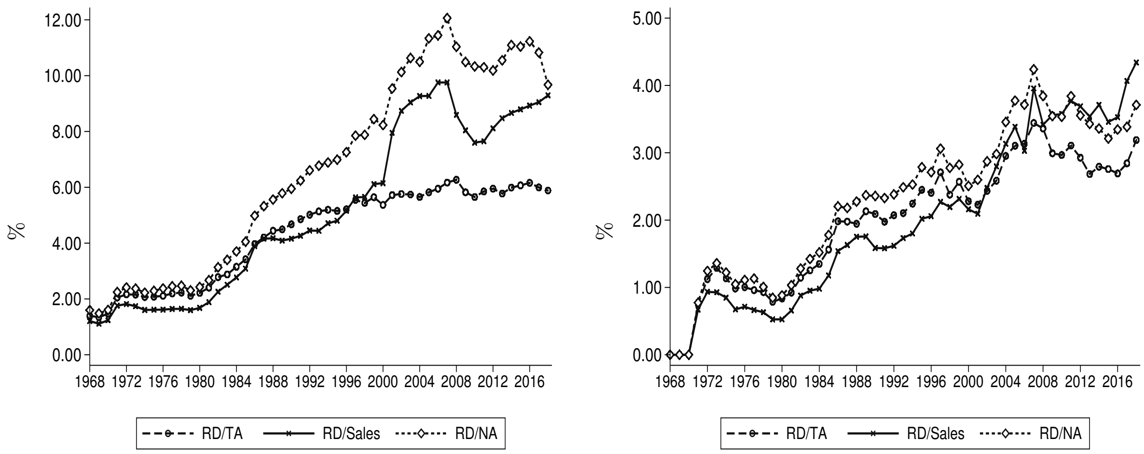
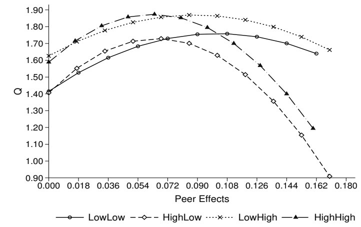


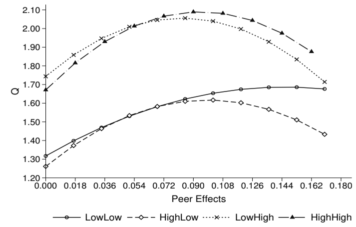
(a) Mean　　**(b)** Median

Figure 1: Time variations in corporate innovation

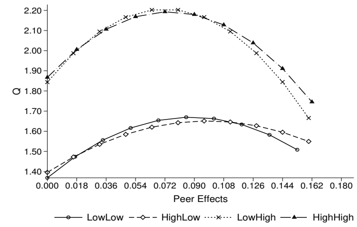
The figure plots the mean RD/TA, RD/Sales and RD/NA over the sample period. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.



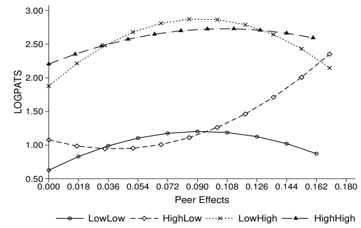
(a) LogSales



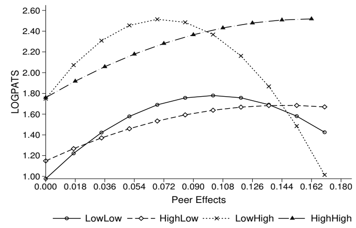
(b) Profit Margin



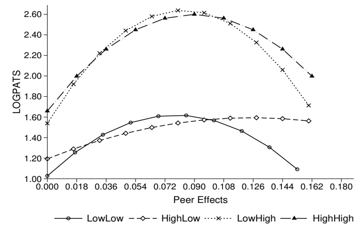
(c) Analyst Followings



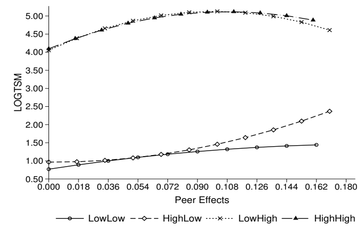
(d) LogSales



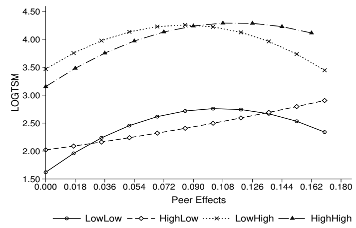
(e) Profit Margin



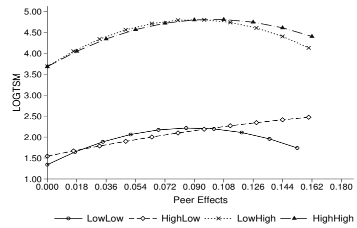
(f) Analyst Followings



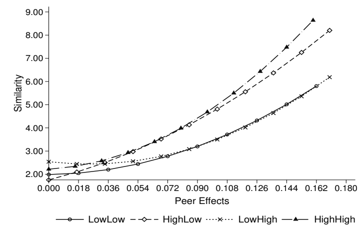
(g) LogSales



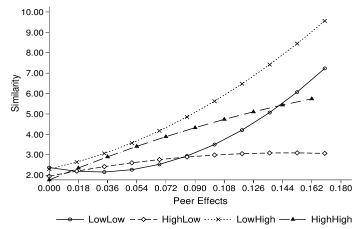
(h) Profit Margin



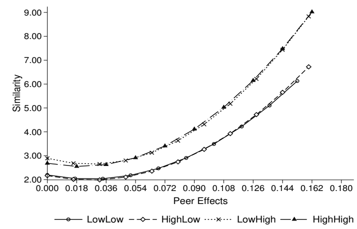
(i) Analyst Followings



(j) LogSales



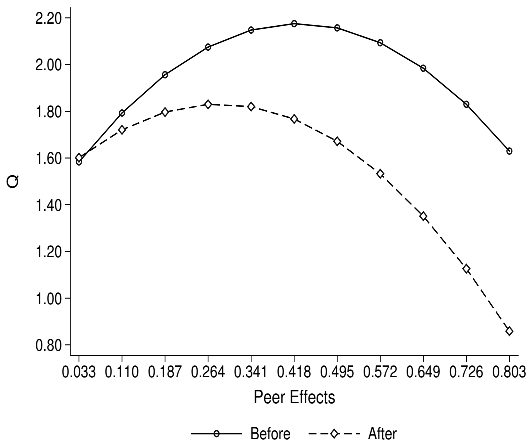
(k) Profit Margin



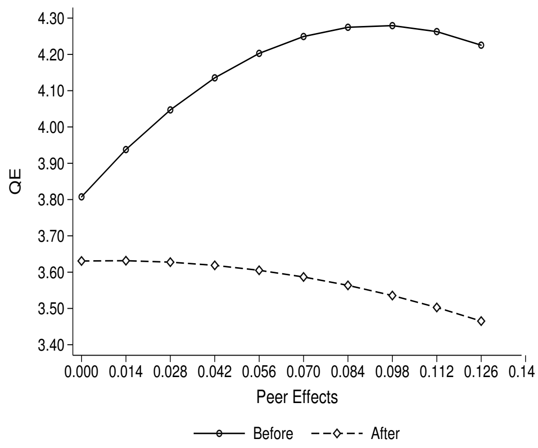
(l) Analyst Followings

Figure 2: The implications of responding to peer firms

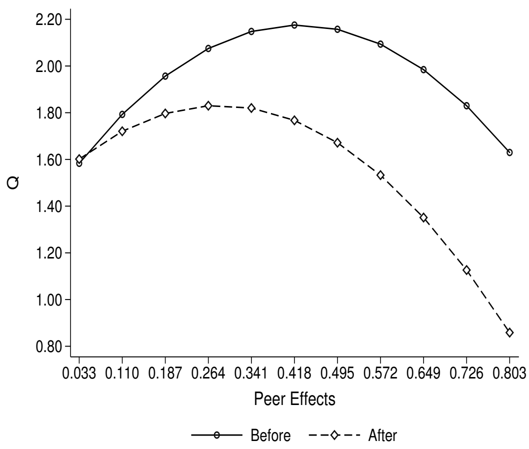
The figure plots the marginal effects of peer firms on corporate outcomes. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. The broad industrial sector categorisations are defined as follows: non-manufacturing (SIC code < 2000 and SIC code > 3999); manufacturing (2000 ≤ SIC code ≤ 3999); durables (2400 ≤ SIC code ≤ 2500 and 3200 ≤ SIC code ≤ 3800); and non-durables (2000 ≤ SIC code ≤ 2300 and 2600 ≤ SIC code ≤ 3100). All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.



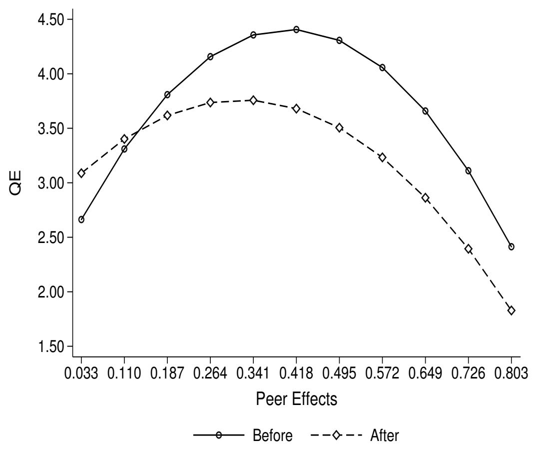
(a) Q-$\overline{RD/TA}$



(b) QE-$\overline{RD/TA}$



(c) Q-$\overline{RDSGA/TA}$



(d) QE-$\overline{RDSGA/TA}$

Figure 3: Peer effects and firm value during the crisis

The figure plots the marginal effects of peer firms on firm value during the Global Financial Crisis. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.

Table 1: Basic statistics

The table presents the summary statistics for all the variables used. The firm-specific characteristics are defined as follows: *RDD* is the research and development dummy, *RD/TA* is research and development to total assets, *RD/NA* is research and development to net assets, $\Delta RD/TA$ is change in research and development to total assets, *RDSGA/TA* is research and development plus selling, general and administrative expenses to total assets, and *RDSGA/Sales* is research and development plus selling, general and administrative expenses to total sales. *Cash* is cash and cash equivalent, *Mtbv* is market to book ratio, *Debt* is total debt, *Size* is log of total assets, *ROA* is return on assets, *EShock* is equity shock, and *ERisk* is equity risk. The peer firms' average characteristics are calculated as the average of all firms within an industry-year, excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.

Variables	Mean	SD	Min	p25	Median	p75	Max
Firm factors							
RDD	0.647	0.478	0.000	1.000	0.000	1.000	1.000
RD/TA	0.045	0.065	0.000	0.019	0.000	0.067	0.529
RD/NA	0.069	0.132	0.000	0.021	0.000	0.084	1.580
$\Delta RD/TA$	0.001	0.020	-0.135	0.000	-0.001	0.002	0.167
RDSGA/TA	0.355	0.264	0.000	0.301	0.166	0.476	1.623
RDSGA/Sales	0.325	0.275	0.000	0.252	0.145	0.433	2.966
Cash	0.152	0.167	0.000	0.086	0.030	0.219	0.822
Mtbv	1.685	1.128	0.413	1.329	1.005	1.931	12.485
Debt	0.193	0.161	0.000	0.177	0.044	0.301	0.729
Size	5.620	2.006	0.952	5.460	4.142	6.918	11.716
ROA	0.079	0.102	-0.641	0.093	0.051	0.133	0.324
EShock	-0.010	0.044	-0.247	-0.008	-0.033	0.015	0.166
ERisk	0.122	0.071	0.025	0.104	0.073	0.150	0.668
Peer averages							
$\overline{RDD}$	0.647	0.323	0.000	0.759	0.357	0.922	1.000
$\overline{RD/TA}$	0.045	0.040	0.000	0.030	0.007	0.081	0.139
$\overline{RD/NA}$	0.069	0.071	0.000	0.036	0.008	0.124	0.366
$\overline{\Delta RD/TA}$	0.001	0.004	-0.020	0.000	-0.001	0.002	0.021
$\overline{\Delta RDSGA/TA}$	0.355	0.158	0.017	0.373	0.235	0.464	0.861
$\overline{\Delta RDSGA/Sales}$	0.325	0.173	0.021	0.282	0.180	0.464	0.919
$\overline{Cash}$	0.152	0.091	0.012	0.122	0.078	0.213	0.384
$\overline{Mtbv}$	1.679	0.543	0.562	1.577	1.277	2.006	4.456
$\overline{Debt}$	0.194	0.073	0.030	0.192	0.138	0.243	0.522
$\overline{Size}$	5.590	0.914	3.401	5.523	4.920	6.198	9.037
$\overline{ROA}$	0.077	0.035	-0.140	0.079	0.055	0.101	0.194
$\overline{EShock}$	-0.010	0.010	-0.069	-0.010	-0.016	-0.004	0.038
$\overline{ERisk}$	0.122	0.034	0.050	0.115	0.098	0.141	0.278
N	51,990						
Industries	74						
Firms	4,545						
$RDD = 1$ *N*	33,663						
$RDD = 1$ *Firms*	3,027						
$RDD = 0$ *N*	18,327						
$RDD = 0$ *Firms*	1,518						

Table 2: Stock return regressions

The table presents the summary statistics of the estimation results of the following model:-

$$R_{ijt} = \alpha_{ijt} + \beta_{ijt}^{M}(RM_t - RF_t) + \beta_{ijt}^{SMB} \times SMB_t + \beta_{ijt}^{HML} \times HML_t + \beta_{ijt}^{MOM} \times MOM_t + \beta_{ijt}^{IND}(\overline{R}_{-ijt} - RF_t) + \eta_{ijt} \quad (2)$$

where R_{ijt} is the total stock return for firm i in industry J over the month t, $RM_t - RF_t$ is the excess market return, SML_t is the size factor, HML_t is the book-to-market factor, MOM_t is the momentum factor, $\overline{R}_{-ijt} - RF_t$ is the excess return on an equally weighted industry portfolio (where the industry is defined at the three-digit SIC code), excluding firm i's return, and η_{ijt} is the error term.

Equation (3) is estimated on a rolling annual basis using monthly returns. At a minimum, each firm is required to have at least 24 months of historical returns data and up to 60 months of data is used for the estimations. Equation (3) is then used to compute the idiosyncratic return and risk using the estimated coefficients from Equation (3) for the previous year (*t-1*) and the monthly factors returns for the current year (*t*) as follows:-

$$\textit{Expected Return} \equiv \widehat{R}_{ijt} = \widehat{\alpha}_{ijt} + \widehat{\beta}_{ijt}^{M}(RM_t - RF_t) + \widehat{\beta}_{ijt}^{SMB} \times SMB_t + \widehat{\beta}_{ijt}^{HML} \times HML_t + \widehat{\beta}_{ijt}^{MOM} \times MOM_t + \widehat{\beta}_{ijt}^{IND}(\overline{R}_{-ijt} - RF_t) \quad (3)$$

$$\textit{Idiosyncratic Return} \equiv \widehat{\eta}_{ijt} = R_{ijt} - \widehat{R}_{ijt} \quad (4)$$

The annual idiosyncratic return is calculated by taking the geometric average of the monthly idiosyncratic returns from Equation (4). Consistent with Adhikari and Agrawal (2018), the annual idiosyncratic risk is calculated as the standard deviation of the idiosyncratic returns from Equation (4). The instruments which are the average peer idiosyncratic return and risk, are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.

Variables	Mean	Median	SD
$\widehat{\alpha}_{ijt}$	0.007	0.006	0.019
$\widehat{\beta}_{ijt}^{M}$	0.476	0.515	1.055
$\widehat{\beta}_{ijt}^{SMB}$	0.414	0.359	1.295
$\widehat{\beta}_{ijt}^{HML}$	0.047	0.051	1.076
$\widehat{\beta}_{ijt}^{MOM}$	-0.048	-0.032	0.734
$\widehat{\beta}_{ijt}^{IND}$	0.510	0.431	0.845
Obs per Regression	57	60	8
R^2	0.343	0.334	0.166
Monthly Return	0.049	0.023	0.180
Expected Monthly Return	0.016	0.015	0.036
Idiosyncratic Monthly Return	-0.001	-0.002	0.048

Table 3: The effect of peer firms on corporate innovation

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variable in Columns (1)–(6) for the IV Probit estimation, RDD, is a dummy variable equals 1 if a firm has R&D and 0 otherwise. In Columns (7)–(12) for the IV Tobit model, the dependent variable, RD/TA, is the firm's R&D to total assets. The independent peer firms' average firm characteristics are defined as follows: $\overline{RDD}$ is a dummy for peer R&D equals 1 if the average peer firms has R&D and 0 otherwise and $\overline{RD/TA}$, is the average peer firms' R&D to total assets. The other peer control Variables are as follows: $\overline{Cash}$ is lagged peer cash and cash equivalent to total assets, $\overline{Mtbv}$ is lagged peer market-to-book ratio, $\overline{Debt}$ is lagged peer debt to total assets, $\overline{Size}$ is lagged peer size (logarithm of total assets), and $\overline{ROA}$ is lagged peer profitability (earnings before interest and tax to total assets). The firm-specific characteristics are defined as follows: $Cash$ is lagged cash and cash equivalent to total assets, $Mtbv$ is lagged market-to-book ratio, $Debt$ is lagged debt to total assets, $Size$ is lagged size (logarithm of total assets), ROA is lagged profitability (earnings before interest and tax to total assets), and $EShock$ is the lagged idiosyncratic stock returns. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	IVProbit						IVTobit					
	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
	$\overline{RDD}$	RDD	$\overline{RDD}$	RDD	$\overline{RDD}$	RDD	$\overline{RD/TA}$	RD/TA	$\overline{RD/TA}$	RD/TA	$\overline{RD/TA}$	RD/TA
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\overline{RDD}$		3.656*** (0.060)		3.536*** (0.077)		3.129*** (1.085)						
$\overline{RD/TA}$								1.343*** (0.016)		1.031*** (0.018)		0.721*** (0.068)
$\overline{Cash}$					0.268*** (0.030)	-0.481 (0.368)					0.231*** (0.002)	0.004 (0.019)
$\overline{Mtbv}$					0.150*** (0.004)	-0.042 (0.168)					0.013*** (0.000)	0.004*** (0.001)
$\overline{Debt}$					-1.592*** (0.028)	0.697 (1.726)					-0.073*** (0.002)	-0.112*** (0.010)
$\overline{Size}$					-0.013*** (0.002)	-0.167*** (0.022)					-0.000* (0.000)	-0.005*** (0.001)
$\overline{ROA}$					-2.206*** (0.049)	-0.340 (2.491)					-0.189*** (0.004)	-0.058*** (0.021)
$Cash$			0.165*** (0.010)	0.487*** (0.062)	0.007 (0.009)	0.650*** (0.061)			0.039*** (0.001)	0.066*** (0.002)	0.006*** (0.001)	0.072*** (0.002)
$Mtbv$			0.028*** (0.001)	0.091*** (0.009)	0.003** (0.001)	0.112*** (0.009)			0.003*** (0.000)	0.010*** (0.000)	0.000 (0.000)	0.010*** (0.000)
$Debt$			-0.217*** (0.010)	-0.819*** (0.058)	-0.045*** (0.009)	-0.958*** (0.075)			-0.018*** (0.001)	-0.076*** (0.002)	-0.002** (0.001)	-0.072*** (0.002)
$Size$			-0.005*** (0.001)	0.157*** (0.005)	-0.002*** (0.001)	0.174*** (0.005)			0.000 (0.000)	0.003*** (0.000)	-0.000 (0.000)	0.004*** (0.000)
ROA			-0.291*** (0.015)	-1.065*** (0.095)	-0.045*** (0.013)	-1.252*** (0.104)			-0.034*** (0.001)	-0.173*** (0.003)	-0.001 (0.001)	-0.173*** (0.003)
$\overline{EShock}$	-2.219*** (0.154)		-1.963*** (0.158)		0.170 (0.140)		-0.366*** (0.015)		-0.323*** (0.015)		-0.036*** (0.011)	
$\overline{ERisk}$	4.837*** (0.063)		4.173*** (0.066)		0.422*** (0.073)		0.893*** (0.006)		0.807*** (0.006)		0.294*** (0.006)	
$EShock$	-0.077*** (0.030)	0.220 (0.156)	0.108*** (0.032)	0.304* (0.176)	0.025 (0.027)	0.310* (0.176)	-0.012*** (0.003)	-0.037*** (0.007)	0.011*** (0.003)	-0.003 (0.007)	0.001 (0.002)	-0.004 (0.007)
$ERisk$	0.184*** (0.020)	-1.570*** (0.110)	0.002 (0.025)	0.250* (0.137)	-0.006 (0.022)	0.487*** (0.136)	0.029*** (0.002)	0.097*** (0.005)	0.014*** (0.002)	0.075*** (0.006)	0.008*** (0.002)	0.084*** (0.006)
N	51,990	51,990	47,445	47,445	47,445	47,445	51,990	51,990	47,445	47,445	47,445	47,445
R^2	0.161		0.206		0.403		0.445		0.505		0.758	
F-Statistic	189.10***		213.00***		510.10***		787.10***		834.60***		2,366.00***	
Wald χ^2		142.00***		60.67***		0.03		87.36***		88.74***		110.20***
J	2.17		8.97***		0.05		0.61		0.34		0.23	
bStdX		1.181		1.137		1.006		0.0532		0.0409		0.0286
bStdY		7.653		7.435		6.581		20.79		16.05		11.22
bStdXY		2.472		2.390		2.116		0.823		0.636		0.445
SDofY		0.478		0.476		0.476		0.0646		0.0643		0.0643
SDofX		0.323		0.321		0.321		0.0396		0.0396		0.0396

Table 4: Product market competition and peer effects on corporate innovation

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variable, RD/TA, is the firm's R&D to total assets. The independent peer averages are firm characteristics are defined as follows: $\overline{RD/TA}$, is the average peer firms' R&D to total assets. The other peer control Variables are as follows: $\overline{Cash}$ is lagged peer cash and cash equivalent to total assets, $\overline{Mtbv}$ is lagged peer market-to-book ratio, $\overline{Debt}$ is lagged peer debt to total assets, $\overline{Size}$ is lagged peer size (logarithm of total assets), and $\overline{ROA}$ is lagged peer profitability (earnings before interest and tax to total assets). The firm-specific characteristics are defined as follows: *Cash* is lagged cash and cash equivalent to total assets, *Mtbv* is lagged market-to-book ratio, *Debt* is lagged debt to total assets, *Size* is lagged size (logarithm of total assets), *ROA* is lagged profitability (earnings before interest and tax to total assets), and $EShock_{ijt}$ is the lagged idiosyncratic stock returns. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	HHI-Assets		HHI-Sales		Concentration index		Lerner index	
	Low	High	Low	High	Low	High	Low	High
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\overline{RD/TA}$	1.120***	0.750***	1.351***	0.611***	1.348***	0.773***	0.898***	0.637***
	(0.110)	(0.086)	(0.093)	(0.083)	(0.086)	(0.088)	(0.133)	(0.078)
Diff (High-Low)		4.51**		32.80***		18.69***		0.06
First stage regressions								
$\overline{EShock}$	-0.032*	-0.031**	-0.128***	-0.026*	-0.183***	-0.033**	-0.069***	-0.064***
	(0.017)	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.022)	(0.016)
$\overline{ERisk}$	0.340***	0.300***	0.385***	0.310***	0.421***	0.298***	0.365***	0.300***
	(0.009)	(0.008)	(0.009)	(0.008)	(0.010)	(0.008)	(0.012)	(0.008)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,987	20,720	23,717	20,678	22,649	19,811	14,829	16,278
R^2	0.80	0.69	0.80	0.71	0.80	0.72	0.75	0.83
F-Statistic	1,427.00***	747.10***	1,549.00***	813.60***	1,443.00***	808.00***	708.60***	1,224.00***
Wald χ^2	7.36***	48.94***	0.11	77.86***	0.01	43.12***	42.96***	4.09**
J	0.16	0.85	0.02	0.02	0.49	0.32	3.45*	1.68
bStdX	0.045	0.026	0.054	0.022	0.053	0.028	0.037	0.024
bStdY	15.760	14.580	19.140	11.290	18.930	14.140	11.030	13.640
bStdXY	0.627	0.503	0.768	0.403	0.738	0.508	0.452	0.514
SDofY	0.071	0.051	0.071	0.054	0.071	0.055	0.081	0.047
SDofX	0.040	0.035	0.040	0.036	0.039	0.036	0.041	0.038

Table 5: Leaders or followers? Who mimics who?

The table presents estimation results of Equation (1), which relate change in R&D to firm-specific and peer firms' average characteristics. The firm specific characteristics are defined as follows: *RD/TA* is research and development to total assets, *Cash* is lagged cash and cash equivalent, *Mtbv* is lagged market to book ratio, *Debt* is lagged total debt, *Size* is lagged log of total assets, *ROA* is lagged return on assets, *EShock* is lagged equity shock, and *ERisk* is lagged equity risk. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. Firms are categorised as *followers* (*leaders*) if they report low (high) sales, low (high) profit margin and few (more) analyst followings. Low (high) sales, profit margin and few (more) analysts are below (above) the median sales, profit margin and the number of analysts in each year, respectively. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Proxies	LogSales				Profit Margin				Analyst Followings			
	Low		High		Low		High		Low		High	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\overline{RD/TA}^{Low}$	1.201***		0.928***		1.267***		2.027***		0.963***		1.102***	
	(0.081)		(0.055)		(0.114)		(0.122)		(0.085)		(0.127)	
$\overline{RD/TA}^{High}$		0.851***		0.602***		0.130*		0.621***		0.560***		0.510***
		(0.116)		(0.069)		(0.068)		(0.067)		(0.075)		(0.109)
Differences												
LL *vs* HL				9.15***				103.30***				21.49***
LL *vs* LH				7.84***				20.52***				0.85
LL *vs* HH				31.41***				24.17***				11.21***
HL *vs* LH				0.38				179.40***				13.84***
HL *vs* HH				3.41*				26.37***				0.15
LH *vs* HH				18.13***				132.40***				20.79***
First stage regressions												
$\overline{EShock}^{Low}$	-0.123***		-0.117***		-0.064***		-0.045***		-0.093***		-0.050***	
	(0.011)		(0.012)		(0.013)		(0.011)		(0.012)		(0.016)	
$\overline{ERisk}^{Low}$	0.268***		0.278***		0.276***		0.189***		0.284***		0.202***	
	(0.006)		(0.007)		(0.007)		(0.006)		(0.007)		(0.009)	
$\overline{EShock}^{High}$		0.039***		0.063***		-0.070***		-0.037***		-0.056***		0.006
		(0.012)		(0.013)		(0.015)		(0.012)		(0.010)		(0.014)
$\overline{ERisk}^{High}$		0.281***		0.325***		0.335***		0.223***		0.302***		0.186***
		(0.008)		(0.008)		(0.009)		(0.007)		(0.007)		(0.009)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	23,580	23,580	23,865	23,865	24,267	24,267	23,178	23,178	27,979	27,980	15,203	15,114
R^2	0.72	0.64	0.77	0.69	0.68	0.71	0.70	0.70	0.71	0.68	0.73	0.73
F-Statistic	135.80***	401.20***	128.40***	528.50***	199.10***	202.90***	120.40***	157.90***	177.40***	349.80***	63.12***	118.80***
Wald χ^2	0.19	48.26***	1.37	107.60***	0.32	149.70***	22.98***	62.83***	14.53***	69.12***	0.01	32.84***
J	0.42	2.52	0.88	1.16	3.17*	1.05	0.21	0.00	1.28	0.04	0.00	0.41
bStdX	0.057	0.029	0.044	0.020	0.042	0.006	0.067	0.031	0.039	0.023	0.045	0.021
bStdY	16.200	11.470	17.730	11.500	22.490	2.309	29.020	8.890	14.350	8.345	17.070	7.894
bStdXY	0.768	0.387	0.838	0.388	0.741	0.114	0.958	0.440	0.581	0.344	0.702	0.330
SDofY	0.074	0.074	0.052	0.052	0.056	0.056	0.070	0.070	0.067	0.067	0.065	0.065
SDofX	0.047	0.034	0.047	0.034	0.033	0.049	0.033	0.050	0.041	0.041	0.041	0.042

Table 6: Peer effects and corporate outcomes

The table presents estimation results of Equation (5) in Panel A (Linear model) and Equation (6) in Panel B (Non-linear model), which relate peers' R&D to corporate outcomes, given firm-specific characteristics. The dependent variables are the measures of corporate outcomes: Tobin's q (Q), market value to equity (QE), risk (RISK), log patent counts (LOGPATS), log of citation-weighted value of patents (LOGTCW), log of the market value of patents (LOGTSM), product concentration (CONCE), product similarity (SIMILARITY), and product fluidity (FLUIDITY). The independent variables are $\overline{RD/TA}$ in Panel A and $\overline{RD/TA}$ and $\overline{RD/TA}^2$ in Panel B. The firm specific characteristics are defined as follows: *Sales Growth* change in sales, *Cash* is lagged cash and cash equivalent, *Debt* is lagged total debt, *PPE* is lagged lagged log of property, plant and equipment, *Size* is lagged log of total assets, and *LogAge* is the log of firm age. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Linear models of peer effects

	Q	QE	ROE	RISK	LOGPATS	LOGTCW	LOGTSM	CONCE	SIMILARITY	FLUIDITY
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\overline{RD/TA}$	0.207***	0.194***	-0.099***	0.032***	0.454***	0.662***	0.722***	-0.153***	2.603***	2.212***
	(0.021)	(0.064)	(0.006)	(0.001)	(0.120)	(0.139)	(0.124)	(0.007)	(0.110)	(0.065)
Sales Growth	0.959***	1.098***	0.235***	-0.022***	-0.286**	-0.214	0.519***	-0.024***	0.839***	0.290***
	(0.029)	(0.085)	(0.008)	(0.002)	(0.122)	(0.137)	(0.131)	(0.009)	(0.158)	(0.093)
Cash	1.402***	2.123***	-0.031***	-0.007***	1.123***	1.322***	1.621***	-0.245***	5.640***	2.823***
	(0.046)	(0.133)	(0.012)	(0.003)	(0.169)	(0.186)	(0.176)	(0.012)	(0.225)	(0.114)
Debt	-0.652***	6.788***	-0.260***	0.069***	-0.848***	-0.922***	-1.628***	0.093***	1.282***	0.550***
	(0.032)	(0.157)	(0.013)	(0.003)	(0.217)	(0.237)	(0.230)	(0.013)	(0.225)	(0.128)
PPE	0.210***	-1.016***	0.020*	-0.009***	1.282***	1.282***	0.946***	-0.068***	0.590***	0.354***
	(0.034)	(0.119)	(0.010)	(0.003)	(0.267)	(0.293)	(0.242)	(0.015)	(0.201)	(0.136)
Size	0.067***	0.199***	0.030***	-0.012***	0.664***	0.698***	1.406***	-0.046***	0.294***	0.283***
	(0.003)	(0.009)	(0.001)	(0.000)	(0.017)	(0.019)	(0.017)	(0.001)	(0.014)	(0.010)
LogAge	-0.112***	-0.148***	0.021***	-0.015***	0.094**	0.022	-0.065	0.100***	-1.163***	-1.121***
	(0.009)	(0.029)	(0.003)	(0.001)	(0.047)	(0.053)	(0.051)	(0.003)	(0.046)	(0.031)
Constant	1.281***	1.379***	-0.117***	0.216***	-3.175***	-2.623***	-6.184***	0.449***	1.658***	5.654***
	(0.031)	(0.101)	(0.009)	(0.002)	(0.184)	(0.203)	(0.188)	(0.012)	(0.170)	(0.114)
N	47,445	47,445	47,445	47,445	2,027	2,027	2,027	20,366	20,366	20,366
R^2	0.25	0.18	0.12	0.28	0.56	0.53	0.85	0.27	0.28	0.39

Panel B: Non-linear models of peer effects

	Q	QE	ROE	RISK	LOGPATS	LOGTCW	LOGTSM	CONCE	SIMILARITY	FLUIDITY
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\overline{RD/TA}$	1.077***	1.919***	-0.044**	0.015***	2.454***	3.222***	2.326***	-0.184***	-3.332***	0.679***
	(0.082)	(0.250)	(0.022)	(0.005)	(0.430)	(0.489)	(0.464)	(0.027)	(0.500)	(0.253)
$\overline{RD/TA}^2$	-0.698***	-1.383***	-0.044**	0.014***	-1.507***	-1.929***	-1.209***	0.024	4.707***	1.215***
	(0.067)	(0.197)	(0.018)	(0.004)	(0.316)	(0.359)	(0.344)	(0.020)	(0.441)	(0.199)
Sales Growth	0.953***	1.087***	0.235***	-0.022***	-0.292**	-0.221	0.514***	-0.024***	0.845***	0.291***
	(0.029)	(0.085)	(0.008)	(0.002)	(0.121)	(0.135)	(0.131)	(0.009)	(0.157)	(0.093)
Cash	1.407***	2.133***	-0.031***	-0.007***	1.107***	1.301***	1.608***	-0.244***	5.774***	2.858***
	(0.046)	(0.133)	(0.012)	(0.003)	(0.168)	(0.185)	(0.176)	(0.012)	(0.225)	(0.114)
Debt	-0.651***	6.790***	-0.260***	0.069***	-0.814***	-0.879***	-1.601***	0.093***	1.339***	0.565***
	(0.032)	(0.157)	(0.013)	(0.003)	(0.216)	(0.234)	(0.229)	(0.013)	(0.223)	(0.128)
PPE	0.218***	-1.001***	0.020*	-0.009***	1.277***	1.276***	0.942***	-0.069***	0.546***	0.343**
	(0.034)	(0.119)	(0.010)	(0.003)	(0.264)	(0.289)	(0.239)	(0.015)	(0.200)	(0.135)
Size	0.066***	0.198***	0.030***	-0.012***	0.668***	0.702***	1.409***	-0.046***	0.295***	0.283***
	(0.003)	(0.009)	(0.001)	(0.000)	(0.017)	(0.019)	(0.017)	(0.001)	(0.014)	(0.010)
LogAge	-0.109***	-0.142***	0.022***	-0.015***	0.094**	0.021	-0.066	0.100***	-1.178***	-1.125***
	(0.009)	(0.028)	(0.003)	(0.001)	(0.047)	(0.052)	(0.051)	(0.003)	(0.046)	(0.031)
Constant	1.130***	1.080***	-0.126***	0.219***	-3.650***	-3.232***	-6.566***	0.454***	2.665***	5.914***
	(0.033)	(0.106)	(0.009)	(0.002)	(0.204)	(0.227)	(0.207)	(0.013)	(0.183)	(0.120)
N	47,445	47,445	47,445	47,445	2,027	2,027	2,027	20,366	20,366	20,366
R^2	0.26	0.18	0.12	0.28	0.57	0.53	0.85	0.27	0.29	0.39

Table 7: Peer effects on corporate innovation across industries

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics across different industries. The firm-specific characteristics are defined as follows: *Cash* is lagged cash and cash equivalent, *Mtbv* is lagged market to book ratio, *Debt* is lagged total debt, *Size* is lagged log of total assets, *ROA* is lagged return on assets, and *EShock* is lagged equity shock. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. Firms are classified into five industrial categorisations as follows: Others (industries except mining and manufacturing), mining ($1000 \leq$ SIC code ≤ 1499), manufacturing ($2000 \leq$ SIC code ≤ 3999), durables ($2400 \leq$ SIC code ≤ 2500 and $3200 \leq$ SIC code ≤ 3800) and non-durables ($2000 \leq$ SIC code ≤ 2300 and $2600 \leq$ SIC code ≤ 3100). The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Others		Mining		Manufacturing		Non-Durables		Durables	
	RDD	RD/TA	RDD	RD/TA	RDD	RD/TA	RDD	RD/TA	RDD	RD/TA
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\overline{RDD}$	1.866		5.186***		3.726***		3.795***		3.607***	
	(1.936)		(1.554)		(0.242)		(0.781)		(0.412)	
$\overline{RD/TA}$		0.511		7.939***		1.146***		1.985***		0.949***
		(0.512)		(2.270)		(0.051)		(0.425)		(0.059)
First stage regressions										
$\overline{EShock}$	0.801***	0.125***	-1.166***	-0.024*	0.065	-0.078***	0.490**	0.003	0.955***	-0.074***
	(0.170)	(0.021)	(0.435)	(0.013)	(0.119)	(0.011)	(0.248)	(0.014)	(0.121)	(0.014)
$\overline{ERisk}$	0.355***	0.161***	-4.027***	-0.068***	2.490***	0.406***	1.520***	0.107***	1.909***	0.439***
	(0.086)	(0.011)	(0.284)	(0.008)	(0.064)	(0.006)	(0.150)	(0.008)	(0.063)	(0.007)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	11,331	11,331	2,689	2,689	33,425	33,425	8,729	8,729	24,140	24,140
R^2	0.80	0.83	0.69	0.61	0.47	0.82	0.56	0.94	0.52	0.80
F-Statistic	735.00***	926.00***	96.31***	67.34***	463.60***	2,333.00***	178.10***	1,998.00***	409.90***	1,568.00***
Wald χ^2	0.04	5.01**	3.77*	8.46***	30.51***	2.41	4.77**	4.38**	10.35***	0.11
J	0.84	1.44	0.47	1.36	1.09	0.11	0.38	0.01	1.65	0.94
bStdX	0.588	0.022	0.781	0.032	0.880	0.043	1.091	0.083	0.700	0.033
bStdY	3.802	7.278	13.870	724.800	8.972	18.130	7.941	31.260	9.579	15.110
bStdXY	1.199	0.311	2.089	2.896	2.120	0.684	2.283	1.309	1.858	0.528
SDofY	0.491	0.070	0.374	0.011	0.415	0.063	0.478	0.064	0.377	0.063
SDofX	0.315	0.043	0.151	0.004	0.236	0.038	0.288	0.042	0.194	0.035

Table 8: Alternative proxies of corporate innovation

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variables are as follows: RD/NA is research and development to net assets (Columns (1)–(3)), $\Delta RD/TA$ is change in research and development to total assets (Columns (4)–(6)), $RDSGA/TA$ is research and development plus selling, general and administrative expenses to total assets (Columns (7)–(9)), and $RDSGA/Sales$ is research and development plus selling, general and administrative expenses to total sales (Columns (10)–(12)). The independent variables are the peer-averages of the measures of R&D: $\overline{RD/NA}$, $\overline{\Delta RD/TA}$, $\overline{RDSGA/TA}$, and $\overline{RDSGA/Sales}$. The firm-specific variables are defined as follows: *Cash* is lagged cash and cash equivalent, *Mtbv* is lagged market to book ratio, *Debt* is lagged total debt, *Size* is lagged log of total assets, *ROA* is lagged return on assets, *EShock* is lagged equity shock, and *ERisk* is lagged equity risk. The other peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	RD/NA			ΔRD/TA			RDSGA/TA			RDSGA/Sales		
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\overline{RD/NA}$	1.436***	0.887***	0.722***									
	(0.020)	(0.021)	(0.115)									
$\overline{\Delta RD/TA}$				3.682***	2.767***	1.574***						
				(0.078)	(0.082)	(0.210)						
$\overline{RDSGA/TA}$							0.763***	0.553***	1.240***			
							(0.014)	(0.017)	(0.149)			
$\overline{RDSGA/Sales}$										0.821***	0.550***	2.080***
										(0.011)	(0.012)	(0.339)
First stage regressions												
$\overline{EShock}$	-0.667***	-0.582***	-0.043***	-0.026***	-0.023***	0.015***	-0.486***	-0.236***	0.729***	-1.376***	-1.241***	0.265***
	(0.027)	(0.027)	(0.017)	(0.002)	(0.002)	(0.002)	(0.073)	(0.075)	(0.063)	(0.067)	(0.067)	(0.038)
$\overline{ERisk}$	1.420***	1.255***	0.311***	0.080***	0.074***	0.039***	2.876***	2.529***	0.021	3.293***	2.828***	-0.053***
	(0.011)	(0.011)	(0.009)	(0.001)	(0.001)	(0.001)	(0.030)	(0.031)	(0.033)	(0.027)	(0.028)	(0.020)
Firm factors	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Peer averages	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
N	51,990	47,445	47,445	49,293	46,206	46,206	51,990	47,445	47,445	51,921	47,389	47,389
R^2	0.45	0.52	0.83	0.29	0.32	0.45	0.22	0.27	0.51	0.44	0.51	0.85
F-Statistic	813.20***	881.90***	3,686.00***	387.20***	380.90***	597.20***	280.60***	302.30***	769.00***	768.30***	860.00***	4,194.00***
Wald χ^2	0.08	0.36	19.15***	659.50***	308.40***	4.84**	118.00***	247.90***	5.68**	11.39***	52.99***	20.10***
J	0.03	0.13	0.07	3.68*	0.06	0.84	0.46	4.14**	46.93***	0.12	0.96	14.62***
bStdX	0.102	0.064	0.052	0.019	0.014	0.008	0.121	0.088	0.196	0.142	0.095	0.361
bStdY	10.890	6.845	5.566	191.000	144.800	82.320	2.886	2.096	4.697	3.007	2.048	7.752
bStdXY	0.776	0.490	0.398	0.971	0.738	0.420	0.457	0.332	0.744	0.520	0.355	1.345
SDofY	0.132	0.130	0.130	0.019	0.019	0.019	0.264	0.264	0.264	0.273	0.268	0.268
SDofX	0.071	0.072	0.072	0.005	0.005	0.005	0.158	0.158	0.158	0.173	0.173	0.173

Table 9: Alternative industrial definitions

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics using alternative industrial classifications. The firm-specific characteristics are defined as follows: *RD/Sales* is research and development to total sales, *RD/NA* is research and development to net assets, *Cash* is lagged cash and cash equivalent, *Mtbv* is lagged market to book ratio, *Debt* is lagged total debt, *Size* is lagged log of total assets, *ROA* is lagged return on assets, *EShock* is lagged equity shock, and *ERisk* is lagged equity risk. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	RDD						RD/TA					
	SIC1	SIC2	FF48	NAICS3	FC100	FC200	SIC1	SIC2	FF48	NAICS3	FC100	FC200
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\overline{RDD}$	2.168*	1.547**	3.191**	3.307***	3.258***	4.156**						
	(1.188)	(0.659)	(1.257)	(1.110)	(0.540)	(2.083)						
$\overline{RD/TA}$							0.377**	0.884***	0.714***	0.583***	0.252***	0.158**
							(0.164)	(0.100)	(0.078)	(0.077)	(0.065)	(0.078)
First stage regressions												
$\overline{EShock}$	-1.089***	-0.601***	0.048	-0.016	-1.612***	-0.097	-0.012	-0.058***	-0.058***	-0.017	-0.260***	-0.144***
	(0.195)	(0.177)	(0.157)	(0.150)	(0.105)	(0.089)	(0.013)	(0.012)	(0.012)	(0.012)	(0.011)	(0.009)
$\overline{ERisk}$	0.298***	0.783***	0.435***	0.492***	-0.273***	-0.177***	0.295***	0.274***	0.295***	0.319***	0.223***	0.180***
	(0.106)	(0.089)	(0.079)	(0.082)	(0.053)	(0.047)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	44,323	44,323	44,323	44,152	43,724	42,552	44,323	44,323	44,323	44,152	43,724	42,552
R^2	0.47	0.44	0.43	0.43	0.35	0.31	0.80	0.79	0.78	0.77	0.72	0.69
F-Statistic	631.40***	559.60	546.50**	543.30**	381.50***	304.50**	2,793.00***	2,706.00***	2,554.00***	2,401.00***	1,780.00***	1,528.00***
Wald χ^2	0.82	6.09**	0.00	0.07	0.90	0.63	110.00***	66.33***	78.55***	127.20***	108.50***	95.85***
J	0.13	0.34	0.02	1.43	7.43***	0.08	0.45	0.16	0.07	0.01	33.46***	3.16*
bStdX	0.533	0.460	0.945	1.010	0.775	1.003	0.010	0.029	0.026	0.022	0.009	0.006
bStdY	4.593	3.276	6.759	7.011	6.918	8.862	6.083	14.270	11.530	9.410	4.050	2.532
bStdXY	1.129	0.974	2.003	2.142	1.646	2.139	0.155	0.470	0.416	0.353	0.147	0.095
SDofY	0.472	0.472	0.472	0.472	0.471	0.469	0.062	0.062	0.062	0.062	0.062	0.063
SDofX	0.246	0.297	0.296	0.306	0.238	0.241	0.026	0.033	0.036	0.038	0.036	0.038

Appendix A: Variable definitions

The table lists the definitions of all Variables used and the account items obtained from Compustat databases.

Variable	Definition
RDD	Research and development dummy.
RD/TA	Research and development to total assets.
RD/NA	Research and development to net asset.
$\Delta RD/TA$	Change in research and development to total assets.
RDSGA/TA	Research and development plus selling, general and administrative expenses to total assets.
RDSGA/Sales	Research and development plus selling, general and administrative expenses to total sales.
Cash	Cash and cash equivalent to total sales.
Mtbv	Market value of assets to book value of assets.
Debt	Total debt to total sales.
Size	Log of total assets.
ROA	Earnings before interest and tax plus depreciation to total assets.
EShock	Equity shock.
ERisk	Equity risk.

Appendix B: Peer equity residuals

The table presents estimation results of the following equation:-

$$\overline{Instrument_{ijt}} = \vartheta + \theta' X_{ijt-1} + \varphi' \overline{X}_{-ijt-1} + \pi' \zeta_t + e_{ijt} \quad (7)$$

where $\overline{Instrument_{ijt}}$ is the peer equity shock ($\overline{EShock_{ijt}}$) or risk ($\overline{ERisk_{ijt}}$) for firm i in industry J at time t, ϑ is a constant, θ' and φ' are the vectors of coefficients to be estimated, $\overline{X}_{-ijt-1}$ and X are vectors of peer firm averages excluding firm i and firm-specific characteristics, respectively. ζ_t and e_{ijt} are year fixed effects and firm-year specific error term, respectively. The vector of firm-specific factors, X_{-ijt-1}, include lagged cash and cash equivalent (*Cash*), lagged market to book ratio ($Mtbv_{ijt}$), lagged total debt ($Debt_{ijt}$), lagged log of total assets ($Size_{ijt}$), lagged return on assets (ROA_{ijt}) and lagged equity shock ($EShock_{ijt}$) or lagged equity risk ($ERisk_{ijt}$). The peer firms' average characteristics, $\overline{X}_{-ijt-1}$, are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	Panel A: Contemporaneous independent Variables		Panel B: Lagged independent Variables	
	$\overline{EShock}$	$\overline{ERisk}$	$\overline{EShock}$	$\overline{ERisk}$
Variables	(1)	(2)	(3)	(4)
Cash	-0.001	0.001	-0.000	0.002*
	(0.000)	(0.001)	(0.000)	(0.001)
Mtbv	0.000***	-0.000	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Debt	0.000	-0.005***	0.001*	-0.004***
	(0.000)	(0.001)	(0.000)	(0.001)
PPE	-0.000	0.001***	-0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.001***	0.004***	-0.000	0.005***
	(0.000)	(0.001)	(0.000)	(0.001)
Firm Equity Shock	Yes	No	Yes	No
Firm Equity Risk	No	Yes	No	Yes
Peer averages	Yes	Yes	Yes	Yes
N	47,445	47,445	47,445	47,445
Firms	4,545	4,545	4,545	4,545
R^2	0.35	0.79	0.34	0.77

Appendix C: Alternative estimations of peer effects on corporate innovation

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variable in Columns (1)–(3), *RDD*, is a dummy variable equals 1 if a firm has R&D and 0 otherwise. In Columns (4)–(6), the dependent variable, *RD/TA*, is the firm's R&D to total assets. The independent peer firms' average firm characteristics are defined as follows: $\overline{RDD}$ is a dummy for peer R&D equals 1 if the average peer firms has R&D and 0 otherwise and $\overline{RD/TA}$, is the average peer firms' R&D to total assets. The other peer control Variables are as follows: $\overline{Cash}$ is lagged peer cash and cash equivalent to total assets, $\overline{Mtbv}$ is lagged peer market-to-book ratio, $\overline{Debt}$ is lagged peer debt to total assets, $\overline{Size}$ is lagged peer size (logarithm of total assets), and $\overline{ROA}$ is lagged peer profitability (earnings before interest and tax to total assets). The firm-specific characteristics are defined as follows: *Cash* is lagged cash and cash equivalent to total assets, *Mtbv* is lagged market-to-book ratio, *Debt* is lagged debt to total assets, *Size* is lagged size (logarithm of total assets), *ROA* is lagged profitability (earnings before interest and tax to total assets), and $EShock_{ijt}$ is the lagged idiosyncratic stock returns. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	IVProbit			IVTobit		
	RDD			RD/TA		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{RDD}$	5.588***	4.221***	3.179***			
	(0.412)	(0.471)	(0.543)			
$\overline{RD/TA}$				1.037***	0.730***	0.914***
				(0.051)	(0.051)	(0.100)
First stage regressions						
$\overline{EShock}$	-0.495***	-0.577***	0.356***	-0.132***	-0.136***	-0.037***
	(0.072)	(0.073)	(0.066)	(0.009)	(0.010)	(0.007)
$\overline{ERisk}$	0.926***	0.839***	0.931***	0.374***	0.360***	0.222***
	(0.036)	(0.036)	(0.037)	(0.005)	(0.005)	(0.004)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes
N	51,990	47,445	47,445	51,990	47,445	47,445
R^2	0.82	0.84	0.87	0.80	0.81	0.89
F-Statistic	2,864.00***	2,692.00***	3,425.00***	2,463.00***	2,310.00***	4,097.00***
Wald χ^2	82.76***	30.42***	8.52***	10.95***	12.17***	0.81
J	1.40	3.10*	0.10	0.40	0.00	1.59
bStdX	1.805	1.357	1.022	0.041	0.029	0.036
bStdY	11.700	8.876	6.686	16.050	11.360	14.230
bStdXY	3.779	2.854	2.149	0.635	0.450	0.564
SDofY	0.478	0.476	0.476	0.065	0.064	0.064
SDofX	0.323	0.321	0.321	0.040	0.040	0.040

Appendix D: Peer effects on corporate innovation excluding firms that change industries or with multiple segments

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variable in Columns (1)–(3), *RDD*, is a dummy variable equals 1 if a firm has R&D and 0 otherwise. In Columns (4)–(6), the dependent variable, *RD/TA*, is the firm's R&D to total assets. The independent peer firms' average firm characteristics are defined as follows: $\overline{RDD}$ is a dummy for peer R&D equals 1 if the average peer firms has R&D and 0 otherwise and $\overline{RD/TA}$, is the average peer firms' R&D to total assets. The other peer control Variables are as follows: $\overline{Cash}$ is lagged peer cash and cash equivalent to total assets, $\overline{Mtbv}$ is lagged peer market-to-book ratio, $\overline{Debt}$ is lagged peer debt to total assets, $\overline{Size}$ is lagged peer size (logarithm of total assets), and $\overline{ROA}$ is lagged peer profitability (earnings before interest and tax to total assets). The firm-specific characteristics are defined as follows: *Cash* is lagged cash and cash equivalent to total assets, *Mtbv* is lagged market-to-book ratio, *Debt* is lagged debt to total assets, *Size* is lagged size (logarithm of total assets), *ROA* is lagged profitability (earnings before interest and tax to total assets), and $EShock_{ijt}$ is the lagged idiosyncratic stock returns. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Peer effects excluding firms that change industries

	IVProbit			IVTobit		
	RDD			RD/TA		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{RDD}$	3.833***	3.875***	3.023***			
	(0.076)	(0.097)	(0.595)			
$\overline{RD/TA}$				1.405***	1.131***	0.986***
				(0.019)	(0.021)	(0.068)
First stage regressions						
$\overline{EShock}$	-1.763***	-1.699***	0.222	-0.332***	-0.302***	-0.052***
	(0.171)	(0.176)	(0.157)	(0.017)	(0.017)	(0.012)
$\overline{ERisk}$	4.741***	4.157***	0.935***	0.879***	0.798***	0.339***
	(0.070)	(0.074)	(0.084)	(0.007)	(0.007)	(0.007)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes
N	37,959	34,453	34,453	37,959	34,453	34,453
R^2	0.20	0.24	0.41	0.51	0.56	0.77
F-Statistic	180.60***	188.00***	384.20***	736.40***	756.60***	1,841.00***
Waldχ^2	146.30***	96.69***	0.03	28.39***	17.64***	39.59***
J	1.32	5.09**	0.02	0.03	0.86	0.58
bStdX	1.194	1.200	0.936	0.055	0.044	0.039
bStdY	8.137	8.274	6.455	21.210	17.140	14.950
bStdXY	2.534	2.563	1.999	0.831	0.673	0.587
SDofY	0.471	0.468	0.468	0.066	0.066	0.066
SDofX	0.311	0.310	0.310	0.039	0.039	0.039

Panel B: Peer effects excluding firms with multiple segments

	IVProbit			IVTobit		
	RDD			RD/TA		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{RDD}$	4.317***	4.162***	2.636**			
	(0.098)	(0.124)	(1.210)			
$\overline{RD/TA}$				1.585***	1.237***	0.781***
				(0.027)	(0.029)	(0.118)
First stage regressions						
$\overline{EShock}$	0.067	-0.193	1.302***	-0.268***	-0.263***	-0.012
	(0.239)	(0.245)	(0.209)	(0.026)	(0.026)	(0.017)
$\overline{ERisk}$	5.760***	4.973***	-0.001	1.001***	0.897***	0.298***
	(0.094)	(0.098)	(0.104)	(0.010)	(0.010)	(0.009)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes
N	22,839	20,862	20,862	22,839	20,862	20,862
R^2	0.23	0.27	0.49	0.51	0.56	0.81
F-Statistic	131.90***	133.60***	318.10***	443.70***	457.70***	1,366.00***
Wald χ^2	130.20***	61.96***	0.17	4.56**	0.84	23.82***
J	0.72	0.89	2.19	3.92**	3.79*	1.17
bStdX	1.319	1.257	0.796	0.064	0.050	0.032
bStdY	9.673	9.413	5.963	20.790	16.310	10.300
bStdXY	2.955	2.842	1.800	0.845	0.661	0.418
SDofY	0.446	0.442	0.442	0.076	0.076	0.076
SDofX	0.306	0.302	0.302	0.041	0.041	0.041

Appendix E: Time-variations in peer effects on corporate innovation

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variable in Columns (1)–(3), RDD, is a dummy variable equals 1 if a firm has R&D and 0 otherwise. In Columns (4)–(6), the dependent variable, RD/TA, is the firm's R&D to total assets. The independent peer firms' average firm characteristics are defined as follows: $\overline{RDD}$ is a dummy for peer R&D equals 1 if the average peer firms has R&D and 0 otherwise and $\overline{RD/TA}$, is the average peer firms' R&D to total assets. The other peer control Variables are as follows: $\overline{Cash}$ is lagged peer cash and cash equivalent to total assets, $\overline{Mtbv}$ is lagged peer market-to-book ratio, $\overline{Debt}$ is lagged peer debt to total assets, $\overline{Size}$ is lagged peer size (logarithm of total assets), and $\overline{ROA}$ is lagged peer profitability (earnings before interest and tax to total assets). The firm-specific characteristics are defined as follows: $Cash$ is lagged cash and cash equivalent to total assets, $Mtbv$ is lagged market-to-book ratio, $Debt$ is lagged debt to total assets, $Size$ is lagged size (logarithm of total assets), ROA is lagged profitability (earnings before interest and tax to total assets), and $EShock_{ijt}$ is the lagged idiosyncratic stock returns. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	IVProbit					IVTobit				
	RDD					RD/TA				
	1970s	1980s	1990s	2000s	2010s	1970s	1980s	1990s	2000s	2010s
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\overline{RDD}$	2.650***	3.521***	2.959***	2.658	2.741***					
	(0.423)	(0.453)	(0.433)	(2.332)	(0.337)					
$\overline{RD/TA}$						1.396***	0.923***	0.929***	0.332	6.680***
						(0.119)	(0.108)	(0.144)	(0.268)	(1.283)
First stage regressions										
$\overline{EShock}$	-1.050***	-3.811***	3.925***	0.211	1.658***	-0.073***	-0.240***	0.269***	-0.001	0.059
	(0.383)	(0.275)	(0.290)	(0.291)	(0.529)	(0.021)	(0.023)	(0.024)	(0.020)	(0.040)
$\overline{ERisk}$	3.518***	0.633***	1.422***	-0.337***	-5.384***	0.274***	0.283***	0.316***	0.148***	-0.099***
	(0.236)	(0.157)	(0.154)	(0.130)	(0.276)	(0.013)	(0.013)	(0.013)	(0.009)	(0.021)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6,247	9,361	10,458	9,653	6,241	6,247	9,361	10,458	9,653	6,241
R^2	0.33	0.46	0.40	0.49	0.45	0.51	0.60	0.76	0.85	0.79
F-Statistic	140.40***	356.60***	313.70***	422.40	240.70***	295.70***	647.00	1,542.00***	2,556.00***	1,122.00
Wald χ^2	0.03	3.78*	0.04	0.05	3.47*	1.40	6.99***	15.07***	17.67***	41.71***
J	0.09	0.10	2.33	0.37	1.09	0.17	10.33***	26.01***	0.29	14.06***
bStdX	0.755	1.036	0.952	0.898	0.926	0.026	0.027	0.039	0.014	0.280
bStdY	5.512	7.292	6.266	5.705	6.007	49.640	21.560	13.730	4.580	87.660
bStdXY	1.570	2.147	2.016	1.928	2.029	0.914	0.624	0.581	0.195	3.674
SDofY	0.481	0.483	0.472	0.466	0.456	0.028	0.043	0.068	0.073	0.076
SDofX	0.285	0.294	0.322	0.338	0.338	0.018	0.029	0.042	0.043	0.042

Appendix F: Macroeconomic conditions, market sentiment and peer effects on corporate innovation

The table presents estimation results of Equation (1), which relate R&D to firm-specific and peer firms' average characteristics. The dependent variable in Columns (1)–(3), RDD, is a dummy variable equals 1 if a firm has R&D and 0 otherwise. In Columns (4)–(6), the dependent variable, RD/TA, is the firm's R&D to total assets. The independent peer firms' average firm characteristics are defined as follows: $\overline{RDD}$ is a dummy for peer R&D equals 1 if the average peer firms has R&D and 0 otherwise and $\overline{RD/TA}$, is the average peer firms' R&D to total assets. The other peer control Variables are as follows: $\overline{Cash}$ is lagged peer cash and cash equivalent to total assets, $\overline{Mtbv}$ is lagged peer market-to-book ratio, $\overline{Debt}$ is lagged peer debt to total assets, $\overline{Size}$ is lagged peer size (logarithm of total assets), and $\overline{ROA}$ is lagged peer profitability (earnings before interest and tax to total assets). The firm-specific characteristics are defined as follows: $Cash$ is lagged cash and cash equivalent to total assets, $Mtbv$ is lagged market-to-book ratio, $Debt$ is lagged debt to total assets, $Size$ is lagged size (logarithm of total assets), ROA is lagged profitability (earnings before interest and tax to total assets), and $EShock_{ijt}$ is the lagged idiosyncratic stock returns. The peer firms' average characteristics are calculated as the average of all firms within an industry-year excluding the i^{th} observations. Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

$\overline{RDD}$	3.232***		3.240***		3.129***		3.129***		3.133***	
	(0.703)		(0.860)		(1.085)		(1.085)		(1.082)	
$\overline{RD/TA}$		0.793***		0.760***		0.721***		0.721***		0.721***
		(0.064)		(0.066)		(0.068)		(0.068)		(0.068)
GDP growth	-0.460	-0.098***							-0.586	-0.051
	(0.928)	(0.037)							(0.871)	(0.040)
Inflation			-0.003	0.290***					-1.364	-0.134
			(3.103)	(0.057)					(2.099)	(0.087)
UMCSENT					-0.003	-0.001***			0.005	0.001
					(0.013)	(0.000)			(0.029)	(0.001)
SENT							-0.056	-0.020***	0.014	-0.013
							(0.247)	(0.003)	(2.077)	(0.081)
First stage regressions										
$\overline{EShock}$	0.132	-0.038***	0.126	-0.039***	0.170	-0.036***	0.170	-0.036***	0.177	-0.036***
	(0.141)	(0.011)	(0.140)	(0.011)	(0.140)	(0.011)	(0.140)	(0.011)	(0.140)	(0.011)
$\overline{ERisk}$	0.644***	0.307***	0.530***	0.300***	0.422***	0.294***	0.422***	0.294***	0.423***	0.294***
	(0.072)	(0.006)	(0.073)	(0.006)	(0.073)	(0.006)	(0.073)	(0.006)	(0.073)	(0.006)
GDP growth	-0.596***	-0.038***							-0.014	0.000
	(0.133)	(0.010)							(0.142)	(0.011)
Inflation			3.159***	0.199***					-0.867***	-0.015
			(0.195)	(0.015)					(0.310)	(0.024)
UMCSENT					-0.011***	-0.001***			0.008**	0.001**
					(0.000)	(0.000)			(0.004)	(0.000)
SENT							-0.214***	-0.012***	-0.246	-0.088***
							(0.009)	(0.001)	(0.298)	(0.023)
Firm factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peer averages	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	47,445	47,445	47,445	47,445	47,445	47,445	47,445	47,445	47,445	47,445
R^2	0.40	0.76	0.40	0.76	0.40	0.76	0.40	0.76	0.40	0.76
F-Statistic	495.50***	2,346.00***	501.90***	2,356.00***	510.10***	2,366.00***	510.10***	2,366.00***	494.60***	2,293.00***
Wald χ^2	0.15	100.50***	0.11	104.30***	0.03	110.20***	0.03	110.20***	0.03	110.20***
J	0.06	0.20	0.06	0.17	0.05	0.23	0.05	0.23	0.05	0.25
bStdX	1.039	0.031	1.042	0.030	1.006	0.029	1.006	0.029	1.007	0.029
bStdY	6.797	12.340	6.813	11.830	6.581	11.220	6.581	11.220	6.588	11.220
bStdXY	2.185	0.489	2.190	0.469	2.116	0.445	2.116	0.445	2.118	0.445
SDofY	0.476	0.064	0.476	0.064	0.476	0.064	0.476	0.064	0.476	0.064
SDofX	0.321	0.040	0.321	0.040	0.321	0.040	0.321	0.040	0.321	0.040

Appendix G: Correlations

Industries are defined at the three-digit SIC code. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period 1968–2018. All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

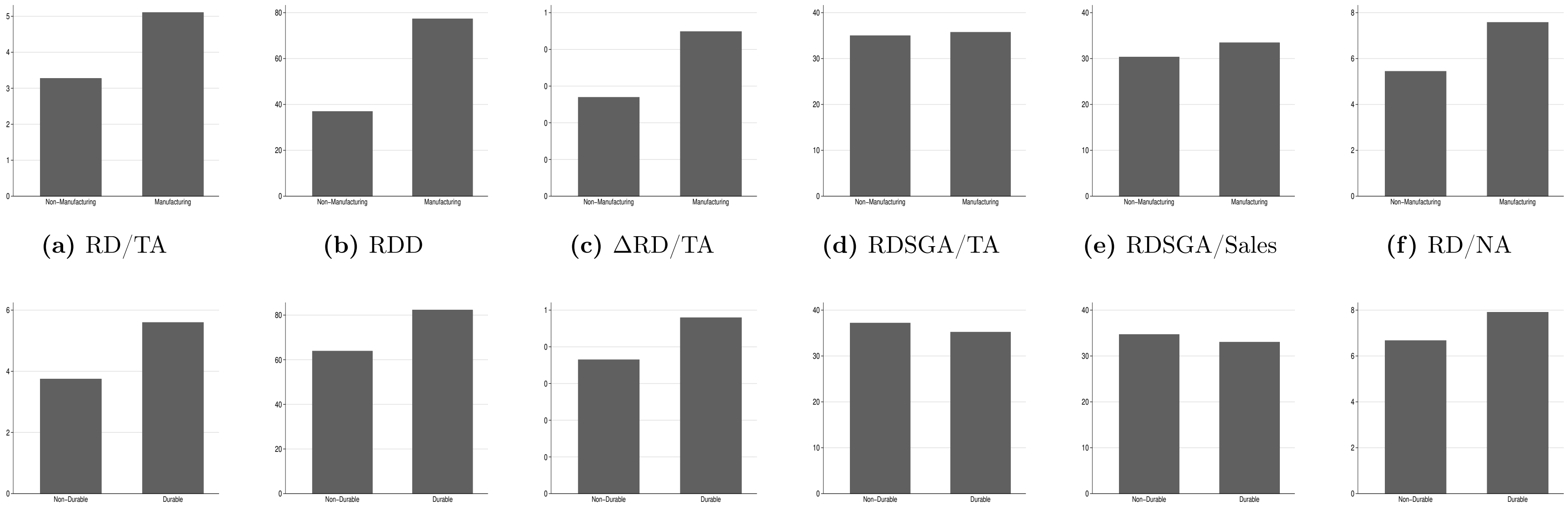
#	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	RD/TA	1	0.841***	0.108***	0.527***	0.690***	0.993***	0.685***	0.645***	0.148***	0.427***	0.585***	0.673***	0.369***
(2)	RDD	0.515***	1	0.050***	0.327***	0.481***	0.841***	0.557***	0.591***	0.110***	0.290***	0.433***	0.543***	0.235***
(3)	$\Delta RD/TA$	0.228***	0.041***	1	0.084***	0.063***	0.097***	0.030***	0.024***	0.063***	0.023***	0.019***	0.026***	0.035***
(4)	$RDSGA/TA$	0.574***	0.252***	0.138***	1	0.750***	0.512***	0.398***	0.329***	0.095***	0.610***	0.472***	0.387***	0.235***
(5)	$RDSGA/Sales$	0.728***	0.395***	0.133***	0.612***	1	0.698***	0.587***	0.499***	0.114***	0.545***	0.677***	0.594***	0.429***
(6)	RD/NA	0.875***	0.387***	0.184***	0.463***	0.740***	1	0.693***	0.648***	0.145***	0.431***	0.600***	0.685***	0.419***
(7)	$Cash$	0.591***	0.509***	0.035***	0.343***	0.539***	0.498***	1	0.851***	0.240***	0.632***	0.848***	0.986***	0.392***
(8)	$Mtbv$	0.464***	0.635***	0.025***	0.243***	0.395***	0.357***	0.774***	1	0.167***	0.473***	0.675***	0.823***	0.283***
(9)	$Debt$	0.130***	0.101***	0.074***	0.079***	0.087***	0.096***	0.244***	0.155***	1	0.177***	0.160***	0.209***	0.066***
(10)	$Size$	0.351***	0.272***	0.023***	0.568***	0.409***	0.279***	0.590***	0.413***	0.154***	1	0.757***	0.610***	0.296***
(11)	ROA	0.520***	0.420***	0.022***	0.387***	0.610***	0.472***	0.873***	0.634***	0.150***	0.669***	1	0.873***	0.431***
(12)	$EShock$	0.562***	0.443***	0.029***	0.309***	0.558***	0.514***	0.953***	0.671***	0.200***	0.530***	0.906***	1	0.418***
(13)	$ERisk$	0.429***	0.217***	0.060***	0.216***	0.524***	0.566***	0.424***	0.258***	0.055***	0.265***	0.457***	0.464***	1
(14)	$\overline{RD/TA}$	0.282***	0.164***	-0.002	0.165***	0.300***	0.282***	0.279***	0.170***	0.052***	0.175***	0.341***	0.309***	0.350***
(15)	$\overline{RDD}$	-0.294***	-0.210***	-0.017***	-0.253***	-0.293***	-0.284***	-0.304***	-0.230***	-0.040***	-0.248***	-0.312***	-0.303***	-0.477***
(16)	$\overline{\Delta RD/TA}$	-0.145***	0.019***	-0.009*	-0.335***	-0.186***	-0.130***	-0.144***	-0.130***	-0.037***	-0.210***	-0.120***	-0.084***	-0.134***
(17)	$\overline{\Delta RDSGA/TA}$	-0.272***	-0.069***	0.068***	-0.218***	-0.339***	-0.303***	-0.167***	-0.111***	-0.005	-0.108***	-0.178***	-0.180***	-0.102***
(18)	$\overline{\Delta RDSGA/Sales}$	-0.061***	-0.019***	-0.078***	-0.045***	-0.082***	-0.054***	-0.065***	-0.033***	0.008*	-0.038***	-0.055***	-0.061***	-0.069***
(19)	$\overline{RD/NA}$	0.221***	0.034***	0.013***	0.254***	0.222***	0.186***	0.216***	0.118***	0.038***	0.156***	0.176***	0.188***	0.082***
(20)	$\overline{Cash}$	0.472***	0.314***	0.017***	0.291***	0.531***	0.459***	0.782***	0.473***	0.112***	0.486***	0.851***	0.868***	0.507***
(21)	$\overline{Mtbv}$	0.348***	0.235***	0.016***	0.217***	0.443***	0.338***	0.581***	0.356***	0.104***	0.363***	0.708***	0.644***	0.348***
(22)	$\overline{Debt}$	-0.412***	-0.341***	-0.014***	-0.329***	-0.438***	-0.364***	-0.679***	-0.516***	-0.089***	-0.557***	-0.699***	-0.678***	-0.399***
(23)	$\overline{Size}$	-0.200***	-0.194***	-0.013***	-0.278***	-0.172***	-0.109***	-0.327***	-0.275***	-0.079***	-0.486***	-0.284***	-0.201***	-0.055***
(24)	$\overline{ROA}$	-0.320***	-0.226***	-0.002	-0.199***	-0.349***	-0.304***	-0.540***	-0.340***	-0.005	-0.344***	-0.574***	-0.586***	-0.316***
(25)	$\overline{EShock}$	-0.186***	-0.111***	0.007	-0.107***	-0.166***	-0.156***	-0.308***	-0.164***	-0.005	-0.183***	-0.278***	-0.293***	-0.138***
(26)	$\overline{ERisk}$	0.277***	0.169***	0.010**	0.200***	0.229***	0.212***	0.457***	0.247***	0.073***	0.343***	0.380***	0.400***	0.150***

Appendix G: Correlations (continued)

#	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	RD/TA	0.292***	-0.310***	-0.084***	-0.073***	-0.040***	0.149***	0.490***	0.365***	-0.470***	-0.242***	-0.343***	-0.192***	0.295***
(2)	RDD	0.185***	-0.199***	0.003	-0.028***	-0.016***	0.031***	0.329***	0.237***	-0.337***	-0.177***	-0.232***	-0.117***	0.183***
(3)	$\Delta RD/TA$	-0.006	0.004	0.007	0.008*	-0.060***	0.008*	0.016***	0.008*	-0.012***	-0.012***	-0.001	-0.002	0.006
(4)	$RDSGA/TA$	0.153***	-0.268***	-0.330***	-0.108***	-0.031***	0.239***	0.361***	0.234***	-0.370***	-0.324***	-0.223***	-0.126***	0.229***
(5)	$RDSGA/Sales$	0.308***	-0.324***	-0.212***	-0.147***	-0.062***	0.216***	0.559***	0.445***	-0.509***	-0.255***	-0.366***	-0.196***	0.284***
(6)	RD/NA	0.306***	-0.338***	-0.086***	-0.070***	-0.040***	0.146***	0.511***	0.380***	-0.488***	-0.231***	-0.359***	-0.196***	0.294***
(7)	$Cash$	0.270***	-0.318***	-0.164***	-0.112***	-0.054***	0.210***	0.743***	0.547***	-0.707***	-0.318***	-0.538***	-0.300***	0.444***
(8)	$Mtbv$	0.189***	-0.230***	-0.139***	-0.088***	-0.033***	0.143***	0.533***	0.388***	-0.526***	-0.249***	-0.394***	-0.188***	0.299***
(9)	$Debt$	0.049***	-0.040***	-0.047***	-0.005	0.005	0.046***	0.130***	0.095***	-0.087***	-0.087***	-0.058***	-0.048***	0.084***
(10)	$Size$	0.199***	-0.269***	-0.204***	-0.082***	-0.038***	0.180***	0.588***	0.420***	-0.594***	-0.454***	-0.393***	-0.225***	0.391***
(11)	ROA	0.343***	-0.341***	-0.161***	-0.117***	-0.051***	0.188***	0.834***	0.669***	-0.751***	-0.324***	-0.568***	-0.298***	0.413***
(12)	$EShock$	0.295***	-0.333***	-0.139***	-0.119***	-0.053***	0.194***	0.787***	0.591***	-0.740***	-0.261***	-0.560***	-0.293***	0.411***
(13)	$ERisk$	0.322***	-0.567***	-0.104***	0.052***	-0.053***	0.063***	0.464***	0.330***	-0.418***	-0.045***	-0.291***	-0.123***	0.129***
(14)	$\overline{RD/TA}$	1	-0.275***	0.130***	0.367***	-0.196***	-0.081***	0.340***	0.499***	-0.314***	0.008*	-0.154***	-0.099***	0.082***
(15)	$\overline{RDD}$	-0.263***	1	0.201***	-0.193***	0.053***	-0.016***	-0.359***	-0.272***	0.381***	0.100***	0.218***	0.126***	-0.135***
(16)	$\overline{\Delta RD/TA}$	0.058***	0.175***	1	0.181***	0.048***	-0.508***	-0.094***	-0.021***	0.103***	0.377***	0.073***	0.101***	-0.215***
(17)	$\overline{\Delta RDSGA/TA}$	0.174***	-0.111***	0.214***	1	-0.080***	-0.285***	-0.123***	-0.027***	0.099***	0.022***	0.253***	0.032***	-0.061***
(18)	$\overline{\Delta RDSGA/Sales}$	-0.186***	0.056***	0.049***	-0.049***	1	-0.044***	-0.050***	-0.034***	0.052***	0.042***	0.042***	0.089***	-0.088***
(19)	$\overline{RD/NA}$	-0.003	0.020***	-0.459***	-0.325***	-0.015***	1	0.149***	0.108***	-0.142***	-0.219***	-0.148***	-0.222***	0.412***
(20)	$\overline{Cash}$	0.314***	-0.329***	-0.037***	-0.186***	-0.054***	0.133***	1	0.669***	-0.844***	-0.186***	-0.542***	-0.274***	0.304***
(21)	$\overline{Mtbv}$	0.440***	-0.238***	-0.002	-0.088***	-0.042***	0.126***	0.662***	1	-0.625***	-0.008*	-0.267***	-0.252***	0.206***
(22)	$\overline{Debt}$	-0.259***	0.380***	0.116***	0.132***	0.055***	-0.134***	-0.771***	-0.553***	1	0.220***	0.408***	0.272***	-0.260***
(23)	$\overline{Size}$	-0.009*	0.123***	0.392***	0.043***	0.038***	-0.189***	-0.109***	-0.006	0.283***	1	0.154***	0.229***	-0.530***
(24)	$\overline{ROA}$	-0.141***	0.188***	0.057***	0.255***	0.045***	-0.138***	-0.573***	-0.245***	0.363***	0.164***	1	0.187***	-0.365***
(25)	$\overline{EShock}$	-0.102***	0.115***	0.080***	0.061***	0.096***	-0.233***	-0.256***	-0.245***	0.259***	0.191***	0.178***	1	-0.448***
(26)	$\overline{ERisk}$	0.131***	-0.126***	-0.179***	-0.084***	-0.106***	0.425***	0.271***	0.256***	-0.259***	-0.450***	-0.321***	-0.479***	1

Online Appendices

Not For Publication

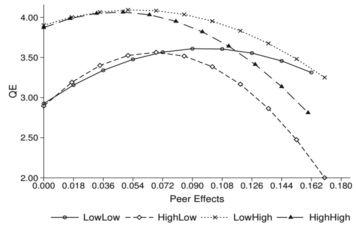


(a) RD/TA (b) RDD (c) ΔRD/TA (d) RDSGA/TA (e) RDSGA/Sales (f) RD/NA

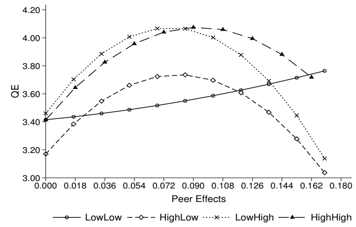
(g) RD/TA (h) RDD (i) ΔRD/TA (j) ΔRDSGA/TA (k) RDSGA/Sales (l) RD/NA

Figure A.1: R&D across industrial sectors

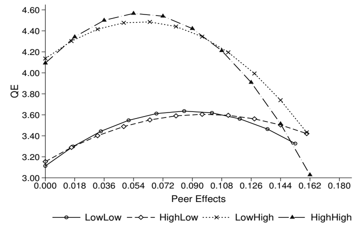
The figure presents the average R&D for firms in the non-manufacturing and manufacturing sectors, and non-durable and durable sectors. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. The broad industrial sector categorisations are defined as follows: non-manufacturing (SIC code $<$ 2000 and SIC code $>$ 3999); manufacturing (2000 $\leq$ SIC code $\leq$ 3999); durables (2400 $\leq$ SIC code $\leq$ 2500 and 3200 $\leq$ SIC code $\leq$ 3800); and non-durables (2000 $\leq$ SIC code $\leq$ 2300 and 2600 $\leq$ SIC code $\leq$ 3100). All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.



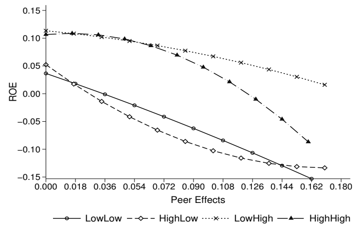
(a) LogSales



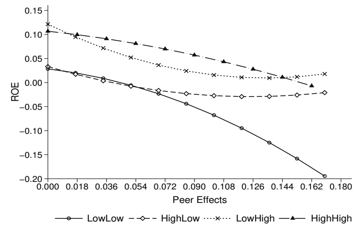
(b) Profit Margin



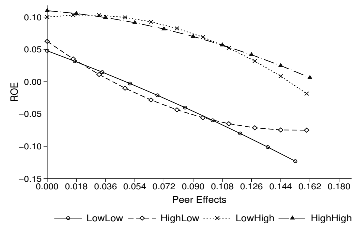
(c) Analyst Followings



(d) LogSales



(e) Profit Margin



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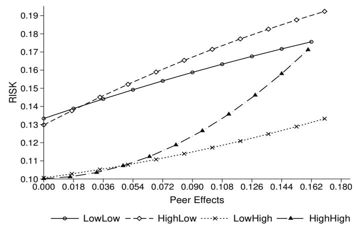
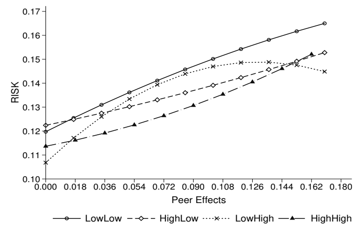
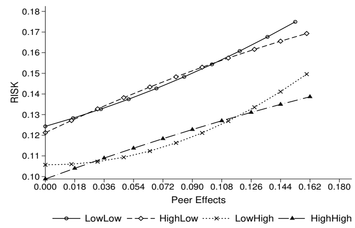


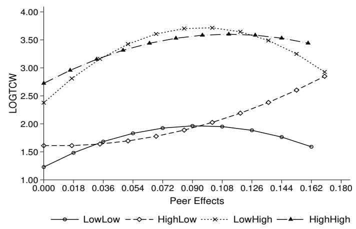
(g) LogSales



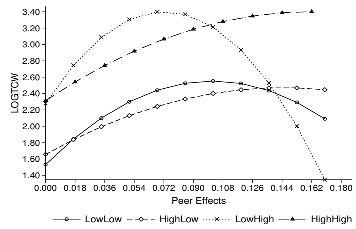
(h) Profit Margin



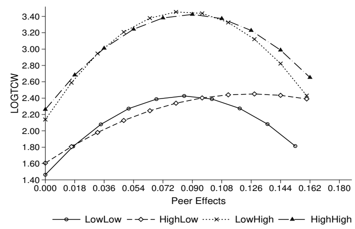
(i) Analyst Followings



(j) LogSales



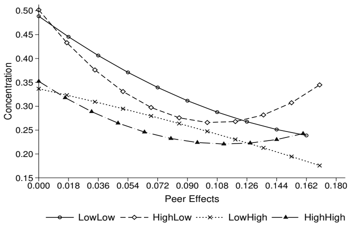
(k) Profit Margin



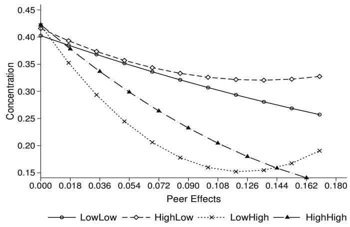
(l) Analyst Followings

Figure A.2: Further tests of the implications of responding to peer firms

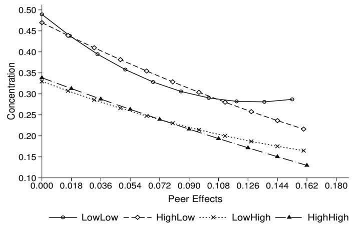
The figure plots the marginal effects of peer firms on corporate outcomes. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. The broad industrial sector categorisations are defined as follows: non-manufacturing (SIC code < 2000 and SIC code > 3999); manufacturing ($2000 \leq$ SIC code ≤ 3999); durables ($2400 \leq$ SIC code ≤ 2500 and $3200 \leq$ SIC code ≤ 3800); and non-durables ($2000 \leq$ SIC code ≤ 2300 and $2600 \leq$ SIC code ≤ 3100). All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.



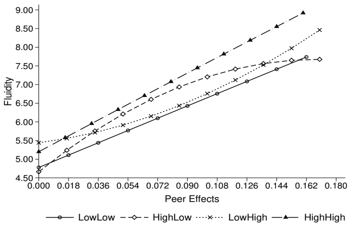
(m) LogSales



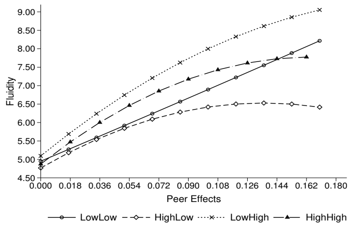
(n) Profit Margin



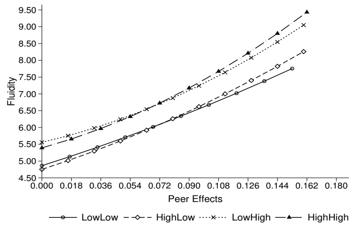
(o) Analyst Followings



(p) LogSales



(q) Profit Margin



(r) Analyst Followings

Figure A.2: Further tests of the implications of responding to peer firms

The figure plots the marginal effects of peer firms on corporate outcomes. The sample consists of listed non-financial firms in the US drawn from *Compustat* over the period from 1968 to 2018. The broad industrial sector categorisations are defined as follows: non-manufacturing (SIC code < 2000 and SIC code > 3999); manufacturing (2000 ≤ SIC code ≤ 3999); durables (2400 ≤ SIC code ≤ 2500 and 3200 ≤ SIC code ≤ 3800); and non-durables (2000 ≤ SIC code ≤ 2300 and 2600 ≤ SIC code ≤ 3100). All Variables used are defined in Appendix A, and are winsorised at the lower and upper one percentiles.