Do innovative firms communicate more? Evidence from the relation between patenting and management guidance

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Published in Accounting Review, 2021, 96 (1), 273-297.
DOI: 10.2308/tar-2017-0082

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ABSTRACT: Successful innovations could induce more disclosure if the information asymmetry between the firm and its investors about post-innovation outcomes leads investors to demand more information. However, such innovations also likely entail greater proprietary cost concerns, which deter disclosure. This paper uses patent grants to examine the effect of innovation success on management guidance behavior. We find that more management guidance follows patent grants, suggesting that despite disclosure cost concerns, firms with successful innovations do respond to information demand. This association is stronger after enactment of Regulation Fair Disclosure and for firms with greater institutional investor ownership, further highlighting the role of information demand. The association is weaker for firms with more competition, consistent with proprietary cost concerns having a moderating impact. Overall, our findings suggest that innovation creates demand for more voluntary disclosure, and firms' disclosure decisions following innovation outcomes vary in ways that disclosure theory and economic intuition predict.

JEL Classifications: G30; G32; G38; M41; M48.

Data Availability: All data are available from the public sources identified in the paper.

Keywords: innovation; patents; voluntary disclosure; management forecasts.

Although innovation can enable a company to achieve higher profit margins, the very newness of innovative products makes demand for them unpredictable. In addition, their life cycle is short—usually just a few months—because as imitators erode the competitive advantage that innovative products enjoy, companies are forced to introduce a steady stream of new innovations. The short life cycles and the greater variety typical of these products further increase unpredictability.
—Fisher (1997, 106)

We appreciate insightful comments from Gregory J. Clinch (editor), Shuping Chen, Gilles Hilary, Tjomme Rusticus, two anonymous referees, and from workshop participants at the University of Rochester, University of Houston, Rice University, and The Hong Kong Polytechnic University. Sterling Huang acknowledges the financial support received from the School of Accountancy Research Center (SOAR) at Singapore Management University.

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Editor's note: Accepted by Gregory J. Clinch, under the Senior Editorship of Mary E. Barth.

I. INTRODUCTION

Innovation is an important driver of a firm's long-term growth and competitiveness (Jovanovic and MacDonald 1994; Klepper 1996). In the modern era, patents serve as an important measure of innovation success, and firms that generate more patents are widely regarded as more innovative (Acs, Anselin, and Varga 2002). However, estimating the future earnings impact of patent grants is difficult because their commercial potential is often hard to determine. These difficulties are exacerbated by the quickening pace of innovation, which leads to a shorter product life cycle, greater competition based on innovation, and increased patent litigations (Fisher 1997; Bessen and Meurer 2006). This problem is further compounded by the fact that to bring an innovation to fruition, a firm likely incurs further near-term expenses, such as those in developing or licensing related patents (Shapiro 2001; Farrell and Klemperer 2007). Hence, capital market participants are likely to demand more forward-looking financial information from innovative firms, such as expected earnings.

Disclosure theory predicts that when there is information asymmetry and uncertainty about firm value among investors, managers have greater incentives to make more voluntary disclosures (Verrecchia 2001; Healy and Palepu 2001). Studies find that the stock market appears to ignore past successes when valuing future innovations, and a long-short portfolio strategy that takes advantage of the information in past track records generates significant abnormal returns annually (Cohen, Diether, and Malloy 2013; Hirshleifer, Hsu, and Li 2013). According to the "expectations adjustment" hypothesis put forth by Ajinkya and Gift (1984), managers disclose earnings forecasts to align investors' expectations of future earnings with those of management.[1] However, the desire to reduce information asymmetry between the firm and its investors is tempered by concerns about the costs and risks of disclosure. For instance, even though obtaining a patent reduces the likelihood that an innovation will be "stolen" by competitors, it remains possible for competitors to disregard the legal implications and adopt the innovation for their own use, especially if voluntary disclosure reveals the patent's potential and the firm's intent to further develop and capitalize on it.

In this paper, we focus on patent grants as an indicator of innovation success. Patenting—an important milestone in the innovation process—has two important features. First, it is a right granted by a country to the owner of an invention that prevents others from making, using, importing, or selling the invention without permission. Second, invention owners must provide detailed public disclosure of the invention being patented. In the U.S., this disclosure is facilitated by the United States Patent and Trademark Office (USPTO), the federal agency responsible for granting U.S. patents and registering trademarks. Disclosure is likely to stimulate greater interest in a patent's future financial outcome. To capture a firm's innovation success, we measure the number of patents and citations to proxy for the quantity and quality, respectively, of the firm's innovation.

Our main results reveal that innovation success, in terms of both the quantity and quality of the patents granted, is followed by more management guidance. Our results are robust to controlling for an array of firm-, CEO-, and board-level characteristics, and to including firm (or industry), year, and CEO fixed effects. We also conduct an instrumental variable regression and find similar results. The collective weight of these tests is indicative of a causal relationship between successful innovation and subsequent voluntary disclosure.

In cross-sectional tests, we find the positive link between innovation and management forecasts to be especially strong in settings where investor demand for voluntary disclosure is high. Regulation Fair Disclosure (Reg FD) curtailed private communications with selected parties and enhanced demand for public disclosure (e.g., Bailey, Li, Mao, and Zhong 2003; Heflin, Subramanyam, and Zhang 2003; Hutton 2005; Wang 2007). Consistent with our conjecture, our main finding is incrementally stronger in the post-Reg FD period. Our main results are stronger for firms with more institutional investors, consistent with prior literature indicating that institutional investors are in a better position to demand and elicit voluntary disclosure from management (Healy, Hutton, and Palepu 1999; Bushee and Noe 2000; Ajinkya, Bhojraj, and Sengupta 2005). We next examine how competition affects firms' willingness to provide more disclosure following innovation success. As competition exacerbates proprietary cost concerns, we expect firms under greater competition to be less forthcoming with earnings guidance. We capture competition using industry concentration following Hoberg and Phillips (2016). Confirming our expectation, we find the positive relationship between patent grants and management guidance to be weaker for firms facing more competition.

In motivating our primary hypothesis, we argue that innovation success creates information asymmetry between firms and their shareholders, and predict that firms respond by issuing more management forecasts. To support this argument, we document that following a patent grant, there is a short-term increase in information asymmetry. In other words, more management forecasts in the wake of innovation success might be attributed to managers responding to increased information asymmetry. This heightened information asymmetry appears to recede following the provision of management forecasts.

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[1] For a survey of this literature, see Hirst, Koonce, and Venkataraman (2008).

Our paper contributes to both the literature on innovation and that on corporate disclosure. While many extant papers in the innovation literature examine the determinants of firm-level innovation (e.g., Hsu, Tian, and Xu 2014; Tian and Wang 2014; Chen, Huang, and Lao 2015), very few consider its consequences. Among those that do, Bena and Li (2014) show that firm innovation is an important driver of business acquisitions. Barth, Kasznik, and McNichols (2001) find a positive association between intangible assets and analyst coverage. They argue that the presence of intangible assets exacerbates information asymmetry between managers and shareholders, thus creating profitable opportunities for private information acquisition for information intermediaries. Jones (2007) examines the research and development (R&D) disclosures of a small sample of highly R&D-intensive firms. However, recent literature highlights several shortcomings of R&D expenditure as a measure of innovation success (Koh and Reeb 2015). Hence, our paper complements Barth et al. (2001) and Jones (2007) by using a large sample to study a common and important form of voluntary corporate disclosure—management forecasts. With this sample, we are able to conduct several additional analyses that shed light on the conditions under which innovation success leads to more voluntary disclosure.

We also contribute to the literature on corporate disclosure, particularly on management forecast antecedents (e.g., Healy and Palepu 2001; Hirst et al. 2008). The prior literature argues that the tendency to issue management forecasts increases with investors' information demand (e.g., Coller and Yohn 1997; Li and Zhuang 2012; Kim, Shroff, Vyas, and Wittenberg-Moerman 2018); it decreases with higher disclosure costs, such as proprietary costs (e.g., Verrecchia 1983; Darrough and Stoughton 1990; Wang 2007). Our paper complements this stream of the literature by studying how product market development in the form of innovation success affects management forecasts. One unique aspect of our setting is that in the presence of innovation, both information demand and proprietary costs are high. Whether and how managers alter their disclosure behavior in such settings is less clear. Hence, our paper contributes to the management forecast literature by documenting how the benefits and costs of disclosure can together shape management guidance decisions. In doing so, we answer Hirst et al.'s (2008) call to advance the literature by examining management forecasting behavior when more than one potentially competing forecast antecedents are in play.

The remainder of the paper is organized as follows. We develop our hypotheses in Section II, and present the sample and empirical design in Section III. Section IV discusses the results of the main tests. In Section V, we present additional analyses and robustness tests. Section VI concludes.

II. HYPOTHESIS DEVELOPMENT

The extant literature suggests that innovation is a crucial driver of long-term economic growth (Solow 1957; Romer 1990). A large body of literature investigates the factors that stimulate firm-level innovation. For example, studies show that innovation is affected by both internal and external financial constraints (Cornaggia, Mao, Tian, and Wolfe 2015; Himmelberg and Petersen 1994), stock market liquidity (Fang, Tian, and Tice 2014), ownership structure (Aghion, Van Reenen, and Zingales 2013), and financial development (Hsu et al. 2014). However, less is known about how innovation outcomes affect firms' disclosure behavior.

Innovation activities can potentially increase the information asymmetry between a firm and its investors because it is difficult for investors to predict future revenue and expenses from attempts to monetize the innovation. As investors become aware of the outcomes of a firm's innovation activities, such as patent grants, they grow keen to discover how these outcomes affect the firm's financial performance in both the long and short terms. While the revenue impact of such activities likely takes time to realize, the costs pertaining to further developing and commercializing innovation outcomes are incurred much earlier. Moreover, the firm's short-term financial outlook is an important piece of information in determining whether the firm is on a sufficiently stable footing to fully realize the potential benefits of its innovations.

Nevertheless, estimating how innovation activities affect firms' future earnings is a complex issue. For instance, barring a few exceptions, U.S. generally accepted accounting principles (GAAP) require all internal R&D costs to be expensed as incurred. However, the cost of acquiring a patent and any legal costs associated with filing and defending it can be capitalized. Patent litigation, on the rise in recent years, also adds to the uncertainty of the expenses and revenue streams. In addition to the gains and losses directly related to court awards arising from patent ligation, these lawsuits can result in injunctions that affect the continuing sales of existing products that rely on the patents or future sales of new products. Furthermore, innovation outcomes could lead to companies entering into complex arrangements that can result in special revenue recognition issues. For example, such arrangements may involve multiple elements, such as the licensing of intellectual property, R&D services, manufacturing services, and commercialization activities, each of which may require separate accounting.

Accounting numbers should reflect the economic substance of a firm's business and earnings and, therefore, are especially important as summary measures of business performance. Relatedly, management guidance is an important form of voluntary disclosure that helps to manage investor expectations about the firm's future performance (Ajinkya and Gift 1984; Kasznik and

Lev 1995; Matsumoto 2002). Therefore, we focus on how innovation outcomes (measured within the context of patent grants) affect firms' earnings guidance behavior.

Innovation and the Provision of Management Guidance

Management forecasts are an increasingly common tool for managers to voluntarily communicate their private information to capital market participants and other stakeholders. Disclosure theory generally predicts that managers have incentives to guide market participants when information asymmetry between the firm and its investors leaves the latter uncertain about the firm's value and, therefore, hungry for information (Verrecchia 2001; Healy and Palepu 2001). Many studies document the benefits of providing earnings guidance (e.g., Coller and Yohn 1997; Li and Zhuang 2012; Goodman, Neamtiu, Shroff, and White 2014).

However, the tendency to guide market participants is weakened by the potential costs of doing so. These can vary from the direct cost of disclosure to indirect costs, such as proprietary costs, which arise from passing valuable proprietary information to existing and potential competitors (Beyer, Cohen, Lys, and Walther 2010).[2] Moreover, managers may choose not to issue management guidance, either because of uncertainty about how investors will respond to the disclosure or due to reputation concerns that stem from making forecasts that might eventually prove inaccurate (Waymire 1985; Skinner and Sloan 2002; Graham, Harvey, and Rajgopal 2005; Suijs 2007). Hence, managers are expected to trade off these benefits and costs in determining whether to provide earnings guidance.

Both the demand for and the costs associated with management guidance are likely higher following successful innovation activities. Information demand is likely higher due to greater information asymmetry and uncertainty about financial performance and firm value. Greater information asymmetry arises because successful innovations may affect firms' operating outcomes and competitive strategies. Relatedly, greater uncertainty about financial performance and firm value arises from the difficulty in predicting whether and to what extent innovations can generate future cash flows for the firm. Moreover, earnings guidance, by increasing firms' visibility, allows them (and their managers) to signal that they are financially astute and careful in evaluating their innovations' potential impact on the bottom line.

In addition, having certain successful innovations may not immediately result in near-term profits. More investment might be needed, such as internal development, acquisition, and/or licensing to develop products and services that would generate future cash flows for the firm. These activities may require more resource commitments that can affect near-term profitability and give managers an incentive to guide the market toward more achievable short-term profit numbers, avoiding, for example, the torpedo effect (Bartov, Givoly, and Hayn 2002; Matsumoto 2002; Skinner and Sloan 2002). Further, stakeholders would also be keen to find out about short-term profitability in order to assess the firm's capability of carrying out its future plans.

Nevertheless, innovative firms might also find it costlier to release management guidance for several reasons. Even after a patent grant, innovative outcomes in general—and the profitability of the resultant products and services in particular—are uncertain by nature. This inherent uncertainty creates difficulty in forecasting earnings following an innovation. For example, Waymire (1985) argues and finds empirical support to suggest that the managers of firms with more volatile earnings are less likely to provide earnings forecasts due to the potential repercussions associated with missing projections. Similarly, Graham et al. (2005) report survey results showing that a major factor discouraging voluntary disclosure is reputation concerns that stem from creating market expectations that may ultimately go unmet. Moreover, management guidance can provide competitors with supplementary information that enables them to gauge a firm's assessment of demand projections, the additional resource commitments required, the effect on the firm's current product line-ups, etc. Accordingly, the proprietary costs associated with management guidance could be particularly high in the wake of a successful innovation (Wang 2007).

Hence, whether a firm would provide more or less management guidance following a successful innovation is an empirical question. Accordingly, we form our main hypothesis in the null form, as follows:

H1: There is no association between firms' innovation output and the provision of management guidance.

Next, we present a number of additional hypotheses aimed at gaining a further understanding of the relationship between innovation and management guidance. Moreover, obtaining additional results consistent with the theoretical predictions would further strengthen the inferences made from the tests of our primary hypothesis.

[2] To an extent, patents provide legal protection that can reduce the proprietary costs of disclosing patent-related information. However, financial disclosures—combined with other market intelligence—could still reveal proprietary information about firms' plans to commercialize the patents granted and the projected financial outcomes of doing so.

Investors' Information Demand

As H1 states, the cost-benefit trade-off of voluntary disclosure for innovative firms is not immediately clear. While investor demand could prompt managers to issue management guidance, proprietary cost concerns could dissuade them from doing so. Investigating this trade-off forms the basis of our second and third hypotheses.

We examine two contexts in which investors are especially likely to seek more information from innovative firms: (1) following enactment of Reg FD, which curtails private communications; and (2) when the fraction of institutional investors is large.

Regulation Fair Disclosure

Private communications are a natural substitute for public disclosure (e.g., Hutton 2005; Wang 2007) and are likely to be particularly useful when the firm engages in significant innovation activities. However, if private disclosure channels are curtailed, then the higher information demand associated with innovation activities can only be met via public channels. The passage of Regulation Fair Disclosure (Reg FD) in the year 2000 is a significant event in this respect because it prohibits private communications with selected parties, such as institutional investors and preferred financial analysts. Consistent with the notion of restrictions on private communications resulting in more public disclosure, Bailey et al. (2003) and Heflin et al. (2003) find that issuance of management guidance increases post-Reg FD. Accordingly, we expect the incremental demand for public disclosure following innovation activities to be higher in the post-Reg FD period. Therefore, we hypothesize in alternative form:

H2a: The association between firms' innovation output and the provision of management guidance (if any) is more positive after the passage of Regulation Fair Disclosure.

Institutional Investors

Prior research suggests that institutional investors are more likely to both demand and elicit more voluntary disclosure from a firm. For example, Healy et al. (1999) report that increases in firms' institutional ownership follow increases in their disclosure ratings. More directly related to our study, Ajinkya et al. (2005) find that firms with greater institutional ownership are more likely to issue management earnings forecasts. Accordingly, we argue that the demand for management forecasts from innovative firms is particularly high when the firms have high institutional ownership. Accordingly, we posit in alternative form:

H2b: The association between firms' innovation output and the provision of management guidance (if any) is more positive for firms with greater institutional ownership.

Competition

The potential proprietary costs associated with revealing information to competitors often discourages management from issuing earnings guidance (Verrecchia 1983; Darrough and Stoughton 1990; Wang 2007). Even though patent protection can mitigate concerns about competitors producing identical or nearly identical duplicates (Darrough 1993; Scotchmer 1991; Bessen and Meurer 2006; Glaeser 2018; Glaeser and Landsman 2019), patents do not provide absolute protection against rivals developing competing products and technologies. While patent information is already in the public domain, public management forecasts would be of particular concern to innovative firms facing higher competition. By combining patent information with management forecasts, competitors could gauge the product market potential of a firm's innovative outcomes, determine its plans and resource commitments, and then then craft counterstrategies that put the firm at a disadvantage. In contrast, innovation-driven proprietary cost concerns that stem from management guidance would be much lower for firms with less competition. Accordingly, such firms are more likely to issue management forecasts compared to innovative firms facing high competition. We formalize this argument in our next hypothesis, in alternative form:

H3: The association between firms' innovation output and the provision of management guidance (if any) is more negative for firms facing higher competition.

III. SAMPLE AND EMPIRICAL DESIGN

We obtain guidance data from the I/B/E/S database. Our sample period starts in 1995 because, although I/B/E/S guidance data are available from the end of 1992, the initial years of coverage are less comprehensive. We focus on quarterly management guidance and consider all types of forecasts (i.e., point, range, and qualitative guidance). We are interested in the provision of voluntary disclosure *per se,* and each piece of guidance, regardless of its nature, can be useful in updating investors' beliefs about the firm's future earnings. Our primary dependent variable is the number of guidance forecasts issued in a fiscal year (*Guidance*).

We obtain the patent records of all firms from the National Bureau of Economic Research (NBER) patent database.[3] We use firm-level patent data as an output-based measure of innovation (Kamien and Schwartz 1975; Griliches 1990; Hirshleifer et al. 2013; Hsu et al. 2014). The key advantage to using such a measure is that it more closely captures firms' success in innovation than an input-based measure such as R&D expenditure (Griliches 1990; Trajtenberg 1990).[4] Using the NBER database, we construct two metrics of innovation output: patent count (*LogPatentCount*) and patent citations (*LogPatentCite*). *LogPatentCount* captures the number of patents granted to a firm in a fiscal year and *LogPatentCite* does the same for the total number of citations received for such patents. *LogPatentCount* can be viewed as a measure of the quantity of successful innovation output and *LogPatentCite* as a measure of quality. Because we examine management guidance behavior *following* patent grants, the patent data used in this paper start in 1994. While this database ends in 2006, we only use patent data up to 2004 due to concerns about truncation bias in the data, which prior literature highlights. We focus on the year of the patent grant, rather than the patent application, because of our interest in whether successful innovation output affects firms' earnings guidance behavior. Moreover, because not all patent applications are granted, focusing on the application year could generate look-ahead bias.[5] Following the literature, we use the logarithmic value of 1 plus the patent or citation count to mitigate skewness in firm-level patents and citations.

The sample construction process is tabulated in Panel A of Table 1. Panel B displays the number of observations by year. While the sample size is somewhat lower in the last three years, this reduction is consistent with the overall decline in the number of listed firms.[6] Panel C presents the sample distribution by industry and, for each industry, the average patent count and average number of citations.

We examine the impact of innovation on the issuance of management guidance with the following regression specification:

$$\begin{aligned} Guidance_{i,t+1} = {} & \beta_0 + \beta_1 Innovation_{i,t} + \beta_2 LagGuidance_{i,t} + \beta_3 R\&D_{i,t} + \beta_4 LogSize_{i,t} + \beta_5 Book\text{-}to\text{-}Market_{i,t} + \beta_6 ROA_{i,t} \\ & + \beta_7 Loss_{i,t} + \beta_8 MeanReturn_{i,t} + \beta_9 RetVol_{i,t} + \beta_{10} Leverage_{i,t} + \beta_{11} NumBizSeg_{i,t} + \beta_{12} Financing_{i,t} \\ & + \beta_{13} KS_{i,t} + \beta_{14} Spread_{i,t} + \beta_{15} Amihud_{i,t} + \beta_{16} ShrTurnover_{i,t} + \beta_{17} InstOwn_{i,t} + \beta_{18} ERC_{i,t} \\ & + \beta_{19} Analyst_{i,t} + Firm\,FE_i + Year\,FE_t + \varepsilon_{i,t}. \end{aligned} \tag{1}$$

where i and t indicate firm and year, respectively. The dependent variable, *Guidance,* is the number of quarterly forecasts issued in the year following a patent grant. The variable of interest, *Innovation,* is measured by either *LogPatentCount* or *LogPatentCite*. We employ a lead-lag structure for the dependent variable and the variable of interest because we examine management guidance behavior following successful patent outcomes. However, because guidance activity tends to be sticky, reverse causality is a concern. We overcome this issue by including the guidance for year t (*LagGuidance*) as a control variable, which effectively ensures that we capture the *change* in guidance behavior following successful innovations.

Our regression model also controls for a number of other firm-level characteristics that could affect managers' decision to issue guidance. We control for R&D expenditure (*R&D*) to ensure that the documented effect of innovation success on management guidance is incremental to that, if any, of R&D spending (Koh and Reeb 2015). We control for the effects of firm size through the natural logarithm of total assets (*LogSize*) because prior literature suggests that larger firms are more likely to issue management forecasts (Kasznik and Lev 1995). To control for investment opportunities and growth options, we include the ratio of the book value of equity to the market value of equity—*Book-to-Market* (Bamber and Cheon 1998; Call, Chen, Miao, and Tong 2014). We control for firm profitability through the return on assets (*ROA*) and include the indicator variable *Loss* to denote whether the firm made a loss, as prior literature finds that loss-making firms are less likely to issue management forecasts (Ajinkya et al. 2005). We also control for the average and standard deviation of the monthly stock returns during the year (*MeanReturn* and *RetVol*) because extant research suggests that firms with more difficult-to-predict earnings are less likely to issue management guidance (Waymire 1985; Ajinkya et al.

[3] See: https://sites.google.com/site/patentdataproject/Home

[4] For example, Koh and Reeb (2015) show that 10 percent of firms with missing R&D values actually file and receive patents, suggesting that output-based measures are better at capturing firms' innovative activities.

[5] We thank an anonymous referee for highlighting this issue.

[6] See: https://data.worldbank.org/indicator/CM.MKT.LDOM.NO?end=2004&locations=US&start=1994&view=chart

TABLE 1

Sample Description

Panel A: Sample Construction

Firm-year observations from NBER patent datasets from 1994 to 2004	61,200
Firm-year observations from I/B/E/S datasets from 1995 to 2005	18,611
Firm-year observations from Compustat from 1994 to 2004	79,511
Less: Observations in the financial and utilities industries	(16,992)
Compustat merged with I/B/E/S guidance and NBER patent datasets	62,519
Observations with missing control variables	(37,624)
Final sample	24,895

Panel B: Number of Observations by Year

Year	Frequency
1994	2,137
1995	2,282
1996	2,388
1997	2,504
1998	2,468
1999	2,368
2000	2,355
2001	2,298
2002	2,068
2003	2,023
2004	2,004

(continued on next page)

2005). Because financing structure and complexity could be related to innovation activities and disclosure decisions, we control for financial leverage (*Leverage*) and the number of business segments (*NumBizSeg*).

Further, we follow Lang and Lundholm (2000) and control for financing needs as the sum of net equity and net debt issues (*Financing*), as both innovation and management forecasts could be associated with financing needs. We use the measure developed by Kim and Skinner (2012) to control for firms' *ex ante* litigation risk (*LitigationRisk*).[7] In addition, we control for liquidity in terms of the bid-ask spread (*Spread*), the Amihud (2002) illiquidity measure (*Amihud*), and the monthly share turnover (*ShrTurnover*). Because institutional investors' information demands could be greater than those of individual investors, we control for the institutional ownership percentage (*InstOwn*). We control for firms' earnings response coefficient to capture the importance of earnings in valuations (*ERC*). We also control for analyst coverage (*Analyst*), as Barth et al. (2001) find analyst coverage to be positively associated with intangible assets, and investment in such assets could influence innovation. Complete definitions of all variables are presented in Appendix A.

We employ firm and year fixed effects to account for time-invariant firm characteristics and time trends, respectively. Employing firm fixed effects ensures greater statistical rigor because significant results (if any) can be more closely attributed to within-firm variations in patent grants. As additional tests, we also examine an alternative model in which firm fixed effects are replaced with industry fixed effects (SIC two-digit level). We cluster standard errors at the firm level.

Table 2 provides the descriptive statistics for our main variables of interest and control variables. The average frequency of management guidance (*Guidance*) is 1.57. Note that the number of patents granted (*LogPatentCount*) and the number of patent citations (*LogPatentCite*) are defined as the natural logarithm of 1 plus the respective raw number. The numbers reported in Table 2 translate to a mean annual patent count of 1.0 and an average of 3.1 citations.

[7] Our results are not sensitive to controlling for *ex post* litigation risk in period $t+1$.

TABLE 1 (continued)

Panel C: Distribution of Patenting Activity by Industry

SIC2	Industry	Average Patent Count	Average Patent Cite	SIC2	Industry	Average Patent Count	Average Patent Cite
01	Agricultural Production—Crops	3.02	39.80	37	Transportation Equipment	41.40	555.44
02	Agricultural Production—Livestock	0.13	0.65	38	Instruments and Related Products	14.73	234.14
07	Agricultural Services	0.07	0.67	39	Miscellaneous Manufacturing Industries	5.33	108.06
08	Forestry	0.00	0.00	50	Wholesale Trade—Durable Goods	0.55	8.75
10	Metal, Mining	0.16	1.51	51	Wholesale Trade—Nondurable Goods	0.84	6.34
12	Coal Mining	0.00	0.00	52	Building Materials and Gardening Supplies	0.38	2.08
13	Oil and Gas Extraction	1.61	41.28	53	General Merchandise Stores	0.06	1.02
14	Nonmetallic Minerals, Except Fuels	2.57	56.84	54	Food Stores	0.01	0.08
15	General Building Contractors	0.04	1.14	55	Automotive Dealers and Service Stations	0.01	0.96
16	Heavy Construction, Except Building	6.70	112.92	56	Apparel and Accessory Stores	0.04	0.36
17	Special Trade Contractors	0.05	0.34	57	Furniture and Home Furnishings Stores	0.22	2.52
20	Food and Kindred Products	2.57	24.74	58	Eating and Drinking Places	0.02	0.05
21	Tobacco Products	1.83	57.73	59	Miscellaneous Retail	0.21	8.59
22	Textile Mill Products	2.12	10.38	70	Hotels and Other Lodging Places	0.00	0.00
23	Apparel and Other Textile Products	0.09	0.77	72	Personal Services	0.04	0.74
24	Lumber and Wood Products	2.25	24.24	73	Business Services	10.44	226.16
25	Furniture and Fixtures	6.53	104.99	75	Auto Repair, Services, and Parking	0.36	4.96
26	Paper and Allied Products	19.14	363.22	76	Miscellaneous Repair Services	0.67	11.93
27	Printing and Publishing	0.96	14.68	78	Motion Pictures	1.02	18.58
28	Chemical and Allied Products	17.26	188.54	79	Amusement and Recreation Services	0.65	18.70
29	Petroleum and Coal Products	15.61	202.02	80	Health Services	0.15	5.32
30	Rubber and Miscellaneous Plastics Products	6.61	66.23	81	Legal Services	0.00	0.00
31	Leather and Leather Products	0.40	5.06	82	Educational Services	0.02	0.65
32	Stone, Clay, and Glass Products	5.83	67.00	83	Social Services	0.00	0.00
33	Primary Metal Industries	3.16	39.14	86	Membership Organizations	1.00	21.13
34	Fabricated Metal Products	4.58	62.34	87	Engineering and Management Services	1.25	25.38
35	Industrial Machinery and Equipment	30.11	637.61	99	Non-Classifiable Establishments	232.78	2261.05
36	Electronic and Other Electric Equipment	34.37	709.80	Unclassified Industry[a]	—	0.10	1.64

[a] This category contains all the firms within our sample with a missing industry classification in Compustat.

The sample spans the period from 1994 to 2004, with the year being the year patents are granted. Note that for our research design, patents granted in year *t* are matched to guidance announced in year *t*+1. We exclude the financial and utility industries (SIC 4000–4999 and 6000–6999). Panel A shows the sample construction process, and Panel B gives a breakdown of the number of observations by year. Panel C shows a breakdown of the number of observations by industry (at the SIC two-digit level) and their average patent activities during our sample period.

All variables are defined in Appendix A.

IV. RESULTS

Main Results (H1)

The results for model (1) are reported in Table 3. Columns (1) and (2), respectively, report the results with *LogPatentCount* and *LogPatentCite* as the measures of innovation output. In columns (3) and (4), firm fixed effects are replaced by industry fixed effects at the two-digit SIC level.[8] In Table 3, column (1), the coefficient on *LogPatentCount* is positive and significant (coefficient size = 0.28, t-statistic = 5.32). The coefficient on *LogPatentCite* in column (2) of Table 3 is also positive (coefficient size = 0.05, t-statistic = 2.66). Together, these results suggest an increase in the provision of management guidance following successful innovation output. They are consistent with the idea that the perceived benefits of reducing information

[8] There are slightly fewer observations with industry fixed effects because industry codes are missing for some firms. As a robustness check, we create an "unclassified industry" category for observations without industry codes, so that those with missing codes can be included. None of our results are sensitive to the decision to either include or exclude these observations.

TABLE 2

Summary Statistics

Variable	n	Mean	Std. Dev.	p25	p50	p75
Guidance	24,895	1.57	3.84	0.00	0.00	1.00
LagGuidance	24,895	1.13	2.86	0.00	0.00	1.00
LogPatentCount	24,895	0.69	1.24	0.00	0.00	1.10
LogPatentCite	24,895	1.41	2.30	0.00	0.00	2.92
R&D	24,895	0.06	0.10	0.00	0.00	0.07
LogSize	24,895	5.90	1.76	4.61	5.75	6.99
Book-to-Market	24,895	0.54	0.44	0.25	0.44	0.70
ROA	24,895	−0.01	0.20	−0.01	0.04	0.08
Loss	24,895	0.26	0.44	0.00	0.00	1.00
MeanReturn	24,895	0.02	0.05	−0.01	0.01	0.04
RetVol	24,895	0.15	0.09	0.09	0.13	0.19
Leverage	24,895	0.20	0.19	0.02	0.17	0.32
NumBizSeg	24,895	3.90	3.91	1.00	3.00	5.00
Financing	24,895	0.09	0.46	−0.02	0.00	0.05
LitigationRisk	24,895	7.03	2.43	5.44	6.50	8.00
Spread	24,895	1.82	1.75	0.52	1.34	2.54
Amihud	24,895	0.50	1.48	0.00	0.03	0.23
ShrTurnover	24,895	7.10	6.83	2.59	4.83	9.05
InstOwn	24,895	0.34	0.30	0.00	0.32	0.60
ERC	24,895	14.19	66.45	−2.39	2.63	19.23
Analyst	24,895	6.44	6.37	2.00	4.00	9.00
FutureFinancing	24,281	0.06	0.22	−0.02	0.00	0.04
CEOComp	9,735	7.76	1.08	7.02	7.69	8.44
CEOTenure	9,735	7.24	7.18	2.00	5.00	10.00
CEOEquityComp	9,735	0.44	0.29	0.20	0.45	0.67
LogDelta	9,735	0.81	1.44	−0.13	0.76	1.70
LogVega	9,735	−0.83	2.64	−1.68	−0.76	0.21
BoardSize	3,867	9.26	2.54	7.00	9.00	11.00
PctIndDirector	3,867	0.81	0.10	0.75	0.83	0.89
CEOChair	3,867	0.79	0.41	1.00	1.00	1.00
PctFemDirector	3,867	0.10	0.09	0.00	0.10	0.14
PatentAttorney	24,842	2.23	2.49	0.50	1.15	3.13
IndusLogPatentCount	24,895	0.49	0.44	0.10	0.33	0.85
IndusLogPatentCite	24,895	1.00	0.82	0.21	0.69	1.82
HHI	20,476	0.47	0.50	0.00	0.00	1.00
InstOwn50	24,895	0.35	0.48	0.00	0.00	1.00
RegFD	24,895	0.34	0.47	0.00	0.00	1.00

Table 2 reports the descriptive statistics for our main variables of interest, as well as for the control variables. The sample spans the period from 1994 to 2004, with the year being the year patents are granted. Note that for our research design, patents granted in year *t* are matched to guidance announced in year *t*+1. We exclude the financial and utility industries (SIC 4000–4999 and 6000–6999).
All variables are defined in Appendix A.

asymmetry by projecting future earnings in light of a successful innovation outcome outweigh the associated disclosure costs. In terms of economic magnitude, we observe that a one-standard-deviation increase in *LogPatentCount* (*LogPatentCite*) increases the number of management forecasts in the subsequent period by 22.1 percent (7.3 percent) relative to its mean.[9] For the control variables, the coefficient on *LagGuidance* is positive, revealing the highly persistent nature of management forecasts. Consistent with prior studies, we also find that firms that are likely to provide more guidance are larger, less likely to incur losses, and have higher and more stable returns. We also find that litigation concerns discourage, whereas stock illiquidity

[9] For *LogPatentCount,* the coefficient = 0.28, s.d. = 1.24. Mean value of *Guidance* = 1.57. Hence, the impact = 0.28 ∗ 1.24/1.57 = 22.1 percent. Following the same process, the impact of *LogPatentCite* = 0.05 ∗ 2.30/1.57 = 7.3 percent.

TABLE 3

Relation between Firm Innovation and Management Guidance

	(1)	(2)	(3)	(4)
LogPatentCount	0.28***		0.06***	
	(5.32)		(3.02)	
LogPatentCite		0.05***		0.03***
		(2.66)		(3.87)
LagGuidance	0.71***	0.71***	0.90***	0.90***
	(27.10)	(27.18)	(43.58)	(43.55)
R&D	0.23	0.15	−0.07	−0.09
	(0.52)	(0.34)	(−0.34)	(−0.47)
LogSize	0.20***	0.22***	0.02	0.02
	(3.82)	(4.06)	(0.84)	(0.91)
Book-to-Market	−0.06	−0.05	−0.16***	−0.16***
	(−0.86)	(−0.79)	(−4.49)	(−4.45)
ROA	0.25	0.22	0.23**	0.23**
	(1.30)	(1.15)	(2.00)	(1.99)
Loss	−0.18***	−0.17***	−0.09*	−0.09*
	(−2.73)	(−2.60)	(−1.70)	(−1.74)
MeanReturn	3.50***	3.44***	3.46***	3.46***
	(6.43)	(6.34)	(7.84)	(7.85)
RetVol	−2.32***	−2.31***	−0.92***	−0.93***
	(−6.68)	(−6.65)	(−3.43)	(−3.49)
Leverage	0.55**	0.59***	0.02	0.03
	(2.49)	(2.66)	(0.22)	(0.31)
NumBizSeg	−0.00	−0.00	−0.02***	−0.02***
	(−0.18)	(−0.20)	(−2.87)	(−2.80)
Financing	−0.06	−0.06*	−0.05	−0.05
	(−1.52)	(−1.65)	(−1.63)	(−1.64)
LitigationRisk	−0.04***	−0.04***	−0.02***	−0.03***
	(−4.00)	(−4.04)	(−2.77)	(−2.79)
Spread	0.18***	0.18***	0.12***	0.12***
	(11.18)	(11.28)	(11.64)	(11.74)
Amihud	0.04***	0.05***	0.01	0.01
	(3.55)	(3.60)	(0.71)	(0.83)
ShrTurnover	−0.00	−0.00	0.03***	0.03***
	(−0.40)	(−0.47)	(8.49)	(8.44)
InstOwn	0.22	0.23	0.29***	0.28***
	(1.16)	(1.24)	(4.13)	(4.02)
ERC	0.00	0.00	0.00*	0.00*
	(0.86)	(0.77)	(1.96)	(1.94)
Analyst	0.07***	0.07***	0.04***	0.04***
	(5.27)	(5.38)	(7.00)	(7.06)
Observations	24,895	24,895	23,608	23,608
Adj. R^2	0.60	0.60	0.61	0.61
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No
Industry FE	No	No	Yes	Yes

***, **, * Indicate significance at the 1 percent, 5 percent, and 10 percent levels (two-tailed), respectively.

Table 3 presents the results of regressions that examine the relation between firm innovation and management guidance. The first (last) two columns present the results with year fixed effects and firm fixed effects (industry fixed effects). Constants are included, but not reported for any of the regressions. t-statistics (in parentheses) are reported below the coefficient estimates and are based on robust standard errors clustered by firm.

All variables are defined in Appendix A.

promotes, management guidance. Management guidance is also positively associated with analyst following, consistent with firms responding to analysts' information demand.

We also note that the coefficient on the control variable *R&D* in Table 3 is insignificant. As discussed previously, our focus is on the successful outcomes of innovation activities as captured by patent grants, as opposed to input measures that could potentially influence innovation. The insignificant coefficient on *R&D* is also in line with the findings of Koh and Reeb (2015) that R&D disclosures are rather unreliable due to both subjective and complex R&D expense allocation decisions and managers' conscious efforts to obfuscate R&D expenditure. In contrast, once granted, managers have no influence whatsoever over the disclosure of patents by the USPTO. Unrelated to the issue of construct validity surrounding R&D disclosures, it is also possible that management is more inclined to issue forecasts after a patent grant because the outcome risk and proprietary costs associated with an already-obtained patent are lower than they are for R&D investments in general.

Addressing Further Concerns about Omitted Correlated Variables and Endogeneity

A major concern for an empirical study of this nature is endogeneity induced by reverse causality and/or omitted correlated variables. As previously discussed, the inclusion of lagged guidance as a control variable and firm fixed effects should alleviate these concerns to some extent. Nonetheless, to lend greater support to our inferences, we conduct a number of robustness tests.

Potential Unobservable Differences between Firms with and without Patents

To address the concern that the positive relationship between patenting and management forecasts may be driven by other unobservable systematic differences between firms or industries that do and do not hold patents, we rerun our main analyses excluding (1) firms that obtained no patents during our sample period, (2) firm-year observations with no patent grants, (3) industries with zero patents, and (4) industry-years with no patenting activities. The results are tabulated in Panel A of Table 4. We continue to find a positive association between our innovation proxies and management forecasts.

Additional Control Variables

While our main regression model controls for a number of firm-level characteristics, in this section, we augment this model by incorporating alternative proxies for financing needs and controlling for several CEO- and board-level characteristics. The results are presented in Panel B of Table 4. In columns (1) and (2), we conduct our main analyses again by controlling for financing needs in the following, instead of the current, fiscal year to address the concern that future financing needs may affect managers' incentives to provide guidance.[10] In columns (3) and (4), we supplement firm and year fixed effects with CEO fixed effects to ensure that our results are not sensitive to the CEO's reporting preferences. We obtain CEO information from Execucomp, which results in a drop in our sample size. In columns (5) and (6), we further rule out CEO incentives as a potential confounding factor by controlling for CEO compensation (*CEOComp*), tenure (*CEOTenure*), the percentage of equity the CEO holds (*CEOEquityComp*), and the CEO's incentive, measured by the portfolio delta (*LogDelta*) and vega (*LogVega*). In columns (7) and (8), we also include the following board characteristics to control for governance: board size (*BoardSize*), the percentage of independent directors on the board (*PctIndDirector*), CEO-chairman duality (*CEOChair*), and the percentage of female directors (*PctFemDirector*). Despite significant sample size shrinkage, the coefficients on *LogPatentCount* and *LogPatentCite* continue to remain positive and significant in all columns in Panel B.

Two-Stage Least Squares (2SLS) Tests

Next, we further rule out endogeneity concerns by conducting 2SLS tests using instrumental variables. While it is extremely difficult to find instruments that meet both the relevance and exclusion restriction conditions, we come up with two instruments based on economic intuition and prior literature.

Our first instrument is the presence of patent attorneys (and agents) in the state where a firm's headquarters is located. Patent attorneys add value to the preparation of a patent application due to their experience with previous applications, and by helping the inventor recognize all of an invention's novel aspects. Furthermore, patent attorneys are likely to be methodical about following and meeting Patent Office due dates, reducing frictions in the patent filing and granting process. They would also be involved in any patent litigation. Consequently, they are more likely to be concentrated in states where there is more demand for patent-related services. Simply stated, it is intuitive to expect firms headquartered in a state with many patent attorneys to have a higher level of patenting activity. But while the presence of patent attorneys is likely indicative of such activity, it is difficult to imagine this labor market condition as having a direct effect on firms' management guidance. It is

[10] Our inference remains unchanged when we control for financing needs at $t+1$ and $t+2$ and at t and $t+1$.

TABLE 4

Addressing Endogeneity Concerns

Panel A: Excluding Firms and Industries with Zero Patents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Excluding Firms with Zero Patents		Excluding Firm-Years with Zero Patents		Excluding Industries with Zero Patents		Excluding Industry-Years with Zero Patents	
LogPatentCount	0.22***		0.30***		0.27***		0.27***	
	(4.30)		(3.61)		(5.30)		(5.19)	
LogPatentCite		0.06***		0.11**		0.05***		0.05***
		(3.19)		(2.23)		(2.69)		(2.65)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,237	11,724	8,388	7,806	24,694	24,694	23,278	22,951
Adj. R^2	0.62	0.62	0.63	0.63	0.61	0.61	0.61	0.60
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Regressions with Additional Control Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LogPatentCount	0.28***		0.26***		0.29***		0.53**	
	(5.25)		(2.99)		(3.65)		(2.52)	
LogPatentCite		0.05***		0.06*		0.08**		0.18**
		(2.63)		(1.72)		(2.49)		(2.15)
Financing			−0.16	−0.18*	−0.09	−0.10	0.01	−0.01
			(−1.58)	(−1.78)	(−0.85)	(−1.01)	(0.03)	(−0.03)
FutureFinancing	−0.05	−0.05						
	(−0.61)	(−0.65)						
CEOComp					−0.24**	−0.24**	−0.48***	−0.48***
					(−2.24)	(−2.22)	(−3.77)	(−3.77)
CEOTenure					0.01	0.01	0.05*	0.05*
					(1.02)	(1.08)	(1.75)	(1.73)
CEOEquityComp					0.53**	0.53**	1.33***	1.34***
					(2.38)	(2.37)	(3.27)	(3.28)
LogDelta					−0.11	−0.12	−0.35*	−0.35*
					(−1.46)	(−1.50)	(−1.87)	(−1.85)
LogVega					0.01	0.01	0.02	0.02
					(0.96)	(0.96)	(0.73)	(0.98)
BoardSize							0.05	0.05
							(0.68)	(0.70)
PctIndDirector							−5.10***	−5.18***
							(−2.88)	(−2.93)
CEOChair							−0.01	−0.02
							(−0.03)	(−0.04)
PctFemDirector							−2.20	−2.30
							(−1.12)	(−1.16)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,281	24,281	11,117	11,117	9,735	9,735	3,867	3,867
Adj. R^2	0.61	0.60	0.57	0.56	0.64	0.64	0.67	0.67
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CEO FE	No	No	Yes	Yes	No	No	No	No

(continued on next page)

TABLE 4 (continued)

Panel C: 2SLS Regressions—*PatentAttorney* and *IndusLogPatentCount/IndusLogPatentCite* as Instrumental Variables

	(1) 1st Stage	(2) 2nd Stage	(3) 1st Stage	(4) 2nd Stage
PatentAttorney	0.02***		0.04***	
	(4.55)		(3.52)	
IndusLogPatentCount	0.48***			
	(9.39)			
LogPatentCount		2.34***		
		(5.92)		
IndusLogPatentCite			0.58***	
			(10.74)	
LogPatentCite				1.22***
				(6.20)
Controls	Yes	Yes	Yes	Yes
Observations	23,962	23,962	23,962	23,962
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
p-value of Sargan-Hansen test	—	0.10	—	0.28

***, **, * Indicate significance at the 1 percent, 5 percent, and 10 percent levels (two-tailed), respectively.
Table 4 presents the results of additional analyses aimed at addressing endogeneity concerns. Panel A presents the results of regressions that address potential fundamental differences between innovative and non-innovative firms and industries. Columns (1) and (2) (columns (5) and (6)) present the results excluding firms (industries) with zero patents. Columns (3) and (4) (columns (7) and (8)) show results excluding firm-years (industry-years) with zero patents. Panel B presents the results using additional control variables. The first two columns show the results using future financing needs as the control variable instead of financing needs in the current year. Columns (3) and (4) present the results after including CEO fixed effects. Columns (5) and (6) show regression results after including the CEO-related control variables. The last two columns present the results after including control variables related to the CEO and those related to the board of directors. Panel C presents the two-stage least squares (2SLS) regressions. Both the number of patent attorneys in the state where the firm is headquartered and the industry average innovation are employed as instruments for firm innovation. Columns (1) and (3) of Panel C report the first-stage results, while columns (2) and (4) report the second-stage results. Constants are included, but not reported. While we also include the control variables in Table 3, their coefficients are not reported. t-statistics (in parentheses) are reported below the coefficient estimates and are based on robust standard errors clustered by firm.
The definitions of the variables can be found in Appendix A.

conceivable that other factors could also influence the concentration of patent attorneys. For example, it is reasonable to expect them to have a greater presence in jurisdictions where more patent lawsuits are heard. However, to the extent that these other determinants are not directly associated with management forecasting behavior, our instrument continues to remain valid. Accordingly, we obtain information on registered patent attorneys (and agents) from the USPTO website and construct the variable, *PatentAttorney,* by counting the number of patent attorneys within each state.[11]

As the second instrument, we follow an approach commonly employed in the accounting literature: using the industry average of the variable of interest. Accordingly, we construct the industry average *LogPatentCount* and *LogPatentCite* at the two-digit SIC level and label them *IndusLogPatentCount* and *IndusLogPatentCite* (Hsu, Lee, Liu, and Zhang 2015). This approach should fulfill the instrument validity conditions because the extent of patent activities likely varies at the industry level. While industry factors could also affect disclosure practices, there is no *ex ante* reason to believe that the underlying determinants of the latter are directly associated with the former. In other words, while industry membership could affect disclosure, there is no compelling reason to believe that industries with high (low) patent activity are also those with a high (low) level of disclosure. Having a second instrument also allows us to test over-identification restrictions to discern whether the exclusion restriction condition is violated.

The results for the 2SLS specifications are reported in Panel C of Table 4.[12] In the first-stage regressions, we observe that the instrumental variable is positive and significantly associated with the relevant patent activity. Moreover, in the second-stage

[11] We obtain patent lawyer information from the following source: https://oedci.uspto.gov/OEDCI/

[12] For parsimony, we report the results with two instrumental variables in each first-stage regression. Our 2SLS results are robust to the inclusion of each instrument variable individually. Specifically, we find a significant positive association between innovation and guidance when we add the instrumental variables one at a time.

regressions, we find that the instrumented constructs of *LogPatentCount* and *LogPatentCite* are again positive and significant, confirming the main findings in Table 3. Further, the p-values of the Sargan-Hansen tests are insignificant, suggesting that over-identification is unlikely to be a problem.

Effect of Investors' Information Demand (H2)

H2 argues that the association between patent grants and management forecasts is more positive when investors are more likely to demand voluntary disclosures from management. Accordingly, H2a and H2b posit that the relationship between innovation output and management forecasts is more positive following the passage of Reg FD and in the presence of more institutional investors, respectively.

To examine the Reg FD effect, we amend model (1) by including the indicator variable *RegFD* and its interactions with *LogPatentCount* and *LogPatentCite*. *RegFD* takes the value of 1 for the years after the regulation's enactment (i.e., 2001 and after), and 0 otherwise. H2a predicts positive coefficients on *LogPatentCount* ∗ *RegFD* and *LogPatentCite* ∗ *RegFD*. The results for the tests of H2a are reported in columns (1) and (2) of Table 5, Panel A. As expected, the coefficients on both the interaction terms *LogPatentCount* ∗ *RegFD* and *LogPatentCite* ∗ *RegFD* are positive and significant. These results suggest that, as hypothesized in H2a, management forecasting behavior following successful innovation outcomes is particularly high after the adoption of Reg FD.

H2b argues that firms with a higher level of institutional investor ownership are more likely to provide greater disclosure following a successful innovation outcome. We examine this prediction by augmenting model (1) with the variable *InstOwn50* and its interaction term with *LogPatentCount* and *LogPatentCite*. *InstOwn50* is an indicator variable that takes the value of 1 if institutional investors collectively hold over 50 percent of outstanding shares, and 0 otherwise.[13] The coefficients of interest are those on the interaction terms *LogPatentCount* ∗ *InstOwn50* and *LogPatentCite* ∗ *InstOwn50*, which we predict will be positive. Columns (3) and (4) of Table 5, Panel A report the results. The coefficients on the interaction terms are significantly positive, as predicted.[14]

Together, the results presented in Table 5, Panel A support our argument that the relationship between innovation and management forecasts is more positive when investor demand for voluntary disclosure is higher.

Effect of Competition (H3)

H3 argues that innovative firms facing greater competition are less likely to issue management guidance because of the higher proprietary costs of voluntary disclosure. We capture competition in terms of industry concentration (*HHI*), following Hoberg and Phillips (2016), who identify firms' competitors based on 10-K product descriptions. We consider this construct to be especially relevant in our setting because product similarity is likely to be a key determinant of the extent to which a competitor might benefit from increased disclosure following a successful innovation. In investigating H3, we extend model (1) by incorporating *HHI* and its interaction term with *LogPatentCount* and *LogPatentCite*. Note that *HHI* is an inverse proxy of competition. Accordingly, H3 predicts positive coefficients on the interaction terms *LogPatentCount* ∗ *HHI* and *LogPatentCite* ∗ *HHI*.

The results, reported in Table 5, Panel B, are consistent with our predictions; the coefficients on both *LogPatentCount* ∗ *HHI* and *LogPatentCite* ∗ *HHI* are significantly positive. These results indicate that firms with greater competition are less inclined to provide management guidance following a patent grant.

V. ROBUSTNESS TESTS AND ADDITIONAL ANALYSES

In this section, we report the results of several robustness tests and additional analyses.

Long-Term versus Short-Term Forecasts

The revenue impact of patent grants likely occurs over the long-term. However, patent grants can also increase demand for short-term forecasts because any costs related to further improvements and the patents' commercialization are usually incurred and recognized over the short term. Moreover, it could be argued that short-term forecasts are also useful in assessing firms'

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[13] This set of data is obtained from the Thomson Reuters Institutional (13F) Holdings database. We use 50 percent as the cut-off because institutional investors are likely to have a greater influence on a firm's disclosure policy when they collectively hold the majority of shares outstanding.

[14] We also observe that the coefficients on *InstOwn50* are either statistically insignificant or marginally negative. One interpretation of these results is that for non-innovative firms with no information demands stemming from innovation success, high institutional ownership is not significantly associated with voluntary disclosure. In some cases, high institutional ownership might even curtail voluntary disclosure because institutional investors might be privy to private information that they might not want publicly disclosed.

TABLE 5

Effect of Information Demand and Competition

Panel A: Effect of Information Demand

	(1)	(2)	(3)	(4)
LogPatentCount ∗ RegFD	0.36***			
	(7.05)			
LogPatentCite ∗ RegFD		0.22***		
		(8.08)		
LogPatentCount ∗ InstOwn50			0.24***	
			(4.08)	
LogPatentCite ∗ InstOwn50				0.09***
				(3.16)
LogPatentCount	0.13**		0.16***	
	(2.48)		(2.81)	
LogPatentCite		−0.04**		0.02
		(−2.02)		(0.77)
RegFD	0.64***	0.60***		
	(9.01)	(8.46)		
InstOwn50			−0.14*	−0.09
			(−1.70)	(−1.18)
Controls	Yes	Yes	Yes	Yes
Observations	24,895	24,895	24,895	24,895
Adj. R^2	0.60	0.60	0.61	0.60
Year FE	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Panel B: Effect of Competition

	(1)	(2)
LogPatentCount ∗ HHI	0.14**	
	(2.13)	
LogPatentCite ∗ HHI		0.08***
		(2.58)
LogPatentCount	0.23***	
	(3.33)	
LogPatentCite		0.01
		(0.40)
HHI	−0.12	−0.13*
	(−1.55)	(−1.82)
Controls	Yes	Yes
Observations	20,476	20,476
Adj. R^2	0.60	0.60
Year FE	Yes	Yes
Firm FE	Yes	Yes

***, **, * Indicate significance at the 1 percent, 5 percent, and 10 percent levels (two-tailed), respectively.
Table 5 presents the results of regressions that examine the effect of investors' information demand. Columns (1) and (2) show the impact of Regulation Fair Disclosure (Reg FD) on the relation between firm innovation and management guidance. Columns (3) and (4) present the results regarding the impact of majority institutional holdings on the association between innovation and guidance. Constants are included, but not reported. While we also include the control variables in Table 3, their coefficients are not reported. t-statistics (in parentheses) are reported below the coefficient estimates and are based on robust standard errors clustered by firm.
The definitions of the variables can be found in Appendix A.

TABLE 6

Short- versus Long-Term Guidance

	(1)	(2)	(3)	(4)
	STGuidance		*LTGuidance*	
LogPatentCount	0.05**		0.23***	
	(2.31)		(5.33)	
LogPatentCite		0.02**		0.04**
		(2.00)		(2.27)
LagSTGuidance	0.42***	0.42***		
	(8.66)	(8.66)		
LagLTGuidance			0.73***	0.73***
			(27.13)	(27.21)
Controls	Yes	Yes	Yes	Yes
Observations	24,895	24,895	24,895	24,895
Adj. R^2	0.36	0.36	0.61	0.60
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

***, **, * Indicate significance at the 1 percent, 5 percent, and 10 percent levels (two-tailed), respectively.
Table 6 presents the results of regressions that examine the relation between firm innovation and short- and long-term management guidance. Constants are included, but not reported in all regressions. t-statistics (in parentheses) are reported below the coefficient estimates and are based on robust standard errors clustered by firm.
All variables are defined in Appendix A.

financial stability and their ability to fully exploit the long-term opportunities afforded by patent grants. Based on this reasoning, our main analyses consider all quarterly management forecasts, irrespective of whether they pertain to the next quarter or a longer period.

As an additional analysis, we investigate whether our results are sensitive to the distinction between short- and long-term forecasts. Accordingly, we rerun model (1) by replacing the dependent variable *Guidance* with either short-term (*STGuidance*) or long-term guidance (*LTGuidance*), along with the respective lag variables. We define *STGuidance* as the number of quarterly forecasts for the current fiscal quarter and *LTGuidance* as the number of quarterly forecasts for quarters beyond the current fiscal quarter.

The results are reported in Table 6. Columns (1) and (2) (columns (3) and (4)) report the respective results with *LogPatentCount* and *LogPatentCite* as the variables of interest and *STGuidance* (*LTGuidance*) as the dependent variable. As can be seen from the table, the coefficients on both *LogPatentCount* and *LogPatentCite* are reliably positive regardless of the dependent variable. In other words, these results reveal that patent grants are followed by increases in both short- and long-term management guidance behavior.

Additional Robustness Tests

We conduct an array of further robustness tests. First, we investigate whether our results hold with respect to the *propensity* to issue management guidance. In untabulated tests, we amend model (1) by replacing the dependent variable *Guidance* with *Guider,* which takes the value of 1 if the firm makes at least one quarterly management forecast during the year, and 0 otherwise. Our inferences remain unchanged. Second, we reexamine our primary hypothesis using Poisson regressions. In untabulated results, we continue to find the coefficients on *LogPatentCount* and *LogPatentCite* to be positive in all but one specification, indicating that, by and large, our main inferences are not sensitive to the regression approach employed.[15] Third, we address potential sampling bias in the management guidance data. Following the recommendations of Chuk, Matsumoto, and Miller (2013), we reexamine our primary hypothesis for subsamples of firms with a large analyst following, firms with high institutional ownership (based on the respective yearly medians), and profitable firms. We observe that the coefficients on both *LogPatentCount* and *LogPatentCite* are positive for all three subsamples of firms that are less likely to suffer from incomplete guidance data. Hence, our inferences do not appear to be affected by management guidance data coverage.

[15] The only exception is the coefficient on *LogPatentCount* in the firm fixed effect regression, which remains positive, but is statistically insignificant.

Last, we address potential look-ahead bias in *LogPatentCite*. The *LogPatentCite* variable captures citations that are obtained subsequent to the patent grant. To the extent that patents with more citations are likely to be more profitable, the look-ahead nature of the *LogPatentCite* measure raises the concern that increases in the number of management forecasts may be induced by the prospect of higher future profits, rather than by innovation *per se*. Obtaining consistent results with *LogPatentCount,* which is immune to look-ahead bias, assuages this concern to a great degree. However, to further rule it out, in untabulated tests, we rerun our regressions after including additional controls for future profitability over different horizons (ROA_{t+1}, ROA_{t+2}, and ROA_{t+3}). These inclusions do not alter any of our inferences.

Increased Management Forecasts and Changes in Information Asymmetry

Next, we investigate whether increased management forecast activity following a patent grant is associated with any discernible change in information asymmetry in the equity market. This investigation is based on the notion that investors demand information to reduce information asymmetry, either among themselves (e.g., between informed and uninformed investors) or between themselves and the firm. An extensive body of theoretical and empirical literature on disclosure documents that disclosure reduces both types of information asymmetry in equity markets (Diamond and Verrecchia 1991; Lambert, Leuz, and Verrecchia 2007, 2012; Li and Zhuang 2012; Goodman et al. 2014). Hence, we expect information asymmetry to be lower for innovative firms that provide voluntary disclosure.

To investigate this conjecture, we construct two measures of information asymmetry. First, to capture the information asymmetry between more and less informed investors, we use the Amihud (2002) stock illiquidity measure (*Amihud*), which captures the price impact of trades. This illiquidity measure is widely used in the finance literature because it is easy to construct and is based on Kyle's (1985) seminal market microstructure model. We calculate *Amihud* as the average daily absolute return scaled by the dollar trading volume in a fiscal year. Second, to capture the information asymmetry between a firm and its investors, we argue that greater information asymmetry between the firm and outside investors is characterized by the comparative lack of precision with respect to information about the firm (Lambert et al. 2007, 2012). As a result, there would be greater uncertainty about firm value and higher return volatility (e.g., Ross 1989; Rogers, Skinner, and Van Buskirk 2009). Hence, we construct the measure, *LogRetVol,* by taking the natural logarithm of the average daily return volatility in a fiscal year.

With the above two measures, we examine the impact of guidance following a patent grant on information asymmetry using the following regression specification:

$$InfoAsy_{i,t+2} = \beta_0 + \beta_1 Guidance_{i,t+1} * Innovation_{i,t} + \beta_2 Guidance_{i,t+1} + \beta_3 Innovation_{i,t} + \beta_4 LagInfoAsy_{i,t+1} + \beta_5 Size_{i,t+1} + \beta_6 LogShrTurn_{i,t+1} + \beta_7 Loss_{i,t+1} + \beta_8 InstOwn_{i,t+1} + \beta_9 LogAnaFol_{i,t+1} + Firm\,FE + Year\,FE + \varepsilon_{i,t}. \quad (2)$$

where *i* and *t* indicate firm and fiscal year, respectively. *InfoAsy* refers to *Amihud* and *LogRetVol*. *Innovation* is measured by the natural logarithm of 1 plus the number of patent grants (*LogPatentCount*) or the natural logarithm of 1 plus the patent citations in a fiscal year (*LogPatentCite*). *Guidance* is measured using the number of quarterly forecasts the firm provides during the fiscal year. We assume the following timeline: a firm receives a patent grant in period *t;* its manager provides guidance in period $t+1$; and information asymmetry effects become apparent in period $t+2$.

We include a set of control variables based on the prior empirical literature that examines the determinants of information asymmetry. Following Fu, Kraft, and Zhang (2012), Brown, Hillegeist, and Lo (2004), and Cheng, Dhaliwal, and Neamtiu (2011), we add the following control variables: *LogSize, LogShrTurn, Loss, InstOwn,* and *LogAnalyst*. *LogSize* is the natural logarithm of the market value of equity at the end of the year. *LogShrTurn* is the natural logarithm of the average daily trading volume divided by shares outstanding in a fiscal year. *Loss* is an indicator variable that equals 1 if the net income before extraordinary items is negative, and 0 otherwise. *InstOwn* is the average percentage of shares held by institutional investors within the fiscal year. *LogAnalyst* is the natural logarithm of 1 plus the analyst following measured in the last month of a fiscal year. We also control for one-year-lagged measures of stock illiquidity (*LagAmihud*) and return volatility (*LagRetVol*), so that we essentially capture changes in stock liquidity and return volatility, respectively, for firms that issue more guidance following innovation success.

The results of the regressions examining the information asymmetry outcomes of innovative firms that provide guidance are reported in Table 7. Columns (1) and (2) document the results with *Amihud* as the dependent variable. The coefficients on the interaction terms *LogPatentCount* $*$ *Guidance* and *LogPatentCite* $*$ *Guidance* in columns (1) and (2), respectively, are negative. This result suggests that when managers of innovative firms provide guidance, information asymmetry is lowered among investors in these firms. This inference is consistent with the prior literature documenting reduced information asymmetry when firms respond to investors' information demand by providing public disclosure, which tends to benefit less informed investors more. Columns (3) and (4) present the results with *LogRetVol* as the dependent variable. The respective

TABLE 7

The Effect of Providing Guidance after Innovation Success on Information Asymmetry

	(1)	(2)	(3)	(4)
	Amihud		***LogRetVol***	
LogPatentCount ∗ Guidance	−0.002**		−0.001***	
	(−2.06)		(−3.34)	
LogPatentCite ∗ Guidance		−0.001***		−0.001***
		(−2.75)		(−3.51)
LogPatentCount	−0.034**		−0.007*	
	(−1.97)		(−1.81)	
LogPatentCite		−0.007		−0.001
		(−0.77)		(−0.50)
LagAmihud	0.522***	0.522***		
	(13.60)	(13.59)		
LagLogRetVol			0.210***	0.211***
			(23.69)	(23.72)
Guidance	0.001	0.001	−0.003***	−0.003***
	(0.17)	(0.48)	(−3.96)	(−4.04)
LogSize	−0.305***	−0.305***	−0.050***	−0.050***
	(−10.44)	(−10.44)	(−13.01)	(−13.01)
LogShrTurn	−0.555***	−0.554***	0.144***	0.144***
	(−14.65)	(−14.65)	(33.50)	(33.53)
Loss	0.259***	0.258***	0.097***	0.097***
	(6.35)	(6.33)	(17.72)	(17.70)
InstOwn	0.469***	0.467***	−0.041***	−0.041***
	(5.83)	(5.79)	(−2.68)	(−2.68)
LogAnalyst	0.029	0.028	−0.016***	−0.017***
	(0.91)	(0.89)	(−3.50)	(−3.52)
Observations	23,895	23,895	23,895	23,895
Adj. R^2	0.71	0.71	0.82	0.82
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

***, **, * Indicate significance at the 1 percent, 5 percent, and 10 percent levels (two-tailed), respectively.
Table 7 presents the results of regressions that examine the effect on information asymmetry in the capital market for firms that provide guidance after innovation success. The first two columns present the results with stock illiquidity (*Amihud*) to proxy for information asymmetry among investors, whereas the next two columns use return volatility (*LogRetVol*) to proxy for information asymmetry between the firm and its investors. Constants are included, but not reported for any of the regressions. t-statistics (in parentheses) are reported below the coefficient estimates and are based on robust standard errors clustered by firm.
All variables are defined in Appendix A.

coefficients on *LogPatentCount ∗ Guidance* and *LogPatentCite ∗ Guidance* are negative, again indicating that investors benefit from reduced information uncertainty when innovative firms provide voluntary disclosure.

In sum, the results reported in Table 7 suggest that management guidance by innovative firms reduces information asymmetry in the equity market.

Innovation Success and Changes in Information Asymmetry

Our primary argument for innovative firms increasing disclosure is that these firms respond to greater investor demand for information after innovation success. The results reported in this section indicate that issuing management forecasts after patent grants reduces information asymmetry and investor uncertainty in the long term. A related question is whether information asymmetry and, thus, information demand increase immediately after patent grants.

Kogan, Papanikolaou, Seru, and Stoffman (2017) examine the equity market effects of innovative firms in the short window after a patent grant announcement. In particular, they find that trading activity increases significantly in the days following an announcement. They also find that the returns on patent grant days are more volatile than they are on days with no patent grant announcement. These findings suggest that patent grants increase investor interest, divergence of opinion, and/or information asymmetry in the equity markets, which, in turn, stimulates trading (Kim and Verrecchia 1994; Kandel and Pearson 1995; Bamber, Barron, and Stober 1999). Kogan et al. (2017) also find that the positive market reaction at the time of the announcement is positively associated with future firm growth, suggesting that, on average, investors rationally expect the firm to build on its innovation success.

To complement Kogan et al. (2017), we examine whether stock illiquidity and return volatility increase after the patent grants in our sample, which would provide within-sample evidence of a short-term increase in investors' information asymmetry in the wake of a patent grant. Similar to the previous section, we consider two forms of information asymmetry: (1) among investors, and (2) between the firm and its investors (or simply investor uncertainty).

To examine immediate changes in information asymmetry following patent grants, we use the sample of firms with patent grants and examine the short-term change in information asymmetry before and after the grant in the short window. Specifically, we use an event-study approach to examine the stock illiquidity and return volatility in the three-day window after a patent grant date [t−1, t+1] relative to the three-day window before the grant date [t−4, t−2] using the following specification:

$$STInfoAsy_{i,t} = \beta_0 + \beta_1 Post_{i,t} + \beta_2 Size_{i,t} + \beta_3 LogShrTurn_{i,t} + \beta_4 Loss_{i,t} + \beta_5 InstOwn_{i,t} + \beta_6 LogAnaFol_{i,t} + Firm\ FE + \varepsilon_{i,t} \quad (3)$$

where i and t indicate firm and patent grant date, respectively. Note that a firm can have multiple patent grant dates within a year, and we examine the short-term market reaction at each grant date.[16] *STInfoAsy* refers to *STAmihud* and *STLogRetVol,* where *STAmihud* is the average daily absolute return scaled by the dollar trading volume over the three-day window, and *STLogRetVol* is the natural logarithm of the average daily return volatility over the three-day window. We regress these dependent variables on the indicator variable *Post,* which takes the value of 1 (0) for the window after (before) a patent grant. As in model (2), we control for the following variables, measured in the fiscal year before the patent grant date: *LogSize, LogShrTurn, Loss, InstOwn,* and *LogAnalyst*. If a firm's information demand increases in the short-term following a patent grant, we would expect a simultaneous increase in stock illiquidity and return volatility, signaled by a positive coefficient on *Post*.

We present the results in Table 8. Column (1) shows the results using *STAmihud* as the proxy for information asymmetry. The coefficient on *Post* is positive and significant, indicating an increase in illiquidity immediately following a patent grant. Column (2) presents the results with *STLogRetVol* as the dependent variable. Similar to the results in the first column, the coefficient on *Post* is positive, indicating greater investor uncertainty. These results offer evidence that firms' information asymmetry increases immediately following a patent grant. This, in turn, suggests that our primary finding that management issues more forecasts following innovation success can be attributed to managers' attempts to mitigate heightened information asymmetry and to respond to investors' information demands.

VI. CONCLUSION

In this paper, we examine whether innovation success, measured in terms of patent grants, induces firms to make more voluntary management forecasts. Following a successful innovation, investor demand for voluntary disclosure is expected to increase because investors would be keen to learn about the innovation's short- and long-term financial implications. But disclosure is also expected to come with high proprietary costs. Our results indicate that management forecasting behavior increases following a patent grant, suggesting that, on average, and at least in our context, the benefits of additional disclosure are perceived to outweigh the costs. We attempt to provide a causal interpretation of our results through several econometric approaches that include controlling for contemporaneous management forecasting behavior, employing firm fixed effects, and applying 2SLS regressions with instrumental variables.

Having established that innovation induces firms to provide more management guidance, we conduct cross-sectional analyses that examine how investors' information demand and managers' disclosure cost concerns impact the relationship between patent grants and guidance. We document a stronger positive association between patent grants and management forecasts following enactment of Reg FD and for firms with higher institutional ownership. These outcomes are suggestive of innovative firms responding to investors' information demands. We also find that firms with greater competition are less likely to increase management forecast issuance following a patent grant, indicating that proprietary costs of disclosure remain an important issue.

Our findings hold with respect to both short- and long-term forecasts and when we replace the number of guidance forecasts released with the propensity to release such forecasts. We also conduct several other robustness tests to ensure that our

[16] Within our sample of patent grant dates, the three-day event windows do not contain overlapping patent grants for any firm.

TABLE 8

Short-Term Impact of Innovation Success on Stock Illiquidity and Return Volatility

	(1) *STAmihud*	(2) *STLogRetVol*
Post	0.01*	0.03***
	(1.71)	(7.53)
LogSize	−0.03***	0.10***
	(−4.09)	(7.61)
LogShrTurn	−0.15***	0.19***
	(−3.49)	(8.65)
Loss	0.02	0.09***
	(1.21)	(4.73)
InstOwn	0.08	−0.51***
	(1.62)	(−6.83)
LogAnalyst	−0.06**	−0.06***
	(−1.96)	(−2.59)
Observations	161,222	161,222
R^2	0.24	0.23
Firm FE	Yes	Yes

***, **, * Indicate significance at the 1 percent, 5 percent, and 10 percent levels (two-tailed), respectively.
Table 8 presents the results of regressions that examine the short-term effect of innovation success on stock illiquidity and return volatility. The first (second) column presents the results with *STAmihud* (*STLogRetVol*) as the proxy for stock illiquidity (return volatility). *Post* is an indicator variable equaling 1 for the three-day window [*t*–1, *t*+1] after a patent grant, and 0 for the three-day window [*t*–4, *t*–2] before the patent grant. Constants are included, but not reported for any of the regressions. t-statistics (in parentheses) are reported below the coefficient estimates and are based on robust standard errors clustered by firm.
All variables are defined in Appendix A.

findings are not sensitive to our regression specification choices and potential sample biases. We further find evidence suggestive of reduced information asymmetry for firms that disclose more information in the wake of innovation success. Finally, we directly examine the premise that uncertainty increases in a firm's information environment following innovation success and find evidence consistent with this maintained assumption.

It is important to note that we capture a firm's innovation success in terms of patent grants, which are accorded certain legal protections. While a patent grant is a stronger measure of innovation success than input-based measures, such as R&D expenditure (e.g., Griliches 1990; Trajtenberg 1990; Koh and Reeb 2015), one may expect the relation between patent activity and voluntary disclosure to vary with the level of legal protection or enforcement, which, in turn, may depend on country- or industry-level institutional factors. Future research may address some of these questions.

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APPENDIX A

Variable Definitions

Variable Name	Definition
Amihud	Average daily absolute return divided by the daily dollar trading volume in a fiscal year, multiplied by 1,000,000.
Analyst	Number of analysts following the firm, measured in the last month of a fiscal year.
BoardSize	Number of directors on the board.
Book-to-Market	Ratio of the book value of equity to the market value of equity at the end of the fiscal year.
CEOChair	Indicator variable equaling 1 if the CEO is also the board chair.
CEOComp	Natural logarithm of the CEO's total compensation for a given year, including salary, bonus, other annual compensation, long-term incentive payouts, other cash payouts, and the value of restricted stock and stock option awards.
CEOTenure	Years of the CEO's tenure until the current fiscal year.
CEOEquityComp	Percentage of the CEO's total compensation that is equity compensation.
ERC	The earnings response coefficient is the stock market reaction (the change in stock price) to one unit of unexpected earnings, where unexpected earnings are measured as the difference between the reported earnings per share and the most recent I/B/E/S consensus forecast.
Financing	Sum of net equity issues and net debt issues. Net equity issues are calculated as the sale of common and preferred stock minus the purchase of common and preferred stock, divided by total assets at the beginning of the year. Net debt issues are calculated as long-term debt issues minus long-term debt reduction plus the change in current debt, divided by total assets at the beginning of the year.
FutureFinancing	*Financing,* measured in the next fiscal year.
Guidance	Number of management quarterly forecasts provided by the firm during the fiscal year.
HHI	Indicator variable equaling 1 if the industry concentration measure based on Hoberg and Phillips (2016) exceeds the median for the year, and 0 otherwise.
IndusLogPatentCite	Average of *LogPatentCite* for firms in the same industry in a fiscal year.
IndusLogPatentCount	Average of *LogPatentCount* for firms in the same industry in a fiscal year.
InstOwn	Average percentage of shares outstanding held by all institutional investors within a fiscal year.
InstOwn50	Indicator variable equaling 1 if the percentage of shares outstanding collectively held by all institutional investors is more than 50 percent for the year, and 0 otherwise.
Leverage	Ratio of long- and short-term debt to total assets.
LagAmihud	*Amihud,* measured in the previous fiscal year.
LagGuidance	*Guidance,* measured in the previous fiscal year.
LagLTGuidance	*LTGuidance,* measured in the previous fiscal year.
LagLogRetVol	*LogRetVol,* measured in the previous fiscal year.
LagSTGuidance	*STGuidance,* measured in the previous fiscal year.
LitigationRisk	Litigation risk, measured following Kim and Skinner (2012).
LogAnalyst	Natural logarithm of 1 plus the number of analysts following, measured in the middle of the last month of a fiscal year.
LogPatentCite	Natural logarithm of 1 plus the total number of citations received for all patents granted to a firm in a fiscal year. The citation measure is adjusted for truncation, following Hall, Jaffe, and Trajtenberg (2005). We use the logarithmic citation count plus 1 to mitigate skewness in firm-level patents and citations. The data are downloaded from the NBER patent database.
LogPatentCount	Natural logarithm of 1 plus the total number of patent grants a firm obtains in a fiscal year. We use the logarithm of the patent count plus 1 to mitigate skewness in the firm-level patent counts. The data are downloaded from the NBER patent database.
LogSize	Natural logarithm of the market value of equity at the end of the fiscal year. The market value of equity is measured in $millions.
LogVega	Natural logarithm of 1 plus the vega. The vega is the dollar change in the value of the portfolio of the CEO's option holdings for a 1 percent change in the volatility of the stock returns.
LogDelta	Natural logarithm of delta. The delta is the sensitivity of the executive's stock and options portfolio to a 1 percent change in the stock price level.
LogRetVol	Natural logarithm of the average daily return volatility in a fiscal year.
LogShrTurn	Natural logarithm of the annual average of the daily trading volume divided by shares outstanding in a fiscal year.
Loss	Indicator variable equaling 1 if the net income before extraordinary items is negative, and 0 otherwise.

(continued on next page)

APPENDIX A (continued)

Variable Name	Definition
LTGuidance	Number of quarterly guidance forecasts for fiscal quarters after the current fiscal quarter in the current fiscal year.
MeanReturn	Mean of the monthly returns during the fiscal year.
NumBizSeg	Number of business segments, as disclosed by the firm under segment reporting.
PatentAttorney	Total number of patent attorneys (and agents) within a state. The number of patent attorneys is obtained by first downloading the directory of patent attorneys from the United States Patent and Trademark Office (USPTO) website (see: https://oedci.uspto.gov/OEDCI/) and then doing a count of how many there are in each state.
PctFemDirector	Percentage of female directors on the board.
PctIndDirector	Percentage of independent directors on the board.
Post	Indicator variable equaling 1 for the three-day window $[t-1, t+1]$ after a patent grant, and 0 for the three-day window $[t-4, t-2]$ prior to the patent grant.
RetVol	Standard deviation of the monthly returns during the fiscal year.
R&D	Ratio of R&D expenses to total assets. If R&D is missing, the ratio is set to 0.
RegFD	Indicator variable equaling 1 for the year 2001 and after, and 0 otherwise.
ROA	Ratio of net income before extraordinary items to total assets.
ShrTurnover	Annual average of the daily trading volume divided by shares outstanding in a fiscal year.
Spread	Average daily bid-ask spread divided by the daily closing price in a fiscal year.
STAmihud	Average daily absolute return divided by the daily dollar trading volume in a three-day window, multiplied by 1,000,000.
STGuidance	Number of management quarterly guidance forecasts for the current fiscal quarter in the current fiscal year.
STLogRetVol	Natural logarithm of the average daily return volatility in a three-day window.