Patents Do Not Measure Innovation Success*

David M. Reeb, National University of Singapore, dmreeb@nus.edu.sg

Wanli Zhao, Renmin University of China, zhaowanli@ruc.edu.cn

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ABSTRACT

We find that a company's patent filings and citations are not good measures of R&D success or failure, even when compared to firms in the same industry. Instead, our analysis reveals that patent counts reflect the firm's mix of product and process innovation. Intuitively, competitor infringements of process innovation are difficult to detect, suggesting these innovations are better protected via trade secret than patents. We document that non-patenting firms frequently announce valuable new products, even though they emphasize process over product innovation. Insider trading in non-patenting firms generates positive excess returns, while such activity in patenting firms yields ordinary returns. The Uniform Trade Secrets Act induced firms to switch from patenting to non-patenting, leading to lower analysts and institutional following. Financial intermediaries potentially influence the disclosure of innovation rather than research and development success (Aghion et al., 2013; Bena et al., 2017). Overall, our tests indicate that patents and citations signify the nature of innovation rather R&D success.

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A substantial literature evaluates the returns to R&D by counting the number of patents a firm obtains, claiming firms with patents possess successful R&D programs. Atanassov (2013) contends that patents and their citations provide credible measures of corporate innovation, especially relative to R&D expenditures, because they capture both innovation successes and failures. Hirshleifer et al. (2017) use patents and their citations to capture the breadth of knowledge built on a firm's R&D spending. Brav et al. (2018) discuss how patent counts and citations, per dollar of R&D spending, allow one to gauge the innovation efficiency of a firm. More generally, patent counts and citations are used to summarize innovation output, providing a way to quantify the success of corporate R&D programs. Firms with patents are depicted as making valuable R&D discoveries, while non-patenting R&D firms are effectively classified as "failed inventors." Appendix A provides a snapshot of recent cross-disciplinary studies that rely on patents to capture innovation output, revealing that 75% of these articles classify non-patenting firms as "failed innovators." In contrast, the remaining 25% of these innovation studies exclude non-patenting companies from the analyses (e.g., Bernstein, 2015).[1]

Yet, the majority of firms with R&D expenditures do not obtain patents, with non-patenting firms arising across a wide spectrum of industries. In 2010, among the 2,000 largest US industrial firms with a combined market capitalization of $6 trillion, slightly over half of them did not seek patents. More surprisingly, about a third of these positive R&D firms have not filed a single patent over the past 25 years. Appendix B shows that these non-patenting firms, in aggregate, spend over $10 billion on R&D each year. As the majority of patenting firms only receive one or two patents a year, it is not surprising that R&D budgets in patenting and non-patenting firms often have similar magnitudes. Specifically, the R&D budgets in non-patenting firms correspond to the 66th percentile of R&D budgets in patenting firms. Non-patenting firms are prevalent, prominent, and exhibit similar R&D spending to many of their patenting peers. If patents provide a measure of corporate R&D productivity, then the vast majority of corporate R&D programs appear unsuccessful. To assess the validity of the claim

[1] Typically, studies that exclude non-patent firms make proprietary cost arguments, suggesting non-patenting firms choose to keep their successful innovation as trade secrets (Hall et al., 2014). At least one of these contradictory viewpoints (and perhaps both) incorrectly portrays non-patenting firms. If patents capture innovation success, then non-patenting firms (failed innovators) systematically, year after year, invest in R&D that fails to achieve success.

that patent (citation) counts measure R&D success, we test whether firms without patents exhibit positive R&D outcomes.

We explore a simple alternative explanation for the limited prevalence of patents in most R&D firms, namely that it reflects the type of R&D undertaken rather than R&D success or failure. Depending on the type of research a firm engages in, it may prefer to keep its innovations a trade secret rather than seeking protection via a patent. Patents help protect intellectual property and provide a disclosure about the firm's innovation activity to both competitors and investors (Spiegel and Tookes, 2013). Patents give competitors a guide that they can use to replicate the innovation even if it requires inventing around the patent claim (Cohen et al., 2000). Thus, a patent offers a firm partial property rights protection at the cost of making the details of the innovation public (Anton and Yao, 2004). For an innovation that leads to a new product or affects the consumers' experience, patents give the firm a method to defend potential duplication by competitors. In contrast, production or process innovation often remains invisible to competitors even if they acquire a sample of the product. For these process breakthroughs, it is likely better to keep the details secret within the firm, than to seek a patent and make the details public. In this context, we posit that firms engaging in process innovation can pursue very successful R&D programs while applying for few if any patents. Of course, firms may engage in both product and process innovation, suggesting that the number of patents a firm obtains reflects the mix of innovation rather than the success of the R&D program.

To gauge innovation failure and success in non-patenting R&D firms, our initial tests rely on new product announcements (Chaney et al., 1991), margin responses to competition shocks (Eberhart et al., 2004), and the revealed assessments of corporate insiders (Aboody and Lev, 2000). We undertake a series of tests, comparing non-patenting R&D firms to firms with zero R&D and to their patenting R&D peers.[2] Our tests primarily focus on full sample analysis as our research question centers on the cross-industry nature of non-patenting firms rather than on the causes of corporate innovation. Yet, to assess whether single-industry or fixed-effects analysis will lead to different inferences about non-

[2] Zero R&D firms are those that explicitly disclose zero R&D expenditures in their financial statements. Our main tests do not include firms without reported R&D but with positive patent activity (Koh and Reeb, 2015). We incorporate these firms in later tests (see Internet Appendix Figure A1).

patenting firms, we generate robust matched samples within each industry-year group during the period 1986 to 2010. Finally, we explore the ability of financial analysts and institutional shareholders to influence corporate disclosures regarding their innovation activity.

If patent and citation counts provide a measure of the success of corporate R&D programs, then non-patenting firms should exhibit similar patterns of new product announcements as their zero R&D peers. Our tests, based on both full and matched samples, reveal that non-patenting R&D firms exhibit substantially greater new product announcement prevalence (67% higher) and intensity (42% higher) than their zero R&D peers. The multivariate results provide similar inferences, revealing about 91% more new product announcements in non-patenting R&D firms than in zero R&D firms. Market reactions to product announcements indicate that non-patenting R&D firms experience about a 164% higher value gain from their new product announcements relative to their zero R&D peers. Non-patenting R&D firms exhibit substantial and widespread positive R&D outcomes.

While the majority of innovation research classifies non-patenting firms as failed innovators, one branch of the patent count literature discards or deletes such firms from the analysis. We note that excluding R&D firms without patents implicitly assumes similar R&D outcomes in both patenting and non-patenting firms, otherwise such an exclusion creates biased inferences. Thus, our next test assesses whether non-patenting firms experience similar outcomes as those found in patenting firms. We find that patenting and non-patenting R&D firms innovate differently, with non-patenting firms exhibiting fewer and less valuable new product announcements than their patenting peers. The evidence allows a rank ordering of the three types of firms by new product announcements and market reactions. Figure 1 provides graphical evidence on this comparison, showing the distribution of new product announcements across each of the three groups, as well as patent-seeking firms without reported R&D (Koh and Reeb, 2015). Thus, non-patenting R&D firms differ from both patenting R&D firms and firms without R&D expenditure, suggesting that the common practice of excluding firms without patents can lead to unfounded conclusions.

Our third set of tests specifically explores the nature of innovation between non-patenting and their patenting R&D peers, namely process- versus product-oriented innovation, using subsequent cost margins to assess corporate outcomes after a tariff induced competition shock. Bloom et al. (2016) observe that companies with more successful innovation fare better against import competition, suggesting that shock-responses provide a venue to capture process innovation. We find that after an industry becomes more competitive due to import tariff shocks, non-patenting R&D firms tend to experience greater process innovation improvements relative to both zero R&D firms and their patenting R&D peers. While the underlying mechanisms behind these results are difficult to assess, importantly they suggest the nature of innovation differs between patenting and non-patenting firms (product-oriented versus process-oriented). Figure 2 provides graphical evidence on this comparison, showing the distribution of process innovation across each of the three groups. So far our evidence points to substantial and distinctive positive R&D outcomes in non-patenting R&D.

In our fourth set of tests, we investigate innovation in non-patenting R&D firms based on the revealed assessments of corporate insiders. Aboody and Lev (2000) document that opportunistic insider trading increases with greater R&D, allowing us to use insider trading activity to evaluate the managers' revealed assessments about innovation outcomes across non-patenting, patenting, and zero R&D firms. Comparing insider trading in patenting and non-patenting R&D firms is revealing. We find that the non-patenting R&D firms, rather than patenting R&D firms, account for the opportunistic insider trading documented in R&D firms. More specifically, non-patenting R&D firms experience significantly greater opportunistic insider purchasing activity relative to zero R&D firms, while patenting firms do not exhibit higher insider trading than zero R&D firms. In short, the revealed assessments of corporate insiders provide evidence against the failed inventor hypothesis; instead, managers of these firms routinely engage in opportunistic insider trading that exploits their information about the firm's innovation outcomes. Notably, these results imply that one potential benefit of patent-based disclosures of corporate innovation is to limit opportunistic insider trading activity. Figure 3 provides graphical evidence on this comparison, showing the distribution of opportunistic insider trading across each of the three groups.

All of the test results in our analyses provide evidence inconsistent with the notion that non-patenting R&D firms are failed innovators. Taken together, these results imply that the non-patenting choice arises from a disclosure choice of the firm. To investigate this disclosure choice and the demand for information about corporate innovation, we explore how financial analysists and institutional investors respond to an exogenous decrease in corporate disclosures about their innovation activity. We exploit the staggered enactment of the Uniform Trade Secrets Act (UTSA), which provides stronger intellectual property rights protection for non-patenting firms after the adoption of the legislation (Png, 2017). Presumably, this legislation does not decrease firms' investments in innovation but does increase their incentives or capacity to protect their innovation under the UTSA. Consistent with this notion, we find a 184% net increase in firms switching from patenting to non-patenting status after UTSA enactment. Importantly, we find that non-patenting firms experience greater changes in both financial analyst following and institutional investor ownership after these changes than their patenting peers. Thus, financial and market intermediary scrutiny appears to be influenced by the firm's strategy to either disclose innovation or protect its intellectual property via trade secrets, suggesting that financial analysts and institutional investors exhibit substantial interest in disclosures about corporate innovation.

Our final series of tests examine how rival firms react to intermediary-induced increases in the disclosure of corporate innovation (Dye, 1985; Verrecchia, 2001). Specifically, we assess whether rival firms increase their R&D spending after an increase in analyst coverage or institutional ownership. We find a 400% differential response to intermediary scrutiny in patenting and non-patenting R&D firms. Rivals of non-patenting firms substantially increase their R&D spending after an increase in analyst coverage or institutional ownership in non-patenting industry firms. Dividing the non-patenting R&D firms into those that increase their innovation disclosures after this increasing intermediary scrutiny, versus those that do not, reveals a 700% difference in rival firms' R&D spending responses. Thus, the rival firms' response to increased R&D spending after an increase in intermediary scrutiny is primarily concentrated in firms that immediately increase their disclosures of corporate innovation. In short, these results suggest that this increased disclosure of corporate innovation comes at a cost to the firm, namely more aggressive innovation spending by their rivals.

Instead of measuring innovation success and failure, this evidence suggests that patents reflect the mix of process versus product innovation and a disclosure choice of the firm. The type of innovation a firm produces, which is likely influenced by firm and industry characteristics, favors keeping some successful innovation as a trade secret and seeking patent protection for other innovations. Presumably, in each industry, firms make different patenting choices based on their distinct mix of product- and process-oriented innovation. Consistent with this notion, we also document substantial within-industry variation in the firms emphasizing product- and process-oriented innovation. Rather than companies in the same industry exhibiting the similar innovation strategies, which is implicit in matched pair samples, firms in standard SIC industries (2, 3, or 4 digit) typically exhibit a steady mix of product and process innovation. Consequently, any matching exercise is likely to pair process and product-oriented innovators. Moreover, single industry studies, such as those based on the pharmaceutical industry (SIC 283), undertake their analyses on firms systematically split between product (55%) and process (45%) oriented innovation.

This study makes several important contributions to the literature. First, our analysis provides evidence inconsistent with the notion that patent counts or citations provide a way to measure innovation success and failure. Both patenting and non-patenting R&D firms release valuable new products and develop cost-saving processes. A key difference is that patenting firms exhibit greater product innovation, while non-patenting firms demonstrate greater process innovation. Instead of depicting failed innovation, non-patenting firms arise from a disclosure choice of the firm. Importantly, the evidence indicates that patents provide a signal about the nature of a firm's innovation even though they do not measure innovation success or failure. In this context, R&D expenditure disclosures stem from mandatory reporting requirements, while patents arise from a voluntary disclosure choice.

Our analysis also suggests that stakeholders outside of the firms potentially influence the firms' decisions to disclose innovation via patenting, i.e., the choice between formal and informal intellectual property protection. While this investigation does not focus on the determinants or mechanisms that lead firms to engage in product or process innovation, the disclosure decision regarding innovation appears related to both information and financial intermediary scrutiny (as well as other firm characteristics). Recent research emphasizes that analysts following (He and Tian, 2013) and institutional ownership (Aghion et al., 2013; Bena et al., 2017) cause firms to achieve more successful innovation output, based on evidence of significantly greater patent activity. Our analysis provides an alternative interpretation of these findings, suggesting that these intermediaries potentially influence the disclosure of innovation rather than its intensity. Whether this increased innovation disclosure stems from attempts to reduce opportunistic insider trading, is aimed at keeping rivals from patenting related products (Cohen et al., 2000), or some alternative reason is difficult to assess. Yet, our evidence does suggest that rather than causing successful corporate innovation as claimed in prior research, outside stakeholders of the firm influence the disclosure of the firm's innovation activities.

Finally, the economics literature on innovation focuses on understanding both the constraints and the impacts of corporate innovation. Research on innovation constraints emphasizes that both human and financial capital limit firms' investments in R&D. Yet, our understanding of why some firms choose to concentrate on innovation activity while other successful firms opt out of this competition remains unclear. Our analysis suggests that the decision to engage in innovation does not center on just the capital endowments of the firm but also the nature of the informal property rights protection. Firms that specialize in protecting their innovation via non-disclosure (trade secrets) likely differ in their decision to pursue innovation relative to firms that focus on seeking patent protection. Against this backdrop, our results imply that modeling the decision to engage in competition also requires a selection or evaluation of the formal and informal property rights protection processes. Firms that undertake trade secret-based R&D likely differ in their governance and decision processes for managing innovation activity. Thus, our analysis highlights the need to incorporate the choice of formal or informal intellectual property protection when modeling corporate decisions to engage in innovation.

1. Data, Sample, and Variables

1.1 Data Sources and Sample

Our sample is a cross-section of all non-finance, non-utility firms with their total assets and sales available on Compustat from 1986 to 2010, consisting of 97,472 firm-year observations of 11,179 unique firms. We obtain firm characteristics and insider trading data from Compustat, CRSP, Thomson Reuters, and the Institutional Brokers' Estimate System (I/B/E/S). We collect firms' product announcements data from the LexisNexis news database (Mukherjee et al., 2017) and patents from the USPTO (Hall, 1990). We search the news releases that are tagged under the subject "new products" whose headlines contain any of the following keywords, or roots of the keywords: "launch", "product", "introduce", "begin" or "unveil." We download all 377,129 news articles and extracted 89,561 stock trading symbols from the articles, which we match with all common stocks traded on the NASDAQ, NYSE, and AMEX from CRSP database. Appendix C shows two examples of new product announcements. Through this process, we obtain 71,092 announcements made by 4,085 unique firms from 1986 to 2010. The number of announcements ranges from 1 to 122 per year per firm.

The sample sizes in our tests vary for two reasons. First, we conduct analyses comparing data from different types of firms. Second, we use both full samples and propensity-score matched samples. Specifically, our analyses involve three categories of firms according to their R&D reporting and patenting choices. Zero R&D firms refer to the firms that explicitly report zero R&D expenditure in their financial statements. Patenting (non-patenting) firms refer to those firms reporting positive amounts of R&D expenditures that also choose to patent (not patent) their R&D outcomes.

We first compare non-patenting firms with zero R&D firms, followed by comparisons between non-patenting and patenting firms. The reason for the first comparison is to assess whether non-patenting firms are similar to zero R&D firms, i.e., whether the non-patenting firms represent failed innovators. Our following set of analyses concentrate on comparisons between patenting and non-patenting firms. The full sample consists of 35,614 (46,062) firm-year observations for the first (second) comparison, involving 1,721 unique zero R&D firms, 4,481 unique non-patenting firms, and 3,193 patenting firms.

Typically, empirical analysis centers on testing causal arguments and controlling for industry specific differences. In this setting, however, the practice of counting all firms across multiple industries as failed innovators implies firms in those industries face similar failures. Thus, the univariate and full sample analyses provide the best test environments for evaluating whether non-patenting firms depict innovation failure. Yet, some studies focus on specific industries (predominantly with patenting firms), which potentially mitigates problems with non-patent firms in the analysis. Consequently, we conduct matching within each 2-digit-SIC industry-year group to allow similar industry comparisons. Specifically, we use propensity score matching for firm size, R&D (only between non-patenting and patenting firms), and firm age, without replacement, and with a caliper of 0.1%. The matched sample consists of 7,782 firm-year observations for non-patenting and zero R&D comparison, with half non-patenting and half zero R&D firms. For the comparison between non-patenting and patenting firms, the matched sample is comprised of 8,088 firm-year observations.

1.2 Variable Definitions

1.2.1 Dependent Variables

We use multiple performance metrics as the dependent variables in our tests. We use product announcements as the first metric to measure a firm's innovation outcome or performance, and we compare product announcements in non-patenting firms to those in zero R&D and patenting firms. *Annoucnement_dummy* is an indicator variable equal to 1 if the firm makes any new product announcement during the year and 0 otherwise. *#Announcement* is a discrete variable for the number of new product announcements. In addition, we also use a market-based metric to gauge the investor assessment of the new product announcements. Much like Kogan et al. (2017), who estimate the value of patents by relying on stock price reactions to patent grants, we use the dollar trading volume surrounding the announcements to gauge the effect of new product announcements. Specifically, *Dollar51* is the dollar trading volume based on the cumulative abnormal return during the window of day -5 to day 1 around the new product announcements, aggregated over the year.

In addition, we also use an accounting-based measure to represent the different operating strategy underlying the firm's patenting choice. Innovation may center on process improvements such as cutting the costs of manufacturing (Chan et al., 2001; Eberhart et al., 2004). *Process Innovation* measures subsequent trends in the cost of goods sold, $(COGS_{t+3}-COGS_t)/Sales_t$. To potentially isolate the role of process innovation on costs of goods sold, our comparison relies on firms' responses to tariff induced competition shocks.

We also explore the issue of failed innovation in non-patenting firms by investigating a managerial perspective, i.e., by observing their trading activity. To mitigate the possibility that insider-trading differentials are due to distinct managerial risk-taking profiles, we examine both insider purchases and insider sales of stocks. If risk preference explains the differential effect of patenting choices on insider trading, we would expect the effect to manifest in both insider purchases and insider sales. On the other hand, if the patenting choice reflects managerial insider information about the firm's innovation, we expect to observe a different effect of patenting choices on insider purchases and sales. We use two measures to capture the opportunistic insider trading of stock purchases and sales by chief executive officers (CEOs) following Cohen et al. (2012)'s methodology. *OppBuyRatio* (*OppSellRatio*) is the number of shares in opportunistic purchases (sales) initiated by the CEO during the year scaled by the shares outstanding. If the non-patenting choice is made to protect the firm's innovation, we expect insider purchases to be greater, while if the non-patenting firms represent poor innovation outcomes, we expect greater insider sales.

Intuitively, the ability of financial analysts, institutional shareholders, and banks to influence corporate disclosures, instead of influencing efficiency of the inventors of the firm, seems plausible. To test this notion, we focus on the market scrutiny of firms by intermediaries, and we use two metrics to measure market scrutiny. The first dependent variable is *Analyst Following*, which is measured by the log of 1 plus the number of analysts following the firm during the year. The second measure is *Institutional Ownership*, the proportion of the firm's common equity held by the institutional investors during the year. Finally, we consider rival responses to increased innovation disclosures, comparing the impact on rival R&D spending of new disclosures by patenting and non-patenting firms.

1.2.2 Right-Hand-Side Variables

Because our sample consists of three types of firms, we use two indicator variables capturing each firm's R&D disclosure and patenting choice. *Non-patenting* (*Patenting*) is a dummy variable indicating a firm with positive R&D and without (with) patents. Our control variables include *Firm Size* (log of assets), *Competition* (Herfindahl index of sales for each 2-digit SIC year), *Leverage* (long-term debt divided by total assets), *ROA* (income before extraordinary items divided by total assets), *Market-to-book* (the market value of the equity divided by the book value of the equity), *Volatility* (annualized daily return volatility during the prior three years). Detailed variable definitions are provided in Appendix D.

2. Non-patenting Firms vs. Zero R&D Firms

2.1 Univariate Statistics

Table 1 Panel A presents summary statistics between non-patenting and zero R&D firms based on the full sample. First, we show that 17.4% of the non-patenting firms announce new products, while 8.6% of zero R&D firms did so during the sample period. Similarly, we find that on average non-patenting firms announce roughly 0.4 new products per year and zero R&D firms announce about 0.2. The dollar trading volume over the announcement window also suggests that non-patenting firms receive higher market reactions than zero R&D firms. Columns 7 and 8 report the results of mean and median tests, showing that all three measures are significantly higher in non-patenting firms than in zero R&D firms.

Turning to other firm variables, Panel A shows that non-patenting firms have average total assets of $341 million, while zero R&D firms have a mean size of $1,110 million. R&D is roughly 10.1% of the total assets among non-patenting firms, while by definition it is zero in zero R&D firms. Leverage is 13.5% in non-patenting firms and 21.2% in zero R&D firms. On average, non-patenting firms are 11.6 years old and zero R&D firms are 12 years old. Industry competition shows that non-patenting firms appear to be in less competitive industries. Mean and median tests suggest that non-patenting firms are smaller, less levered, younger, and face less industry competition than zero R&D firms.

Panel B shows the summary statistics for the matched sample. First, we note that because we hard-match firms within each industry-year, the matched firms have statistically similar firm size, leverage, firm age, and industry competition. Second, we observe that non-patenting firms are more likely to announce new products than matched zero R&D firms and announce more new products as well. These differences are statistically different in both mean and median tests. The market reaction metric is similar in the mean test but different in the median. Taken together, Table 1 clearly indicates that non-patenting firms have more new products than zero R&D firms, which is inconsistent with the notion that they represent failed innovation.

2.2 Multivariate Results

Table 2 presents the regression results where we focus on new product announcements. Columns 1-3 show the full sample results and columns 4-6 show the matched sample findings. In all specifications we control for the industry and year fixed effects on time-invariant and firm-invariant factors. We use the Huber-White Sandwich Estimator clustered at the firm level as a control for firm-level serial correlation. More specifically, in Column 1 we use logit regression to assess the effect of announcement propensity, and we find that the coefficient of *Non-patenting* is 1.103 and significant at 1% (z-statistics > 8.05), suggesting that non-patenting firms are more likely to announce new products than zero R&D firms.

In Column 2, we report the results from a Poisson regression. The dependent variable in this specification is the number of new product announcements.[3] The coefficient is 0.992 and is significant at 1% (z-statistics > 5.82), indicating that non-patenting firms on average have roughly 1 more new-product announcement than zero R&D firms per year. Turning to the market assessment of new product announcements, we again find that non-patenting firms receive significantly higher investor reaction than zero R&D firms. Presumably, better quality products are expected to generate more positive market reactions. This evidence suggests that non-patenting firms probably have higher quality new products than zero R&D firms as well. Columns 4-6 show the matched sample results,

[3] Alternative specifications using negative binomial regression yield similar inferences as the Poisson regressions.

which are qualitatively and quantitatively similar to the full sample findings. In sum, Table 2 provides strong evidence that non-patenting firms generate more new products than zero R&D firms. Non-patenting firms do not appear to be failed innovators.

3. Non-patenting vs. Patenting Firms

3.1 Univariate and Multivariate Results

Table 3 Panel A shows the summary statistics of the full sample of non-patenting and patenting firms. Here we find that non-patenting firms exhibit a lower propensity to announce new products than patenting firms. In addition, they tend to announce 0.42 new products per year while patenting firms announce almost three times more products. Patenting firms also have higher dollar trading volumes upon new product announcements than non-patenting firms. Mean and median tests show that these differences are all significant at the 1% level. In addition, we also find that non-patenting firms are significantly smaller, less leveraged, younger, and face less industry competition. The full sample allows our analysis to examine the notion that zero patents mean similar failures across different industries. To test whether single industry schemes mitigate these patent concerns, we generate a propensity score hard-matched sample. Panel B, based on matched sample, shows again that the firm variables that we use for the match are statistically similar between non-patenting and patenting firms, suggesting that the matching process achieves covariate balancing across the two groups. More importantly, we note that non-patenting firms have a lower propensity to announce new products, announce fewer new products when they do make announcements, and generate smaller market reactions because of the new product announcements. These statistics in Panel A and Panel B indicate that non-patenting firms make fewer new products from their operations relative to their patenting peers.

Panel C provides the multivariate results; columns 1-3 show results for the full sample and columns 4-6 for the matched sample. As the univariate results show, we find consistent results across the two samples. More specifically, in Column 1 we use logit regression to check the propensity to announce new products, and we find that the coefficient is negative and significant at 1% level (|z-statistics| >

10.91), suggesting that non-patenting firms have a significantly lower probability of announcing new products. The negative and significant coefficient in the Poisson regression in Column 2 shows again that non-patenting firms, on average, announce fewer new products than their patenting peers. Finally, in Column 3 we find that the dollar trading volume associated with new product announcements is significantly lower among non-patenting firms than in patenting firms. Overall, the full-sample results indicate that non-patenting firms generate fewer new products than patenting firms. Turning to the matched sample results in Columns 4-6, we find very similar inferences both qualitatively and quantitatively. For instance, in the results of the logit regression in Column 4 we find that non-patenting firms have a 41.6% lower probability of announcing new products than their patenting peers. Similarly, Column 5 shows that on average non-patenting firms announce 47.6% fewer new products than their patenting peers. Taken together, the results in Table 3 indicate that compared to patenting firms, non-patenting firms seem to engage in innovative activities that result in lower quantities of new products.

3.2 Process Innovation

So far, we find that in terms of new products, non-patenting firms outperform zero R&D firms but lag behind their patenting peers. One possible explanation could be that non-patenting firms engage in different types of innovative activities. Specifically, patenting firms may be more sales- or product-oriented and therefore focus their R&D on generating new products. In contrast, non-patenting firms may be more process-oriented, suggesting a cost-focus strategy. An alternative possibility is that non-patenting firms represent failed innovators. If so, then we expect the operating performance of patenting firms to prevail over non-patenting firms. Consequently, our next exercise centers on differentiating the effect of firms' strategic patenting considerations on the firms' operating performance.

We use staggered industry competition shocks to evaluate implications of the differential effects on firm performance between patenting and non-patenting firms. Specifically, we rely on the industry competition shocks that result from a sudden import tariff increase (Feenstra, 1996; Feenstra and Romalis, 2014). Following Fresard (2010), we use the Census Bureau imports database to identify industries that have experienced drastic import tariff decreases, which causes the intensification of competition among peer firms. We classify 4-digit SIC (2011 to 3999) industries as experiencing increased competition if year-to-year tariff decreases are over 2.5 times the magnitude of the average tariff decrease. Over the time-period our study covers, we identify 57 industry competition shocks due to a sudden drop in import tariffs. [4] We expect that as industry competition increases, non-patenting firms will have fewer product announcements after the industry becomes more competitive relative to their patenting peers. We test the following specification,

$$\textit{Process Innovation} = \beta_1 * \textit{Non-patenting} + \beta_2 * \textit{Post} + \beta_3 * \textit{Post} * \textit{Non-patenting} + \beta_X * \textit{Controls} + \xi \quad (1)$$

Process Innovation, which captures the cost saving orientation of the firm, is measured by the COGS of year t+3 minus the COGS of year t and scaled by year t sales. We then multiply process innovation by -1 to achieve an easier interpretation. We create a dummy variable *Post* that equals 1 indicating the two-year window after the tariff increase shock and zero for the two-year period before the shock. Control variables include firm size, industry competition, leverage, market-to-book, and volatility.

Table 4 presents the results. In Column 1, we show the comparison between non-patenting and zero R&D firms; Column 2 shows the result when we compare non-patenting and patenting firms. In Column 1, we find that on average, non-patenting firms have a similar change in the cost of goods sold as zero R&D firms. However, we find that on average non-patenting and zero R&D firms experience greater cost savings after industry competition increases. The *Post* dummy variable is positive and significant at the 5% level. Finally, we find that the interaction term is positive and significant at the 5% level (t-statistics > 1.99), indicating that non-patenting firms have higher cost savings after an industry competition shock than zero R&D firms.

Turning to Column 2, where we compare non-patenting firms to their patenting peers, we find that non-patenting firms are not different from patenting firms, in general, in regards to cost savings. We

[4] Products imported to the U.S. are coded based on the Harmonized System (HS) established by the World Customs Organization (WCO), in which each product is assigned a ten-digit HS code. Feenstra (1996) and Pierce and Schott (2011) develop concordance tables that map each HS product code into four-digit SIC codes. Because HS codes are only based on product characteristics and SIC codes incorporate the method of production, HS codes cannot be directly matched to SIC codes. Consequently, it is possible that a given HS category can be matched to several four-digit SIC codes. In practice, however, we find no cases in which a specific product (HS code) is assigned to multiple (four-digit) SIC codes in the industries in our sample.

observe that sample firms have higher cost savings after the industry becomes more competitive. Finally, focusing on the interaction term, we find that it is significant in Column 2. Even though the results in Table 4 do not allow for causal inferences, they do imply that non-patenting firms potentially focus on cost-saving innovations. Non-patenting firms appear to fare relatively well after a tariff-induced industry shock, providing evidence inconsistent with the failed innovator hypothesis. Overall, the evidence in these tests is inconsistent with the notion that non-patenting firms are failed innovators.

3.3 Revealed Managerial Assessments

Our final test in this section compares different types of patenting choices and offers evidence from the perspective of the managers. Specifically, we explore the issue by investigating whether managers of non-patenting firms engage in more insider-trading than managers of zero R&D or patenting firms. First, we calculate the CEO opportunistic insider trading of stock purchases and sales following Cohen et al. (2012)'s methodology. Second, considering that a product announcement conveys positive information to the market, we investigate whether product announcements induce different insider trading behaviors between non-patenting and patenting firms.

We use two matched samples with the following specification,

$$\textit{Insider Trading} = \beta_1 * \textit{Non-patenting} + \beta_X * \textit{Controls} + \xi \qquad (2)$$

where we use two metrics to measure insider trading. *OppBuyRatio* (*OppSellRatio*) is the number of shares in opportunistic purchases (sales) initiated by the CEO during the year scaled by the shares outstanding.[5] We include the control variables, i.e., firm size, industry competition, leverage, ROA, market-to-book, and volatility.

Table 5 presents the results. In Columns 1-4, we include all three types of firms in the test by creating a three-way matched sample. Specifically, we first match between non-patenting and zero R&D firms, and then between non-patenting and patenting firms. The final matched sample includes those that are matched on the common non-patenting firms, consisting of 4,440 firm-year

[5] We find very similar results if we use the number of shares in opportunistic purchases. Our main sample excludes finance and utility firms, suggesting limited concerns about trading by informed government regulators (Reeb et al., 2014). Excluding pharmaceutical firms gives similar inferences.

observations with 1,480 firms in each type. In Columns 1 and 2, we combine non-patenting and patenting firms into one category which we label as *Positive R&D*. We find that positive R&D firms, on average, engage in more opportunistic managerial purchases of their firm's stocks than zero R&D firms (t-statistics > 1.80), consistent with the notion that firms with innovation activity yield greater future performance. In Column 2, we find that positive R&D firms have lower managerial sales of their firms' stock than zero R&D firms but the difference is not statistically significant. These results are also inconsistent with a risk-based explanation in which managers would engage in both purchases and sales of their firms' stock. In Columns 3 and 4, we split this group into non-patenting and patenting firms, further testing the managerial opportunistic trades of each group. Column 3 shows that non-patenting firms engage in significantly higher managerial inside purchases than zero R&D firms, while there is no difference between zero R&D firms and patenting firms. Column 4 shows that non-patenting and patenting firms have lower managerial inside sales than zero R&D firms but the difference is insignificant. In Columns 5 and 6, we focus on the 2-way matched sample between non-patenting and patenting firms. We find consistent results, namely that non-patenting firms engage in significantly higher managerial insider purchases and lower insider sales of their stock than their patenting peers. These findings via revealed managerial assessment of the innovation activity clearly suggests that they view the potential gains from the R&D investment more positively than their patenting peers.

In untabulated results, we examine the notion that if product announcements reveal information about R&D quality or efficiency, it can be expected that managers are more likely to engage in opportunistic trading in non-patenting firms than in patenting firms. Arguably, product announcements in patenting firms are relatively less informative given that the information is already contained in the patents of those firms. We include the number of product announcements, and an interaction term between *Non-patenting* dummy and the number of product announcements. The interaction term captures the incremental effect of product announcements on opportunistic trading. Results show that the product announcements variable is positive and significant, suggesting that product announcements contain positive news about the firm. In addition, we observe that the interaction term is positive and significant in both specifications, indicating that CEOs in non-patenting firms engage in more stock purchases when they announce new products than CEOs in patenting firms. New product announcement is negatively associated with insider sales of stock, consistent with the notion that new products reflect better performance expectations. In addition, we find that the interaction term of products announcements and non-patenting firm is negative and significant in both the full sample and the matched sample, suggesting that non-patenting firms with product announcements experience less insider sales of the stock.

Taken as a whole, the results in Table 5 reveal that managers of non-patenting firms engage in more insider trading than their peers of zero R&D and patenting firms. This evidence is inconsistent with the failed innovator hypothesis, instead suggesting that managers in non-patenting firms take advantage of the opacity surrounding the innovation in their firms.

4. Market Scrutiny and Patenting Choice

4.1 Cross-sectional Evidence

So far, we have found evidence suggesting that non-patenting firms engage in meaningful innovation activity that improves the firms' future performance. In this section, we examine the capital market research implications, focusing on the effect of information and financial intermediaries documented in prior studies (Aghion et al. 2013; He and Tian, 2013).

The first type of market scrutiny comes from financial analysts, who serve as important information intermediaries for the financial markets. Prior studies document that financial analyst coverage influences patent activity, which has been interpreted to suggest changes in innovation intensity. On the other hand, analyst coverage may influence the innovation disclosure decision. Consequently, we first explore if intermediaries are attracted to firms with more innovation disclosures. We investigate whether there is a difference in the number of analysts following non-patenting and patenting firms. Furthermore, if new product announcements help to mitigate the information opaqueness about non-patenting firms' R&D outcomes, then we expect that product announcements would increase the number of analysts following the firms, and that non-patenting firms benefit more than patenting firms from product announcement. Similarly, we also test whether institutional investors influence the firm's patenting choices.

We first provide cross-section test results based on both the full and the matched sample using the following specification:

$$Market\ Scrutiny = \beta_1 * Non\text{-}patenting + \beta_2 * \#Announcement + \beta_3 * Non\text{-}patenting * \#Announcement + \beta_X * Controls + \xi \qquad (3)$$

where we use two metrics to measure market scrutiny. The first dependent variable is *Analyst Following*, which is measured by the log of 1 plus the number of analysts following the firm during the year. The second measure is *Institutional Ownership*, the proportion of the firm's common equity held by the institutional investors during the year. *#Announcement* is the number of new product announcements during the year. We include the control variables, i.e., firm size, industry competition, leverage, ROA, market-to-book, and volatility.[6] If the intermediaries treat non-patenting and patenting firms similarly, then we expect that the coefficient of *Non-patenting* dummy be insignificant. In addition, if non-patenting firms are not opaquer than patenting firms, we expect no differential between non-patenting and patenting firms, holding the product announcement constant. On the other hand, if non-patenting firms are opaquer than patenting firms, we expect the interaction term to be positive, as new product announcements provide more valuable information about the R&D efficiency for non-patenting firms than for patenting firms.

We present the results in Table 6 Panel A. Poisson regression in Column 1 using the full sample shows that the non-patenting dummy variable is negative and significant at the 1% level (|z-statistics| > 5.28) where the dependent variable is the number of analysts. Economically, this indicates that non-patenting firms have 41.8% less analyst coverage. Column 2 with the matched sample shows a similar result. In addition, we find that in the full sample there is no effect from new product announcements.

In the matched sample, however, we find that analysts tend to follow firms with more new product announcements (z-statistics > 2.43). Finally, we find that the interaction term is positive and significant in both specifications (z-statistics > 2.16), suggesting that the analyst coverage is more sensitive to

[6] We define the variables in Appendix D.

new product announcements for non-patenting firms than for patenting firms. Turning to Columns 3 and 4, where we focus on institutional investors, we find very similar results. First, we show that in the full and matched samples, non-patenting firms have significantly less institutional investors than the patenting firms. Second, we find that institutional investors increase more among non-patenting firms that announce new products than among patenting firms, verifying the same inference from analysts.

4.2 Evidence from UTSA Shock

One question of interest centers on the impact of intermediary scrutiny on firm disclosures. If non-patenting firms represent failed innovators, then we do not expect an exogenous change to a firm's trade secret protection to influence their patenting choices or coverage by market intermediaries (e.g., analysts and institutional investors). On the other hand, if non-patenting firms stem from a disclosure choice and the type of innovation in the firm, then we expect non-patenting firms to change their innovation disclosures and influence intermediary coverage. We rely on the staggered adoption of UTSA by the individual states to evaluate whether patenting choices influence coverage by market intermediaries. The Uniform Trade Secrets Act is a legislation that facilitates the protection of firms' trade secrets as a result of their inventions, which has a prominent influence on the firm's choice of protection mechanism for their inventions and secrecy. More specifically, the UTSA strengthens the protection of trade secrets by dropping the requirement that the trade secret information be business-related and in continuous use, and defining misappropriation to include mere acquisition of the secret. The UTSA also stipulates civil procedures for claims, including time limitations, as well as injunctive and damage remedies for misappropriation (Pooley, 1997). Naturally, the passage of the new legislation lowers the probability of the trade secrets being reverse engineered, thus lowering the incidence of misappropriation of the trade secrets. Png (2017) documents that the adoption of the UTSA results in firms being more likely to use trade secrets to protect their inventions. Between 1979 and 2010, forty-four states enacted the UTSA, while Alabama, North Carolina, South Carolina, and

Wisconsin enacted trade secrets statutes that did not conform to the UTSA. We identify the state-year of the enactment of the UTSA by each state.[7]

We use the staggered state adoption of this new legislation to generate an exogenous shock to firm's patenting or non-patenting choices for their R&D outcomes. We expect that after the enactment of the UTSA, firms in those states will reduce their patenting activity due to the stronger protection of trade secrets by the legislation, resulting in lower analyst following and institutional ownership. More specifically, we expect that for non-patenting firms, the influence of UTSA will be minimal because they already choose to use trade secrets as their protection mechanism. For patenting firms, however, we expect that their propensity to use trade secrets to protect their R&D outcomes after the enactment of the UTSA will become higher. We expect that market scrutiny differs significantly between patenting and non-patenting firms after the passage or adoption of legislation that offers stronger protection of trade secrets, and therefore we expect to observe a significant difference in market scrutiny between patenting and non-patenting firms, namely that the patenting firms may receive a lower level of market scrutiny while non-patenting firms remain roughly the same.

To test the relationship between firms' patenting choices and market scrutiny from market participants, we rely on the staggered adoption of the UTSA by the states with the following specification,

$$\textit{Market Scrutiny} = \beta_1 * \textit{UTSA} + \beta_2 * \textit{Non-patenting} + \beta_3 * \textit{UTSA} * \textit{Non-patenting} + \beta_X * \textit{Controls} + \xi \quad (4)$$

where *Non-patenting* is a dummy variable indicating the firm's non-patenting status prior to the adoption of the UTSA and we hold the status constant for each firm. *UTSA* is a dummy variable that equals 1 for the two-year period after the state adopts the UTSA, and 0 for the two-year window prior to legislative change. We include the control variables, i.e., firm size, industry competition, leverage, ROA, market-to-book, and volatility. We expect that, on average, after the UTSA enactment, firms will reduce their patenting activity, resulting in a lower analyst following and lower levels of

[7] The data shows a small change from the common law to the UTSA for three states during our sample period: Arizona in 1990, Maryland in 1989, and Ohio in 1994. We do not classify these states as experiencing an increase in the protection of trade secrets (see Png, 2017). Five other states retained the same protection during the sample period (Massachusetts, New Jersey, New York, North Carolina, and Texas).

institutional ownership. In addition to the full sample, we have also generated a matched sample of patenting and non-patenting firms. The process is as follows. For the year prior to the state's adoption of the UTSA, we identify a similar firm of the same type as the treatment firm based on propensity score matching. More specifically, within each 2-digit SIC and year group we match each patenting (non-patenting) firm experiencing UTSA enactment with a comparable patenting (non-patenting) firm without UTSA enactment in the 2-year period surrounding the event, based on firm size, R&D, leverage, and firm age, without replacement and with a caliper of 0.1%.[8] The interaction term in the specification above thus indicates the difference-in-difference of the reaction in market scrutiny between the two types of firms after the UTSA enactment. This matching process yields 1,224 firm-year observations.[9]

We present the results testing equation (4) in Table 6 Panel B. In Columns 1 and 2, we use the entire sample, and we show that in Column 1, non-patenting firms have lower analyst following than patenting firms but the difference is insignificant. In addition, on average, after the adoption of the UTSA both patenting and non-patenting firms experience lower analyst following while the difference is again insignificant. The interaction term of non-patenting and the passage of the UTSA, however, is both positive and significant (z-statistics > 2.57), suggesting that non-patenting firms experience incrementally higher analyst following after the new legislation relative to patenting firms, consistent with the notion that patenting firms experience decreased analyst following while non-patenting firms remain at the same level of analyst coverage. This result provides a causal inference on the effect of firm's patenting choices on analyst coverage. In Column 2, we show similar results for institutional ownership, i.e., institutional ownership is relatively higher in non-patenting firms than in patenting firms after the passage of stronger trade-secret protection laws.

In Columns 3 and 4, we use a matched sample where we match non-patenting (patenting) firms experiencing legislative change with similar patenting (non-patenting) firms without legislative change. Based on the matched sample, we show that the results offer a similar inference as the full sample;

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[8] Using R&D Stock instead of current R&D expenditure as a matching variable yields similar results.

[9] In addition, we use a restricted sample which contains only the firms that choose to switch their patenting choice. We present the results in Table A1 Panel B.

that is, non-patenting firms have higher analyst coverage and institutional ownership after the passage of the new legislation relative to patenting firms, suggesting that the stronger protection of trade secrets which exogenously changes firm's patenting choices subsequently alters the market participants' interest in the firms. This evidence is consistent with the notion that the non-patenting choice yields greater information asymmetry than it does in patenting firms. Overall, the results of Table 7 provide causal inferences that patenting choices potentially influence intermediary scrutiny or coverage; or, alternatively, that these information intermediaries heavily focus on signals of innovation. Furthermore, these findings suggest that institutional investors and financial analysts differentiate their coverage of firms with innovative activities based on their patenting choice, indicating that the patenting firms fail to circumvent the informational shortfall of non-patenting firms even though these non-patenting firms perform similarly to their patenting peers. Consequently, interpreting declines or increases in patent activity compared to changes in the level of institutional shareholders or financial analysts as indicators of innovation activity may be difficult.

4.3 Is Disclosure a Plausible Explanation?

In this section, we more directly explore the capital market research on the effect of market scrutiny on firms' innovation activity. Aghion et al. (2013) and He and Tian (2013) suggest that greater market scrutiny by intermediaries helps to improve a firm's innovation performance or R&D efficiency. Our evidence so far, however, offers another explanation that centers on intermediary scrutiny inducing firms to provide greater innovation disclosures. To explore this alternative explanation, we test whether firms change their disclosure behavior after an exogenous shock on market scrutiny.

Specifically, we first explore whether the adoption of the UTSA leads to changes in a firm's new product announcements, comparing between non-patenting and patenting firms. We examine whether firms' new product announcement behavior changes after their patenting choice receives a shock. Our second test relies on S&P 500 Index inclusion. Prior studies often use a three-year window around patent grants to evaluate the effect of intermediary attention and the subsequent grants of patents on innovation activity. Given the time it takes to file a patent and receive approval, this window indicates that intermediary-induced changes in innovation policy would need to be quite quick, thereby leading the firm to start the project, complete the project, and file the patent in a very tight timeframe. More importantly, it seems unlikely that scrutiny by intermediaries would immediately (within the first year) cause the firm to successfully bring valuable new products to market. However, it seems quite plausible that firms could change their policies about new product announcements in a short window of time. Consequently, using a short window (one year) we test whether increased market scrutiny leads to immediate increases in the disclosure or release of new product announcements. We posit a short window allows for more robust inferences about changes in disclosures about corporate innovation.

In Table 7 Panel A, we first use the UTSA adoption to explore the effect of firm's disclosure choices after the shock to trade secret protection. We find that after the adoption of UTSA in a firm's headquarters state, 35.4% of patenting firms choose to announce their new products, an increase from 26.1% prior to the adoption. Among the non-patenting firms, we observe that 19.2% choose to announce new products prior to the legislative change and that proportion has increased to 36.3% after the change. The t-test shows that both increases are statistically significant. Furthermore, the difference between patenting and non-patenting firms is significant at the 1% level prior to the change, while the difference after the change becomes insignificant. Consequently, we find that the difference-in-differences is significant at the 1% level.

In addition, in Panel A where we focus on S&P 500 Index induction, we find that after inclusion in the S&P 500 index, both patenting and non-patenting R&D firms increase their announcements of new products within the first year. Specifically, prior to the shock, 41% of patenting firms announce their new products while after the shock 53.2% of the patenting firms choose to make announcements (a 29.8% increase). In contrast, non-patenting R&D firms increase their new-product announcements from 19.7% to 39% (a 98% increase) in the first year of S&P 500 inclusion, which corresponds to a 68% greater propensity to make product announcements in non-patenting R&D firms relative to their patenting peers. Thus, we find that the immediate increase in new product announcements is substantially greater in the more opaque non-patenting R&D firms than in their patenting peers. The t-test shows that the difference-in-differences is significant at the 10% level. Thus, these results point to an alternative explanation for intermediary scrutiny of corporate innovation, specifically that information and financial intermediary coverage leads to greater disclosures about corporate innovation. Moreover, the greater propensity of new product announcements in the non-patenting firms compared to the patenting firms, within the first year, seems to suggest this demand for information is greater in more opaque firms. We interpret this evidence to suggest that institutional investor ownership in the firm has a substantial impact on corporate disclosures about their innovation activities.

Both tests indicate that firms' patenting choices have a significant differential effect on the firms' disclosure choices. Clearly, a plausibly exogenous increase in external scrutiny leads patenting firms to drastically increase their disclosures as compared to non-patenting firms, indicating that an alternative explanation for the findings in prior studies could be that firms choose to disclose more about their innovative activity rather than improving their innovative efficiency.

In Panel B, we show regression results based on the two exogenous events. The dependent variable *Announcement_dummy* is used to capture the propensity of firms announcing new products. As discussed above, we suggest that using short window (1-year) around the exogenous shock to detect the disclosure effect is suitable in this context to rule out the possibility that disclosure improves R&D efficiency rather than just R&D disclosure. Consequently, in order to test the notion that patenting choice change manifest in disclosure choice change but only within a short period of time, we explicitly include three dummy variables for each of the three years after the exogenous shock. We also include the interaction terms of non-patenting with the three yearly dummy variables. If the results indicate just a change in disclosure policy then we expect to observe the effect in the latter years being at most significantly attenuated relative to the initial year. We focus on the interaction terms in the results. We find that in Column 1 after the adoption of the UTSA, non-patenting firms tend to be more likely to announce new products than their patenting peer firms. However, this differential effect decays year by year after the exogenous shock. We find that the coefficient becomes significantly smaller as time goes by after the adoption of UTSA. In Column 2, we find similar results, namely that after firms have been included in the S&P 500 Index, which is accompanied by increasing market scrutiny, the non-patenting firms experience a relatively higher propensity to announce new products than their patenting peer firms. Again, this effect is only significant in the first year after the shock while becomes smaller and insignificant in the latter two years. In sum, the multivariate results in Panel B confirm what we observe in the univariate tests in Panel A.

4.4 Competitor Responses to Intermediary-Induced Disclosures

We explore a potential cost to intermediary-induced increases in corporate disclosures of corporate innovation, namely competitor responses. The immediate increase in new product announcements reveals information about the firm's innovative activities to its competitors, which potentially incentivizes them to increase their own innovation activities. To investigate competitor responses to greater disclosures of corporate innovation, we examine peer R&D spending patterns. We compare peer responses to both patenting and non-patenting R&D firms. As our prior tests document a substantial increase in innovation disclosures by non-patenting firms, relative to patenting firms, we posit substantive competitor responses to non-patenting firm disclosures. Our benchmark group consists of the other firm-year observations where there is no S&P 500 Index induction among the firms in the industry (we exclude industries around a 2-year window surrounding the market scrutiny shock for the same industry).

We present the test results in Table 8. We restrict the peer firms to be in the same 2-digit SIC and within 15% of each other in terms of size and R&D expenditure of the newly included S&P 500 firm. In Panel A column 1, we show after inclusion in the S&P 500 Index, a firm's peers increase their R&D spending by 0.2 percentage of total assets. Given the average R&D investment is roughly 4.2% of total assets, the increase is approximately 5%. Column 2 shows that when the newly included firm in the S&P 500 is a patenting firm, their peers respond with an increase in R&D spending by 0.1 percentage. In column 3, we show that when the newly included S&P 500 firm is a non-patenting firm, their peers increase their R&D spending by roughly 0.4 percentage. Among non-peers and non-S&P included firm, the average change in R&D spending is -0.1 percent (column 4). Columns 4 through 8 provide t-tests about the differences between each pair. Column 8 indicates this peer effect on R&D

spending is substantially higher in non-patenting firms relative to patenting firms, the firms with the greatest increase in the disclosure of innovation.

In Panel B, we split the non-patenting R&D firms that are newly included in the S&P 500 Index into those who immediately increase their innovation disclosures (via new product announcements) and those who do not increase their innovation disclosures. Column 1 of Panel B shows that if the newly included S&P 500 non-patenting firms do not increase their disclosures of new products, then their peers marginally increase their R&D spending. In contrast, column 2, shows that when newly inducted firms immediately begin to disclose new products, their peers respond with a substantial increase in R&D spending. The t-tests in column 4 and 5 indicate that the peer firm effect is significantly higher than that of control sample for each scenario. Finally, column 6 shows that the difference of peer firm effect between column 1 and 2 is significant at 1%, suggesting that the peer firms react to non-patenting firms that increase their innovation disclosures substantially more than found in firms that do not increase their disclosures of innovation. Taken together, these findings are consistent with the notion that intermediary-induced increases in disclosures about corporate innovation, lead to potentially costly, competitor responses.

4.5 Within-Industry Variations of Patenting vs. Non-patenting Firms

A common practice in empirical studies on innovation, including ours, is to use matched samples to mitigate covariate unbalancing problems. Academic studies often rely on using either a single industry or matched pairs to mitigate concerns about non-patenting firms. In Table 9, we show the proportion of non-patenting firms across 2-digit and 3-digit SIC industries. The purpose is to demonstrate that even within the same industry, some firms appear to focus on product innovation while others focus on process innovation. As shown in the table, many industries contain a significant number of both types of firms, suggesting that even single industry studies are unlikely to mitigate the problems associated with non-patenting R&D firms.

5. Robustness Tests

We conduct two robustness tests. In the first test, we rely on the endogenous change of firms' patenting status and focus on the sample of firms that switch from patenting to non-patenting and vice versa. The advantage of the specification is that we are able to compare within the same firm, i.e., holding their other characteristics constant and observe the effect of their patenting choice change. Including a 2-year period around the patenting status change, we present the results in Table A1 based on 968 firm-year observations. We show that the findings in Panel A, where we repeat the Table 2 test, and Panel B repeating the Table 6 Panel A, yielding the same inference as our main results.

Second, we repeat all the main tests using the entire sample of firms from 1986 to 2010, i.e., adding another group of firms into the sample, namely missing R&D firms. In sum, we find that 1) non-patenting firms have fewer product announcements than patenting firms; 2) non-patenting firms have lower market value changes than patenting firms when they announce new products; 3) there are lower market- or industry-adjusted stock returns among non-patenting firms than patenting firms; 4) non-patenting firms have significantly lower market scrutiny from analyst following and institutional investors; and 5) corporate insiders in non-patenting firms engage in more insider purchases than patenting firms. To account for the disparate set of conditioning variables used in patent-based research (Reeb and Zhao, 2018), we also repeat our analysis with alternative control variables and find similar inferences.

6. Concluding Remarks

Corporate research and development aims to develop new products and improve production processes. A common benchmark for measuring innovation in capital markets research relies on patents and their citations (Lerner and Seru, 2017). In our 25-year sample period, among positive R&D firms the majority of firm-year observations do not have patents. These non-patenting R&D firms are prevalent and persist over time. Of course, R&D projects can span multiple calendar years, but almost one-fourth of the R&D firms in machinery and transportation did not patent anything over a time span of 10 years. Empirical research often brands these non-patenting firms as failed innovators, typically indicating that these firms have unproductive R&D results. Supporting this argument, Moser

(2013) argues that the historical evidence suggests that firms tend to patent important and high-quality innovations.

The trade secret literature emphasizes an alternative view of non-patenting firms, suggesting that patenting decisions center on the ability to secure intellectual property rights using informal protections, thus escaping the need to disclose this information to potential competitors. Multiple surveys, including the Yale I survey (Levin et al., 1987) and the Carnegie Mellon survey (Cohen et al., 2000) indicate that trade secrets are more often used than patents. Cohen et al. (2000) suggest that US firms often seek patents for strategic reasons rather than to protect their inventions. Png (2017) argues that firms rely more on trade secrets when the legal system provides better propriety information protection relative to patents. We posit the scarcity of patents among R&D firms arises because many firms focus their innovation activity on process over product innovation. Intuitively, competitor infringements of process innovation are difficult to detect, suggesting these innovations are better protected via trade secret than patents.

We test innovation in non-patenting R&D firms, focusing on theses contradictory views that patents measure R&D success or provide information on the relative mix of product and process innovation. Our investigation reveals that non-patenting firms release valuable new products and develop cost-saving processes. Our first series of tests focus on whether non-patenting R&D firms denote failed innovation by comparing the potential outcomes of innovation activity in non-patenting R&D firms to zero R&D firms and their patenting R&D counterparts in the same industry. We document that non-patenting R&D firms announce significantly more new products and products of greater value than their zero R&D industry peers. The results show a 91% differential in new product announcements, which is inconsistent with the failed innovator explanation for non-patenting R&D firms. A comparison of non-patenting and patenting R&D firms shows that there are more new product announcements in patenting firms, while non-patenting firms appear to exhibit more process innovation. After an industry shock to competitiveness, non-patenting firms experience relative cost savings improvements as compared to patenting firms, again providing evidence against the failed innovator hypothesis.

We also document that executives in non-patenting R&D firms engage in more opportunistic insider trading than either zero R&D firms or their patenting peers. Prior research emphasizes than managers have often capitalized on R&D success by engaging in opportunistic insider trading. Our analysis indicates that the results of greater insider trading in R&D firms appear to be driven by managers in non-patenting R&D firms. In short, the trading activity of managers in non-patenting R&D firms reveals the insiders' perspective that the firms engage in successful R&D. Overall, our analysis suggests that non-patenting R&D firms arise from a disclosure choice that is related to the type of innovation undertaken by the firm rather than unsuccessful innovation.

Further analysis highlights an alternative explanation for intermediary effects on patent activity, namely an increase in the disclosure of innovation. To assess the plausibility of information intermediaries influencing corporate disclosure policy, we exploit staggered exogenous shocks to trade secret protection. Our tests reveal that non-patent-seeking R&D firms receive significantly less scrutiny from both financial analysts and institutional investors after an increase in their reliance on trade secrets rather than patents. Thus, it appears that information and financial intermediaries placed a strong emphasis on corporate disclosures of innovation activities.

Overall, our results are inconsistent with the hypothesis that non-patenting firms represent failed innovation. Against the backdrop of these findings on non-patent-seeking R&D firms, our analysis suggests that both the type of innovation and firm governance potentially influence the disclosure of innovation, which suggests classifying these firms as failed innovators or discarding them creates biased inferences in academic research. For instance, CEOs with greater stock options are arguably incentivized to disclose innovation via patent activity. Thus, our analysis suggests the need to incorporate this disclosure choice in evaluating corporate decisions to engage in innovation activities. Firms that rely more on trade secrets to protect their intellectual property likely differ from patent-seeking R&D firms in choosing whether and what to innovate. Moreover, these firms should differ along other important aspects related to their ability to manage and keep trade secrets secret.

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Appendix A: A Snapshot of Cross-Disciplinary Treatment of Non-patenting Firms*

Journal	**How They Treat Non-Patent Firms**			
	Number of Articles	***Count as Failed Innovator***	***Exclude 0 Patent Firms***	***% Count as Failed Innovator***
Journal of Finance	6	4	2	67
Journal of Financial Economics	19	18	1	95
Review of Financial Studies	7	5	2	71
The Accounting Review	1	1	0	100
American Economic Review	2	1	1	50
Econometrica	1	0	1	0
Quarterly Journal of Economics	1	0	1	0
Management Science	10	10	0	100
Strategic Management Journal	1	1	0	100
Academy of Management Journal	5	0	5	0
Total	**53**	**40**	**13**	**75%**

*See Internet Appendix Table A2 for a list of the articles underlying this summary.

Appendix B: Distribution of Patenting Firms

Category	**0 Patents**	**1 Patent**	**2 Patents**	**3-5 Patents**	**6-10 Patents**	**11-20 Patents**	**20+ Patents**
Number of Patents	0	1	2	3.8	7.7	14.6	141.8
R&D/Assets	4.1%	7.9%	8.9%	9.6%	9.8%	9.1%	6.9%
Average R&D ($mil)	17.4	15.4	19.2	27	44.3	70.5	534.3
Annual Total R&D ($mil)	10,346	3,409	2,384	5,200	5,862	7,157	108,277
Number of Firms	8,857	2,855	1,832	1,892	1,145	735	525
% of Patenting Firms	0.0%	31.8%	20.4%	21.1%	12.7%	8.2%	5.8%

Appendix C: Examples of New Product Announcements

March 27, 2007 Tuesday 4:01 AM GMT

Adobe Unleashes Creative Suite 3 Product Line; Largest Software Release in Adobe's 25-year History Revolutionizes Creative Workflows

Adobe Systems Incorporated (Nasdaq: ADBE) today announced the Adobe® Creative Suite® 3 product line, a revolutionary offering of tightly integrated, industry-leading design and development tools for virtually every creative workflow. Adobe's new Creative Suite 3 line-up unites the best of Adobe and Macromedia® product innovation to provide designers and developers with a broad spectrum of creative options for all facets of print, web, mobile, interactive, film, and video production.

There are six all-new configurations of Adobe Creative Suite 3. These include Adobe Creative Suite 3 Design Premium and Design Standard editions; Adobe Creative Suite 3 Web Premium and Web Standard editions; and Adobe Creative Suite 3 Production Premium (see separate releases). Rounding out the product line is Adobe Creative Suite Master Collection which combines 12 of Adobe's new design and development applications in a single box-the most comprehensive creative environment ever delivered.

March 27, 2007 Tuesday 8:00 PM GMT

3M Introduces New Miniserial Attached SCSI (SAS) Interconnect Products

Next-generation designs enabling high-speed data transmission can be supported with the new 3M brand miniserial attached SCSI (small computer system interface) connectors from the 3M Electronic Solutions Division. The RoHS compliant* mini-SAS supports data transmission rates of six of 10 GBps in server and storage applications, doubling the capacity of first-generation SAS connectors.

The 3M brand mini-SAS interconnect ensures signal integrity, protecting against data loss. It also significantly reduces the connector size for storage systems currently using SAS 4-lane. The 0.8 mm pitch board mount connector provides increased I/O density with greater channel capabilities and requires less space on printed circuit boards.

Appendix D: Variable Definitions

Announcement_dummy: a dummy variable indicating whether the firm makes any new product announcements during the year;

#Announcement: the number of new products announced by the firm during the year;

R&D: R&D expenditures scaled by total assets;

Process Innovation: the COGS of year t+3 minus COGS of year t scaled by sales of year t, multiplied by -1;

Dollar51: the trading volume in dollar multiplied by the daily abnormal return during the product announcement window (-5, +1), aggregated by year;

OppBuyRatio: the number of the firm's shares bought by opportunistic purchases by the CEO during the year divided by shares outstanding; we identify opportunistic purchases following Cohen et al.'s (2012) methodology;

OppSellRatio: the number of the firm's shares sold by opportunistic sales by the CEO during the year divided by the number of shares outstanding; we identify opportunistic purchases following Cohen et al.'s (2012) methodology;

Firm Size: log of total assets;

Leverage: the long-term debt divided by total assets;

ROA: income before extraordinary items divided by total assets;

Market-to-book: the market value of an equity divided by the book value of equity;

Volatility: annualized daily return volatility during the prior 3 years;

Competition: Herfindahl index based on sales for each 2-digit SIC industry;

Non-patenting: positive R&D firms that do not have patents;

Patenting: positive R&D firms with patents;

Zero R&D: an indicator variable denoting firms explicitly reporting zero R&D expenditure;

Inst_own: institutional ownership of a common equity;

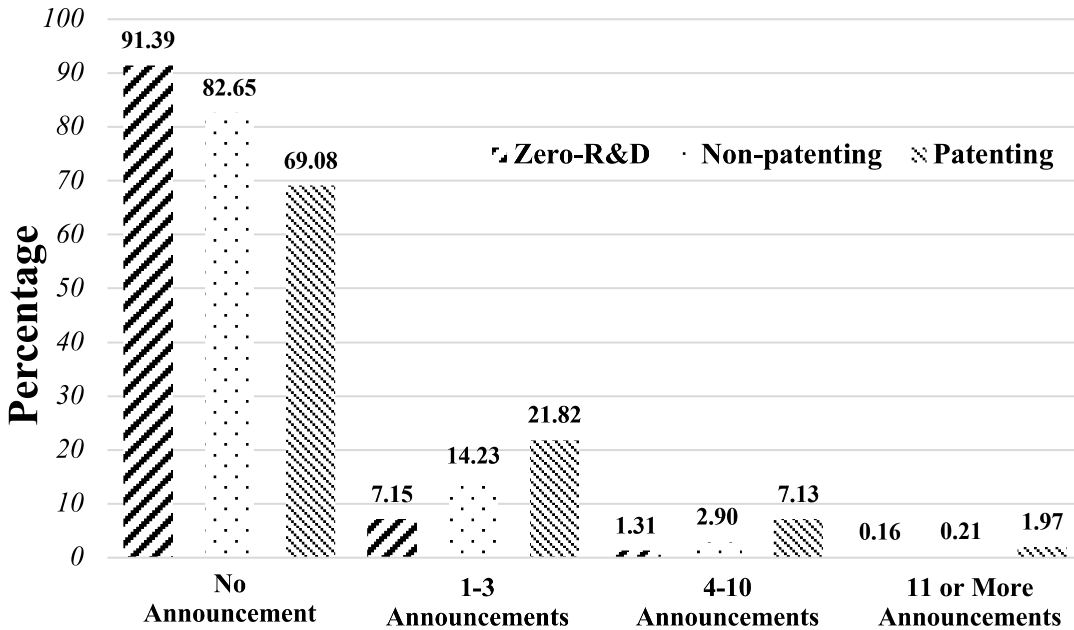
Analyst Following: number of financial analysts that follow the firm during the year;

Age: log number of years that the firm appears in the Compustat;

Post: a dummy variable equal to 1 for the two-year period after the exogenous shock and equal to 0 for the two-year window before the exogenous shock;

UTSA: a dummy variable that equals 1 for the two-year period after the state adopts the Uniform Trade Secrets Act, and 0 for the two-year window prior to the legislative change.

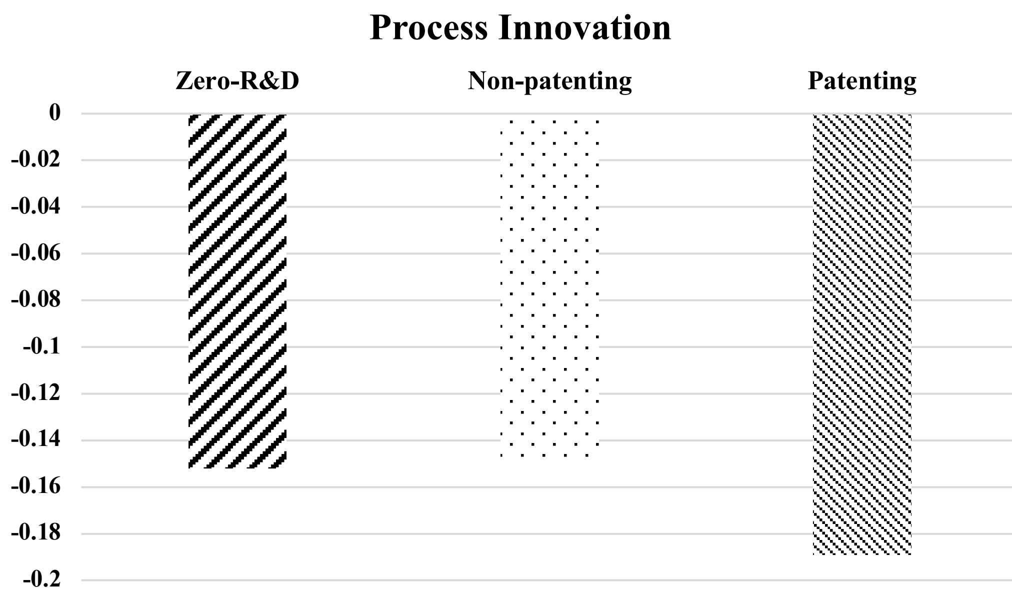
Figure 1: Distribution of New Product Announcements by R&D Type



Description: this figure shows the distribution of new product announcements by different types of R&D firms. We compare new product announcements in firms that report zero R&D spending, Non-patenting R&D firms, and patenting R&D firms. Firms are shown in buckets of new announcements, ranging from firms without any new product announcements to those with 11 or more new product announcements.

Interpretation: Non-patenting firms make significantly more new product announcements than zero R&D firms, which is inconsistent with the notion that patents measure R&D success.

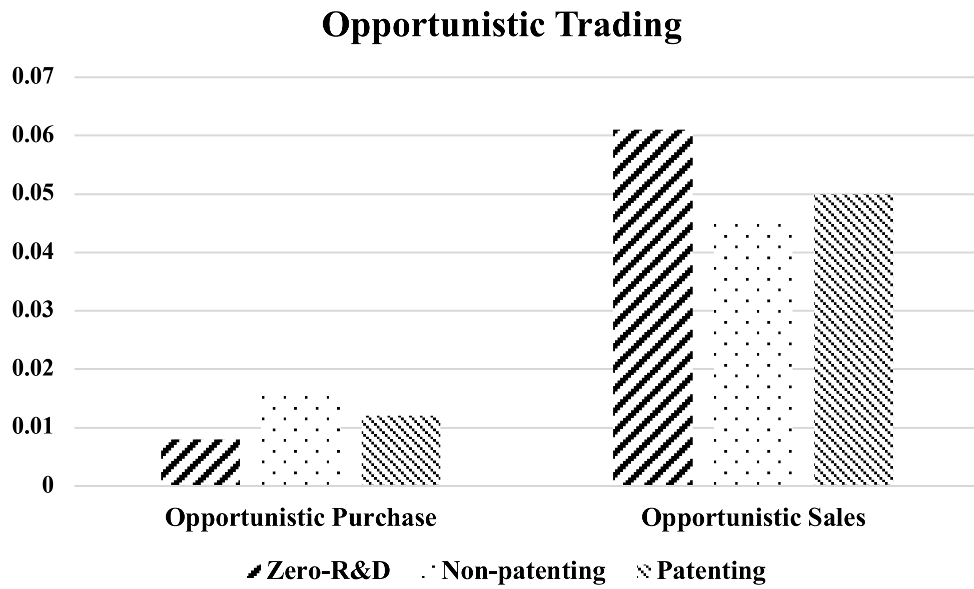
Figure 2: Rank Order of Firms in Process Innovation



Description: This figure shows the cost reductions from process innovation in non-patenting and patenting firms. The y-axis is process innovation after industry competition shock, which is measured by the COGS of year t+3 minus the COGS of year t and scaled by year t sales, where year t is the year of industry tariff-induced competition shocks.

Interpretation: When an industry becomes more competitive, non-patenting firms improves process innovation more than patenting firms. Patenting and non-patenting firms differ in the type of research and development rather than in the success or failure of their R&D projects.

Figure 3: Rank Order of Firms in Opportunistic Insider Trading



Description: This figure shows opportunistic stock purchases and sales by the CEO across different types of R&D firms. Managers of non-patenting firms engage in more opportunistic insider purchases than managers in patenting firms and zero R&D firms.
Interpretation: Managers in non-patenting R&D firms are better able to exploit their information about the firm's innovation activities relative managers in patenting firms. Instead of representing R&D success and failure, patents are a disclosure choice of the firm.

Table 1 Summary Statistics and Univariate Analysis

Description: Panel A shows the summary statistics for the full sample. In Panel B, we match firms within the same industry-year by propensity score, matching by firm size, leverage and firm age.

Interpretation: Non-patenting firms are smaller than zero R&D firms but make substantially more new product announcements.

Panel A: Full Sample (n = 35,614)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-patenting			**Zero R&D**			**Mean test p-value**	**Median-test p-value**
	Mean	Median	SD	Mean	Median	SD	(1)-(4)	(2)-(5)
Announcement_dummy	0.174	0.000	0.379	0.086	0.000	0.280	0.00***	0.00***
#Announcement	0.415	0.000	1.416	0.197	0.000	0.948	0.00***	0.00***
Dollar51	0.448	0.000	4.889	0.117	0.000	3.742	0.00***	0.00***
Firm Size	3.668	3.559	1.916	5.311	5.483	2.210	0.00***	0.00***
R&D/Total Assets	0.101	0.054	0.126	0.000	0.000	0.000	-	-
Leverage	0.135	0.039	0.204	0.212	0.157	0.221	0.00***	0.00***
Age	2.448	2.398	0.678	2.486	2.485	0.680	0.00***	0.00***
Competition	0.094	0.066	0.091	0.064	0.054	0.068	0.00***	0.00***
N	24,447			11,167				

Panel B: Matched Sample (n = 7,782)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-patenting			**Zero R&D**			**Mean test p-value**	**Median-test p-value**
	Mean	Median	SD	Mean	Median	SD	(1)-(4)	(2)-(5)
Announcement_dummy	0.130	0.000	0.337	0.078	0.000	0.269	0.00***	0.00***
#Announcement	0.283	0.000	1.029	0.199	0.000	1.051	0.00***	0.00***
Dollar51	0.206	0.000	4.245	0.120	0.000	3.718	0.34	0.00***
Firm Size	4.888	4.856	2.003	5.108	5.236	2.157	0.13	0.07*
R&D/Total Assets	0.055	0.019	0.095	0.000	0.000	0.000	-	-
Leverage	0.177	0.122	0.196	0.180	0.126	0.198	0.26	0.50
Age	2.569	2.539	0.729	2.530	2.585	0.689	0.36	0.25
Competition	0.087	0.065	0.111	0.086	0.065	0.114	0.89	0.88
N	3,891			3,891				

Table 2 Comparing Non-patenting Firms with Zero R&D Firms

Description: This table presents the results of the differences of multiple measures between non-patenting firms and zero R&D firms. All variables are defined in Appendix D. Column 1 uses the logit model and Columns 2 and 3 use Poisson regression. Column 4 uses OLS regression. The Huber-White Sandwich estimator is clustered at firm level. Statistical significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***, respectively.
Interpretation: Non-patenting firms have more new products than zero R&D firms, rejecting the hypothesis that patents measure R&D success.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	*Full Sample*			*Matched Sample*		
Dependent Variable:	**Announcement_dummy**	**#Announcement**	**Dollar51**	**Announcement_dummy**	**#Announcement**	**Dollar51**
Constant	-8.008***	-7.441***	-0.234	-8.676***	-7.738***	0.210
	(-5.94)	(-6.34)	(-0.69)	(-5.22)	(-5.37)	(0.32)
Non-patenting	**1.103*** **	**0.992*** **	**0.402*** **	**1.102*** **	**0.908*** **	**0.250** **
	(8.05)	**(5.82)**	**(4.42)**	**(5.21)**	**(2.72)**	**(2.55)**
Firm Size	0.405***	0.397***	0.078***	0.492***	0.513***	0.073**
	(21.43)	(20.00)	(4.63)	(10.48)	(9.53)	(2.17)
Competition	-0.605	-0.975	-	0.474	0.104	-0.631
	(-0.84)	(-1.22)	(-3.20)	(0.44)	(0.11)	(-0.91)
Leverage	-1.301***	-1.205***	-	-0.793**	-0.364	0.053
	(-8.63)	(-6.77)	(-3.23)	(-2.44)	(-0.97)	(0.24)
ROA	-0.795***	-0.837***	-0.081	-1.080***	-1.510***	-0.225
	(-7.79)	(-7.80)	(-0.74)	(-3.47)	(-4.28)	(-0.82)
Market-to-book	0.016***	0.023***	0.021***	0.036***	0.036***	0.006
	(4.82)	(6.16)	(4.82)	(3.58)	(4.25)	(0.52)
Volatility	0.032	0.076***	0.153***	-0.042	-0.049	0.028
	(1.60)	(3.99)	(4.57)	(-0.86)	(-0.96)	(0.47)
Industry and Year Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	35,614	35,614	35,614	7,782	7,782	7,782
Pseudo R^2/ Log Likelihood/ Adjusted R^2	0.203	-25,438	0.008	0.265	-3,712	0.009

Table 3 Comparing Patenting and Non-patenting Firms

Description: This table presents the effect of patenting choices on multiple firm performance metrics based on both the full sample and the matched sample. All variables are defined in Appendix D. The Huber-White Sandwich estimator is clustered at firm level. Statistical significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***, respectively. This table shows that non-patenting firms have lower new product announcements than patenting firms.

Interpretation: Non-patenting firms engage in less new product innovation than patenting firms.

Panel A: Full Sample (n = 46,062)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-patenting			**Patenting**			**Mean test p-value**	**Median-test p-value**
	Mean	Median	SD	Mean	Median	SD	(1)-(4)	(2)-(5)
Announcement_dummy	0.174	0.000	0.379	0.309	0.000	0.462	0.00***	0.00***
#Announcement	0.415	0.000	1.416	1.187	0.000	3.963	0.00***	0.00***
Dollar51	0.448	0.000	4.889	0.860	0.000	7.357	0.00***	0.00***
Firm Size	3.668	3.559	1.916	5.541	5.550	2.316	0.00***	0.00***
R&D/Total Assets	0.101	0.054	0.126	0.100	0.060	0.118	0.09*	0.00***
Leverage	0.135	0.039	0.204	0.144	0.089	0.176	0.00***	0.00***
Age	2.448	2.398	0.678	2.790	2.773	0.752	0.00***	0.00***
Competition	0.094	0.066	0.091	0.090	0.065	0.085	0.00***	0.09*
N	24,447			21,615				

Panel B: Matched Sample (n = 8,088)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-patenting			**Patenting**			**Mean test p-value**	**Median-test p-value**
	Mean	Median	SD	Mean	Median	SD	(1)-(4)	(2)-(5)
Announcement_dummy	0.202	0.000	0.402	0.295	0.000	0.456	0.00***	0.00***
#Announcement	0.487	0.000	1.386	0.843	0.000	2.251	0.00***	0.00***
Dollar51	0.586	0.000	5.450	0.997	0.000	6.859	0.00***	0.00***
Firm Size	4.428	4.300	1.878	4.487	4.335	2.179	0.33	0.15
R&D/Total Assets	0.111	0.056	0.141	0.115	0.077	0.120	0.18	0.00***
Leverage	0.134	0.048	0.191	0.130	0.049	0.179	0.38	0.77
Age	2.538	2.485	0.695	2.550	2.565	0.722	0.58	0.04
Competition	0.086	0.065	0.075	0.085	0.064	0.082	0.75	0.75

N	4,044	4,044	

Panel C: New Product Announcement

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	*Full Sample*			*Matched Sample*		
Dependent Variable:	**Announcement_dumm**	**#Announcement**	**Dollar51**	**Announcement_dumm**	**#Announcement**	**Dollar5**
Constant	-6.543***	-7.471***	0.899	-6.799***	-6.695***	0.752
	(-8.87)	(-14.61)	(0.80)	(-4.92)	(-5.96)	(0.43)
Non-patenting	**-0.490*** **	**-0.461*** **	**-0.315*** **	**-0.485*** **	**-0.475*** **	**-0.365** **
	(-10.91)	**(-9.79)**	**(-4.76)**	**(-6.82)**	**(-7.11)**	**(-2.52)**
Firm Size	0.334***	0.447***	0.125***	0.275***	0.361***	0.270***
	(20.41)	(17.13)	(6.03)	(9.83)	(14.73)	(5.13)
Competition	0.132	0.641	-1.085**	-0.851	-1.247	-0.382
	(0.25)	(1.08)	(-2.00)	(-0.64)	(-1.09)	(-0.26)
Leverage	-1.193***	-1.467***	-0.402***	-1.340***	-0.973***	-
	(-8.86)	(-6.40)	(-2.96)	(-5.10)	(-4.02)	(-4.44)
ROA	-0.799***	-1.024***	-0.277**	-0.643***	-0.750***	-
	(-8.54)	(-9.84)	(-2.13)	(-3.87)	(-5.13)	(-3.82)
Market-to-book	0.015***	0.024***	0.034***	0.020***	0.011**	0.031**
	(5.56)	(5.19)	(6.15)	(3.48)	(2.37)	(2.38)
Volatility	0.083***	0.097***	0.238***	0.090***	0.117***	0.307***
	(4.75)	(5.38)	(5.82)	(2.68)	(4.72)	(2.97)
Industry and Year Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	46,062	46,062	46,062	8,088	8,088	8,088
Pseudo R^2/Log Likelihood/Adjusted R^2	0.215	-54,052	0.011	0.198	-8,717	0.013

Table 4 Competition Shocks and Process Innovation

Description: This table presents the results of the differences in firm performance between different types of R&D disclosure choices. We focus on exogenous shocks induced by increased competition following import tariff reductions. Column 1 shows the comparison between non-patenting and zero R&D firms. Column 2 presents results comparing non-patenting and patenting firms. We include a two-year period before and after the staggered shocks. All variables are defined in Appendix D. The Huber-White Sandwich estimator is clustered at firm level. Statistical significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***, respectively.

Interpretation: Non-patenting firms engage in more process innovation than patenting firms.

	(1)	(2)
	Non-patenting vs. Zero R&D	Non-patenting vs. Patenting
Dependent Variable:	**Process Innovation**	
Constant	1.615**	0.463
	(2.15)	(0.85)
Non-patenting	-0.203	-0.081
	(-1.26)	(-0.49)
Post	0.448**	0.371*
	(2.39)	(1.76)
Non-patenting * Post	**0.322****	**0.077****
	(1.99)	**(2.33)**
Firm Size	-0.302***	0.108**
	(-2.86)	(2.45)
Competition	0.478	1.162
	(0.12)	(0.85)
Leverage	0.296	-0.490
	(0.51)	(-0.90)
ROA	-1.232*	0.090
	(-1.89)	(0.17)
Market-to-book	0.035	-0.015
	(1.28)	(-1.15)
Volatility	0.245*	0.008
	(1.71)	(0.07)
Industry and Year Dummy	*Yes*	*Yes*
Observations	172	165
Adjusted R^2	0.147	0.105

Table 5 Managerial Insider Trading

Description: This table presents the effect of patenting choices on managerial insider trading based on both the full sample and a matched sample. All variables are defined in Appendix D. The Huber-White Sandwich estimator is clustered at firm level. Statistical significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***, respectively.

Interpretation: Managers of non-patenting firms engage in more insider trading than managers in patenting firms. Instead of depicting innovation success and failure, patents represent a disclosure choice about corporate innovation. Managers exploit this disclosure choice in their trading activity.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	*3-Way Matched Sample*				*2-Way Matched Sample*	
Dependent Variable:	**OppBuyRatio**	**OppSellRatio**	**OppBuyRatio**	**OppSellRatio**	**OppBuyRatio**	**OppSellRatio**
Constant	-0.015	-0.044	-0.015	-0.045	0.016	-0.006
	(-1.37)	(-0.49)	(-1.38)	(-0.49)	(1.13)	(-0.13)
Positive R&D	**0.008***	**-0.086**	-	-	-	-
	(1.80)	**(-0.92)**				
Non-patenting	**-**	**-**	**0.008****	**-0.086**	**0.002****	**-0.004***
			(2.41)	**(-0.92)**	**(2.46)**	**(-1.75)**
Patenting	-	-	**0.006**	**-0.083**	-	-
			(0.60)	**(-0.96)**		
Firm Size	-0.000	0.015***	-0.000	0.015***	-0.001	0.000
	(-0.46)	(4.82)	(-0.44)	(4.83)	(-1.12)	(0.20)
Competition	0.031	-0.200**	0.031	-0.200**	-0.015	-0.090*
	(0.99)	(-2.16)	(0.98)	(-2.17)	(-1.18)	(-1.75)
Leverage	0.010	-0.092***	0.010	-0.092***	0.006	-0.023
	(1.51)	(-4.45)	(1.51)	(-4.45)	(1.32)	(-1.47)
ROA	-0.010**	0.056***	-0.010**	0.055***	-0.009**	0.101***
	(-2.08)	(3.76)	(-2.09)	(3.75)	(-2.48)	(7.73)
Market-to-book	0.000	0.002***	0.000	0.002***	-0.000	0.002***
	(0.24)	(2.96)	(0.24)	(2.96)	(-1.54)	(3.56)
Volatility	0.001	0.007*	0.001	0.007*	0.001	0.018***
	(0.80)	(1.76)	(0.80)	(1.76)	(0.83)	(4.26)
Industry and Year Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	4,440	4,440	4,440	4,440	8,088	8,088
Adjusted R^2	0.021	0.058	0.021	0.058	0.035	0.052

Table 6 Intermediaries and Patenting Choices

Description: These tables present the results of the effects of patenting choices on market scrutiny from information and financial intermediaries. All variables are defined in Appendix D. The z(t)-statistics provided in parentheses are adjusted for heteroskedasticity using the Huber-White Sandwich estimator and are clustered at firm (shock) level in Panel A (B). Statistical significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***, respectively.

Interpretation: Financial analysts and institutional investors are attracted to firms that disclose their innovation activities. Financial intermediaries influence the disclosure of corporate innovation rather than the intensity or success of research projects.

Panel A: Cross-sectional Test Results

	(1)	(2)	(3)	(4)
Sample:	*Full*	*Matched*	*Full*	*Matched*
Dependent Variable:	**Analyst Following**		**Institutional Ownership**	
Constant	-1.101***	-0.757*	-0.418***	-0.420**
	(-4.31)	(-1.84)	(-2.97)	(-2.19)
Non-patenting	**-0.418*** **	**-0.252** **	**-0.108*** **	**-0.108*** **
	(-5.28)	**(-2.18)**	**(-5.44)**	**(-3.53)**
#Announcement	0.002	0.032**	0.002	0.001
	(0.32)	(2.43)	(0.53)	(0.18)
Non-patenting * #Announcement	**0.035*** **	**0.051** **	**0.016*** **	**0.014** **
	(3.02)	**(2.16)**	**(2.76)**	**(1.99)**
Firm Size	0.600***	0.544***	0.125***	0.108***
	(29.70)	(13.92)	(18.77)	(9.13)
Competition	-0.591	-0.616	-0.055	0.036
	(-1.09)	(-0.62)	(-0.27)	(0.10)
Leverage	-0.752***	-0.730*	-0.223***	-0.221**
	(-3.60)	(-1.80)	(-4.34)	(-2.56)
ROA	-0.330	-0.164	-0.096**	-0.027
	(-1.41)	(-0.52)	(-2.16)	(-0.39)
Market-to-book	0.017***	0.024***	0.003***	0.002
	(3.87)	(3.06)	(2.67)	(1.16)
Volatility	-0.094***	-0.087	-0.050***	-0.053***
	(-2.70)	(-1.39)	(-5.45)	(-3.44)
Industry and Year Dummy	Yes	Yes	Yes	Yes
Observations	46,062	8,088	46,062	8,088
Log Likelihood/Pseudo R^2	-256,010	-41,495	0.159	0.116

Panel B: UTSA Enactment

	(1)	(2)	(3)	(4)
Sample:	**Full**		**Matched**	
Dependent Variable:	**Analyst Following**	**Institutional Ownership**	**Analyst Following**	**Institutional Ownership**
Constant	-1.257***	-0.340**	-1.721*	-0.394*
	(-2.74)	(-2.34)	(-1.72)	(-1.75)
Non-patenting	**-0.186**	**-0.059***	**-0.036**	**-0.063***
	(-1.52)	**(-1.84)**	**(-1.12)**	**(-1.93)**
UTSA	-0.148	-0.055	-0.022	-0.039
	(-0.84)	(-1.18)	(-1.07)	(-1.17)
Non-patenting * UTSA	**0.089****	**0.067*****	**0.159****	**0.079*****
	(2.57)	**(2.69)**	**(2.30)**	**(2.95)**
Firm Size	0.586***	0.103***	0.529***	0.102***
	(12.27)	(7.38)	(5.68)	(4.76)
Competition	1.643*	0.046	5.543**	0.486
	(1.74)	(0.13)	(2.39)	(0.68)
Leverage	-1.083**	-0.177**	-0.228	-0.110
	(-2.38)	(-2.08)	(-0.27)	(-0.78)
ROA	-0.821**	-0.133*	-0.879	-0.269**
	(-2.54)	(-1.92)	(-1.24)	(-2.32)
Market-to-book	0.037***	0.006***	0.030*	0.007
	(3.70)	(2.92)	(1.74)	(1.53)
Volatility	-0.064	-0.039**	-0.273	-0.053
	(-1.06)	(-2.23)	(-1.43)	(-1.24)
Industry and Year Dummy	Yes	Yes	Yes	Yes
Observations	8,313	8,313	1,224	1,224
Log Likelihood/Pseudo R^2	-36,448	0.092	-4,787	0.151

Table 7 More Innovation or More Disclosure? Evidence from Exogenous Shocks

Description: This table presents results on the effect of market scrutiny on firm's propensity to announce new products, comparing between non-patenting firms and patenting firms. We use 1-year window around the year in which the firm is inducted in the S&P 500 index or experience UTSA shock. Post is a dummy variable equals to 1 for the year after the shock and 0 for the year before the shock. Huber-White Sandwich estimator clustered at the shock level is used. Statistical significance at 10%, 5%, and 1% is denoted by *, **, and ***, respectively.
Interpretation: Institutional ownership influences the disclosure of corporate innovation rather than causing changes in the intensity or success of research projects.

Panel A: Univariate Test

	Propensity to Announce New Product						
	Patenting	Non-Patenting	*t-test*		Patenting	Non-Patenting	*t-test*
Pre-UTSA	0.261	0.192	*0.00****	***Pre-S&P Induction***	0.410	0.197	*0.00****
Post-UTSA	0.354	0.363	*0.96*	***Post-S&P Induction***	0.532	0.390	*0.12*
t-test	*0.00****	*0.00****	*0.00****	*t-test*	*0.061**	*0.032***	*0.06**

Panel B: Regression Results

	(1)	(2)
Shock:	***UTSA***	***S&P Index Induction***
Dependent Variable:	**Announcement_Dummy**	
Constant	-2.763	-16.782***
	(-0.36)	(-2.90)
Non-patenting	-0.039	-0.089
	(-1.61)	(-1.33)
Year1	0.297	0.056
	(1.43)	(1.11)
Year2	0.036	0.037
	(0.50)	(0.85)
Year3	0.066	0.029
	(0.23)	(1.21)
Non-patenting * Year1	**0.281*** **	**0.233** **
	(2.91)	**(2.26)**
Non-patenting * Year2	**0.185***	**0.136**
	(1.68)	**(1.46)**
Non-patenting * Year3	**0.075**	**0.068**
	(1.07)	**(0.98)**
Firm Size	0.329**	0.452*
	(2.37)	(1.78)
Competition	-0.008	7.228
	(-0.01)	(0.89)
Leverage	-1.338**	-2.211
	(-2.27)	(-1.36)
ROA	-0.792*	-2.655
	(-1.91)	(-1.45)
Market-to-book	0.013**	0.008
	(2.31)	(0.35)
Volatility	0.047*	-0.085
	(1.88)	(-0.79)
Industry and Year Dummy	Yes	Yes
Observations	1,224	334
Log Likelihood/Pseudo R^2	0.239	0.382

Table 8 Peer Effect of Induced Disclosure

Description: This table presents results of whether firm's disclosure increase after S&P 500 Index induction leads to higher R&D increase among its peer firms. We compare firms in the same industry-year of the peer firm induction to firms with no peer firm market scrutiny change. In addition, we check the type of source firms being non-patenting or patenting.

Interpretation: The disclosure of corporate innovation induces a firm's competitors to increase their own innovation activity. Patenting R&D firms view non-patenting firm as innovative threats.

Panel A: Source Firm Type and Peer Effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Source Firm Type			**Control Sample**	**t-test**			
	Both	**Patenting Firms**	**Non-Patenting Firms**		**(1) - (4)**	**(2) - (4)**	**(3) - (4)**	**(3) - (2)**
R&D Change	0.002	0.001	0.004	-0.001	3.57***	2.99***	6.67***	4.01***

Panel B: Disclosure and Peer Effect

	(1)	(2)	(3)	(4)	(5)	(6)
	Non-Patenting Firms		**Control Sample**	**t-test**		
	Without New Product Announcement	**With New Product Announcement**		**(1) - (3)**	**(2) - (3)**	**(1) - (2)**
R&D Change	0.001	0.007	-0.001	2.50**	7.50***	6.21***

Table 9 Within-Industry Patenting Choice

Description: This table shows the proportion of patenting vs. non-patenting firms within each industry. In Panel A, we show the top quartile of all 2-digit SIC industries by the rank of proportion of non-patenting firms in that industry. In Panel B, we show the top quartile of all 3-digit SIC industries by the rank of proportion of non-patenting firms in that industry.

Interpretation: Even within the same industry some firms pursue product innovation while others focus on process innovation. Matching firms within the same industry does not solve the non-patenting firm problem in studies of corporate innovation.

Panel A: 2-digit SIC Industry

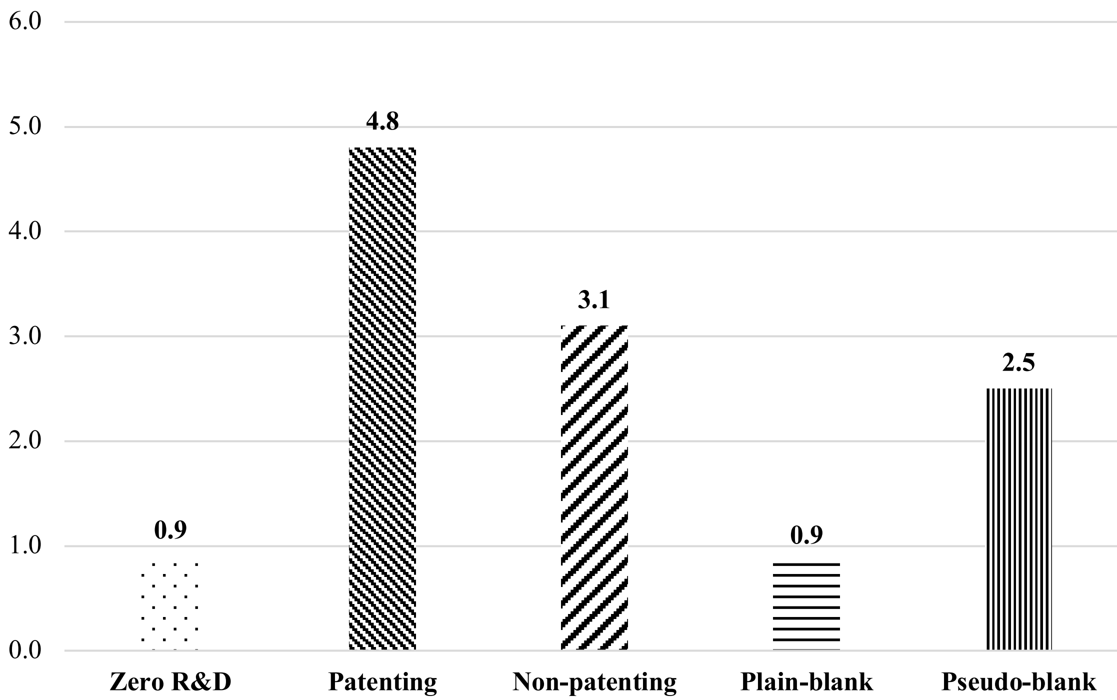
2-digit SIC Industry	*Proportion of Non-patenting Firms*	*2-digit SIC Industry*	*Proportion of Non-patenting Firms*
86	0.50	30	0.31
73	0.45	39	0.30
38	0.45	37	0.29
36	0.43	32	0.26
35	0.41	34	0.25
28	0.40	33	0.22
07	0.34	76	0.22
99	0.32	87	0.22

Panel B: 3-digit SIC Industry

2-digit SIC Industry	*Proportion of Non-patenting Firms*	*2-digit SIC Industry*	*Proportion of Non-patenting Firms*	*2-digit SIC Industry*	*Proportion of Non-patenting Firms*
482	0.68	395	0.38	349	0.33
366	0.59	322	0.38	289	0.33
737	0.57	361	0.38	872	0.32
357	0.53	355	0.37	284	0.32
321	0.50	359	0.37	999	0.32
860	0.50	299	0.36	371	0.31
381	0.49	352	0.35	394	0.31
386	0.48	489	0.35	342	0.30
369	0.47	356	0.35	306	0.30
382	0.46	281	0.35	339	0.30
362	0.45	399	0.35	336	0.30
283	0.45	367	0.34	285	0.30
329	0.44	070	0.34	286	0.29
384	0.44	335	0.34	252	0.29
358	0.42	202	0.34	353	0.28
365	0.42	334	0.34	376	0.28
280	0.40	325	0.33	200	0.27
254	0.40	308	0.33	343	0.27
385	0.40	287	0.33	220	0.27
873	0.39	374	0.33	372	0.26
379	0.39				

Internet Appendix

Figure A1: Number of New Product Announcements by All Types of Firms



Description: Zero R&D, Patenting, and Non-patenting denote firms that report R&D. Plain-blank represents firms that do not report or R&D or seek patents. Pseudo-blank firms fail to report R&D but seek patents (Koh et al., 2017).
Interpretation: Non-patenting firms have more new products announcements than zero R&D firms, plain-blank firms and pseudo-blank firms, suggesting that non-patenting firms have material innovation activity.

Table A1 Alternative Sample: Firms that Switch Their Patenting Choice

Description: This table presents results repeating Table 2 (Table 3) in Panel A (B). The sample is based on the 2-year period surrounding the year when positive R&D firms switch from non-patenting (patenting) to patenting (non-patenting). All variables are defined in Appendix D. The z(t)-statistics provided in parentheses are adjusted for heteroskedasticity using the Huber-White Sandwich estimator and are clustered at the firm level. Statistical significance at 10%, 5%, and 1% is denoted by *, **, and ***, respectively.

Interpretation: Changing from patenting to non-patenting stems from changes in the type of innovation activity of the firm rather than success or failure.

Panel A: Product Announcement

	(1)	(2)
Dependent Variable:	**Announcement_dummy**	**#Announcement**
Constant	-31.038***	-29.846***
	(-10.21)	(-9.23)
Non-patenting	**-0.774*** **	**-0.639*** **
	(-4.23)	**(-3.45)**
Firm Size	0.156*	0.171*
	(1.91)	(1.77)
Competition	-4.544	-3.363
	(-1.32)	(-1.06)
Leverage	-1.489**	-0.822
	(-2.56)	(-1.43)
ROA	0.702	0.687
	(1.22)	(1.17)
Market-to-book	0.015	0.021
	(0.75)	(0.98)
Volatility	0.289***	0.209***
	(2.93)	(3.54)
Industry and Year Dummy	Yes	Yes
Observations	968	968
Pseudo R^2/Log Likelihood	0.196	-950.2

Panel B: Analyst Following and Institutional Investors

	(1)	(2)	(3)	(4)
Dependent Variable:	**Analyst Following**		**Institutional Ownership**	
Constant	-36.416	-36.400	-4.049***	-4.045***
	(-0.35)	(-0.43)	(-11.97)	(-11.49)
Non-patenting	**-0.148***	**-0.243****	**-0.031***	**-0.052***
	(-1.88)	**(-2.37)**	**(-1.69)**	**(-1.95)**
#Announcement	-	-0.060	-	-0.015*
		(-1.01)		(-1.90)
Non-patenting * #Announcement	**-**	**0.119***	**-**	**0.040*****
		(1.81)		**(4.27)**
Firm Size	0.363***	0.377***	0.022***	0.023***
	(2.89)	(2.94)	(3.39)	(3.64)
Competition	6.268**	6.288**	1.884***	1.901***
	(2.03)	(2.02)	(6.18)	(6.24)
Leverage	-1.086	-1.065	-0.011	-0.006
	(-1.34)	(-1.31)	(-0.16)	(-0.09)
ROA	0.000	-0.048	0.412***	0.403***
	(0.00)	(-0.05)	(15.43)	(14.92)
Market-to-book	0.040***	0.040***	0.008***	0.008***
	(2.76)	(2.74)	(4.44)	(4.32)
Volatility	-0.092	-0.072	-0.054***	-0.050***
	(-0.87)	(-0.70)	(-3.71)	(-3.37)
Industry and Year Dummy	Yes	Yes	Yes	Yes
Observations	968	968	968	968
Log Likelihood/Adjusted R^2	-4,069	-4,055	0.095	0.097

Table A2: Articles included in Appendix A

Panel 1: Selected Finance Studies using Patents to Measure Success and Failure

	Title	*Approach*	*Finance*	*Year*
1	Private equity and long-run investment: The case of innovation	Exclude 0 patent firms	JF	2011
2	Are overconfident CEOs better innovators?	Count as zero	JF	2012
3	Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting	Count as zero	JF	2013
4	Does going public affect innovation?	Exclude 0 patent firms	JF	2015
5	Does stock liquidity enhance or impede firm innovation?	Count as zero	JF	2014
6	Corporate innovations and mergers and acquisitions	Count as zero	JF	2014
7	The bright side of financial derivatives: Options trading and firm innovation	Count as zero	JFE	2017
8	Independent boards and innovation	Count as zero	JFE	2017
9	Financial dependence and innovation: The case of public versus private firms	Count as zero	JFE	2017
10	Investment cycles and startup innovation	Count as zero	JFE	2013
11	Pilot CEOs and corporate innovation	Count as zero	JFE	2017
12	Are foreign investors locusts? The long-term effects of foreign institutional ownership	Count as zero	JFE	2017
13	Do corporate taxes hinder innovation?	Count as zero	JFE	2017
14	Credit supply and corporate innovation	Count as zero	JFE	2013
15	Innovative efficiency and stock return	Count as zero	JFE	2013
16	Firm boundaries matter: Evidence from conglomerates and R&D activity	Count as zero	JFE	2014
17	Did bank distress stifle innovation during the Great Depression?	Count as zero	JFE	2014
18	Banking deregulation and innovation	Count as zero	JFE	2013
19	Non-executive employee stock options and corporate innovation	Count as zero	JFE	2015
20	Does banking competition affect innovation?	Count as zero	JFE	2015
21	The dark side of analyst coverage: The case of innovation	Count as zero	JFE	2013
22	Creditor rights and innovation: Evidence from patent collateral	Exclude 0 patent firms	JFE	2017
23	Financial market development and innovation: Cross-country evidence	Count as zero	JFE	2014
24	How does hedge fund activism reshape corporate innovation?	Count as zero	JFE	2017
25	Motivating innovation in newly public firms	Count as zero	JFE	2014
26	Misvaluing Innovation	Count as zero	RFS	2013
27	Bankruptcy codes and innovation	Count as zero	RFS	2009
28	Corporate venture capital, value creation, and innovation	Count as zero	RFS	2014
29	Tolerance for failure and corporate innovation	Count as zero	RFS	2011
30	Wrongful discharge laws and innovation	Exclude 0 patent firms	RFS	2014
31	The real effects of lending relationships on innovative firms and inventor mobility	Exclude 0 patent inventors	RFS	2017
32	Intellectual property rights protection, ownership, and innovation: Evidence from China	Count as zero	RFS	2017

Panel 2: Selected Other Studies using Patents to Measure Success and Failure

	Title	*Approach*	*Acct/Econ/Mgt*	*Year*
1	The R&D premium and takeover risk	Count as zero	TAR	2016
2	Innovation and institutional ownership	Exclude 0 patent firms	AER	2013
3	Financing innovation: evidence from R&D grants	Count as zero	AER	2017
4	Identifying technological spillovers and product market rivalry	Exclude 0 patent firms	Econometrica	2013
5	Technological innovation, resource allocation, and growth	Count as zero	QJE	2017
6	CEO overconfidence and innovation	Count as zero	MS	2011
7	Entry and patenting in the software industry	Count as zero	MS	2011
8	What makes them tick? Employee motives and firm innovation	Count as zero	MS	2010
9	CEO confidence and unreported R&D	Count as zero	MS	2017
10	Innovation in business groups	Count as zero	MS	2010
11	Do unions affect innovation?	Count as zero	MS	2017
12	Debtor rights, credit supply, and innovation	Count as zero	MS	2017
13	Employment non-discrimination acts and corporate innovation	Count as zero	MS	2017
14	Learning from customers: Corporate innovation along the supply chain	Count as zero	MS	2017
15	Entrepreneurial exits and innovation	Count as zero	MS	2014
16	Knowing when to leap: Transitioning between exploitative and explorative R&D	Exclude 0 patent firms or Count as zero	SMJ	2014
17	The quest for originality: A new typology of knowledge search and breakthrough inventions	Exclude 0 patent firms	AMJ	2016
18	Making the most of where you are: Geography, networks, and innovation in organizations	Exclude 0 patent firms	AMJ	2014
19	Exploring the locus of invention: The dynamics of network communities and firms' invention productivity	Exclude 0 patent firms	AMJ	2014
20	Geographic distribution of R&D activity: How does it affect innovation quality?	Exclude 0 patent firms	AMJ	2010
21	A longitudinal study of the influence of alliance network structure and composition on firm exploratory innovation	Exclude 0 patent firms	AMJ	2010