Offsetting illegitimacy? How pressures from securities analysts influence incumbents in the face of new technologies

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Abstract

Radical shifts in technology create strong pressures for firms' survival. Yet, the strategic changes and investments required to respond to these technical pressures may cause firms to be increasingly misaligned with their traditional investor or analyst category, triggering perceptions by important stakeholders - such as shareholders and analysts - that actions to respond to the new technology are not legitimate. Research has not addressed how such reactions from securities analysts subsequently affect the strategies firms pursue. We study how analysts' recommendations affect firms' strategies during periods of technological change. We find that negative pressures from analysts to improve cash flow and stock price trigger reductions in strategic investments during periods of radical technological change. We find further that firms that continue investments to respond to the new technology are more likely to undertake share repurchases, actions that signal alignment with shareholders' interests. We examine the question using a large sample longitudinal statistical study of three settings during radical technological shifts: photography, wireline telecommunications, and newspaper publishing. We also discuss the steps we have taken to address risks of endogeneity and unobserved heterogeneity. Studying settings of radical technological change provides a natural experiment for more broadly understanding how institutional pressures influence firms' subsequent actions.

Firms face pressures to adapt to changes in their environments. An important adaptation challenge documented in prior research is the major shifts in technology that can render incumbent firms' existing assets and capabilities obsolete. Scholars have explored the challenges of technological change for incumbent firms (e.g. Henderson & Clark, 1990; Tushman & Anderson, 1986; Christensen & Bower, 1996; Cooper & Smith, 1992), and much of this work has focused on the evolutionary nature of the firm's history (Nelson & Winter, 1982) that constrains capabilities and inhibits learning processes (Tushman & Anderson, 1986; Leonard-Barton, 1992). Recent attention has also been focused on the role of managers' cognition in restricting firms' actions (Tripsas & Gavetti, 2000; Garud & Rappa, 1994). Scholars studying how established incumbents can adapt in the face of radical technological change have similarly highlighted the role of internal factors, such as complementary assets (Teece, 1986; Tripsas, 1997; Rothaermel, 2001) or dynamic capabilities (Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000; Winter, 2003) in overcoming the constraints of organizational and managerial inertia.

At the same time, work in organization theory has focused on the influences on organizational action of external institutions (e.g. Pfeffer & Salancik, 1978; DiMaggio & Powell, 1983; Tolbert and Zucker, 1983). The nature of these influences is often determined by prevailing institutional logics (Friedland and Alford, 1991; Thornton and Ocasio, 1999; Scott, 2001) that by categorization (Rosch, 1978; Zerubavel, 1997) influence the perceived legitimacy of particular activities or policies, further influencing action (Tolbert, 1985; Sutton & Dobbin, 1996; Porac, Wade, & Pollock, 1999). Although the implication in much of this research is that organizations are constrained by institutional pressures, other research suggests alternative outcomes. Researchers have found evidence for divergent rather than isomorphic strategies in response to institutional pressures, suggesting that pressures to adapt to a firm's technical environment can outweigh institutional pressures (Kraatz and Zajac, 1996; D'Aunno, Succi & Alexander, 2000). Other work proposes that firms address institutional constraints by decoupling

responses to the institutional pressures from the firms' core activities and strategies (Meyer & Rowan, 1977; Westphal & Zajac, 2001). Oliver (1991) further suggests how firms proactively manage institutional environments.

More specifically, researchers have explored how financial market pressures from sell-side securities analysts influence firms. Zuckerman (1999) showed that analysts were more likely to drop coverage of stocks that, due to unrelated diversification, were misaligned with the single-industry analysts' categories, and in turn, this lack of coverage resulted in a lower stock price, or an "illegitimacy discount." This work provides an additional explanation for the diversification discount that has been documented in a large body of work in accounting, economics, and finance. Zuckerman (2000) further showed that the firms most misaligned with a particular analyst category were more likely to divest the business units that were most misaligned with the firm's core industry category. Rao & Sivakumar (1999) also document analysts' influences on organizational actions, describing the rise of investment relations offices to manage interaction with analysts.

Recently, researchers have begun to examine the possible influences of sell-side securities analysts in the context of firms facing radical technological change. Major shifts in technology create strong pressures for firms' adaptation, and survival in the face of such shifts can require strategic changes and investments to develop new knowledge and capabilities. Yet, technological change triggers high uncertainty that heightens the role of categories in interpreting the appropriateness of firms' actions and gives rise to increased potential for institutional pressures. The strategic changes required to respond to technical pressures may cause firms to be increasingly misaligned with their traditional analyst or investor category (Benner, 2007). One implication of this prior research is that firms' actions to maintain and extend an old technology may be perceived as more legitimate by analysts and shareholders than actions to respond to a new, substitute technology. But research has not addressed whether and how the

reactions from analysts subsequently affect the strategies firms pursue in the face of new technologies. We address this gap by asking: How do analysts' pressures affect firms' strategies during a technological change?

We find that pressures from analysts affect firms' subsequent strategic investments. In particular, increasingly negative recommendations from analysts dampen firms' investments in capital expenditures and R&D during periods of radical technological change. We also find, in these settings with strong pressures for technological adaptation, that firms that maintain investments despite pressures from analysts are likely to offset their growing illegitimacy by announcing stock repurchases, legitimacy-enhancing activities that signal alignment with shareholders.

This study makes several contributions. Although there is a large body of research exploring the challenge of technological change for firms, its focus has been on the constraints arising from factors internal to firms, such as routines, myopic learning, or managerial cognition. There is little research on how external institutional pressures influence firms' adaptation to major technological changes. Second, settings of technological change are characterized by strong pressures for adaptation and survival, and are characterized by very high uncertainty, situations in which sensemaking is more likely to unfold through cognitive categories that organize and legitimate particular activities and strategies. Thus, this is a fruitful setting for studying the potential role of institutional pressures in adaptation and the possible tensions between organizational attempts to adapt to technical pressures and institutional pressures. In addition, the technological change setting provides a natural experiment for studying the broader question of how analysts affect firms' strategies and actions. This study makes contributions to both theory and empirical research, improving our understanding of the challenges firms face as they respond to new technologies. The study findings, while often stronger in the technological change settings, are

consistent across other settings, suggesting these findings have implications for understanding the influence of analysts on firms' innovation generally, beyond the specific setting of technological change.

The paper proceeds as follows. We first review prior research on technological change and the role of sell-side analysts as mediators in financial markets, and then draw from research in institutional theory and technological change to develop our hypotheses concerning how analysts' pressures likely affect firms faced with a major technological change. Following that, we describe our empirical setting, three contexts undergoing radical technological change. We then describe the large sample study to test our hypotheses, relying on archival data available from I/B/E/S, Compustat, and CRSP, followed by a description of the results and the steps we have taken to address endogeneity and unobserved heterogeneity issues. We conclude with a discussion of the implications and contributions of our study.

HYPOTHESES DEVELOPMENT

Securities Analysts, Radical Technological Change, and Reactions to Incumbents

Following previous research (e.g. Zuckerman, 1999; 2000; Benner 2009), we focus on the potential for institutional pressures from sell-side securities analysts arising from their role as mediators in public equity markets. Securities analysts assess the performance of firms and publish periodic reports including forecasts of a firm's future stock price and recommendations about whether to "buy," "hold," or "sell" a firm's stock (e.g. Schipper, 1991; Bradshaw, 2004). The importance of analysts is suggested by the large body of research in finance and accounting that has focused on the behaviors of analysts and the effects of their forecasts on investors' behaviors. This research has shown the significant impact securities analysts' evaluations and recommendations have on the price and the trading volume of firms' stock (e.g. Womack, 1996; Barber, Lehavy, McNichols, and Trueman, 2001). In this research, analysts are widely assumed to increase the informational efficiency of markets, and have superior private knowledge than is available publicly (e.g. Frankel, Kothari, and Weber, 2006; Lys & Sohn, 1990;

Ramnath, Rock and Shane, 2008). While this research has considered the influence of analysts on investors, it has not considered analysts as a possible source of pressures on the strategies and behaviors of the firms they cover. Analysts' recommendations affect firms' stock prices (i.e. market value). Moreover, their interpretations of investors' likely behaviors and underlying perceptions that affect a firm's stock price are frequently communicated in interactions with managers and recommendations concerning changes in strategy. Thus, their influences extend beyond effects on investors' behaviors to influencing firms' actions and strategies (e.g. Rao & Sivakumar, 1999).

An increasing body of work in institutional theory research has explored the role of cognitive categories in affecting perceptions of the legitimacy of firms' actions (cf. Porac, Wade, and Pollock, 1999; Zuckerman, 1999). Similarly, securities analysts' coverage is organized by category, corresponding to industries or sectors within industries, and each analyst typically covers a single industry category (Schipper, 1991; Zuckerman, 1999). Organization and management scholars have recently begun to study how these categories used by analysts affect perceptions of legitimacy and firms' actions. In a small number of recent studies, researchers have shown that firms that have multiple unrelated businesses (Zuckerman, 1999), or undertake more complex or unique strategies compared to their peer group (Moreton & Zenger, 2005), are followed by fewer analysts because they do not fit in well into the analysts' industry or sector categories. This resulting lack of analyst coverage leads further to discounting of the firm's stock price by investors, and further influences firms' corporate diversification activities, pressuring firms to reverse unrelated diversification and divest the businesses most out of fit with their core analyst category (Zuckerman, 2000). In a study of identity change in one organization, Tripsas (2009) further showed that analysts were slow to change the dimensions of the evaluative category used to assess the firm.

We seek to understand whether and how analysts' recommendations affect firms' strategic investments during a period of radical technological change. The challenge of technological change for the incumbent firms in an industry has been documented in a large body of prior work (e.g. Tushman & Anderson, 1986; Henderson & Clark, 1990; Tripsas 1997). The advent of a radical technological discontinuity in an industry ushers in a period of high uncertainty (e.g. Tushman & Anderson, 1986; Abernathy and Utterback, 1978), characterized further by increased competition. Radical technological change involves a shift to a new base of knowledge underlying the products in an industry, that offers the potential for a superior price/performance trajectory (e.g. Gatignon, et al, 2002), for example, the shift from film photography based on chemistry, to digital photography based on electronics (cf. Tripsas & Gavetti, 2000), or from mechanical watch technology to quartz; (Glasmeier, 1991; Landes, 1983). In addition, technological upheavals challenge managers with whether and how to respond through efforts to develop the new knowledge and capabilities required for the new technology.

The increased uncertainty arising from the advent of a new technology also heightens the challenges for securities analysts who are charged with assessing the firms' future value and the appropriateness of current investments. Because the future success of firms following a radical technological change depends on the technological standards and business models that emerge but are known only ex post (cf. Anderson and Tushman, 1990; Utterback, 1994), there is high uncertainty about the future value of firms during the unfolding technological change. As a result, it is also difficult to predict the future value (and wisdom) of current investments undertaken during periods of major technological transition. These characteristics of technological change are likely to trigger increasing cognitive categorization to make sense of firms' actions and strategies and heighten the potential for institutional pressures guiding firms toward actions and strategies aligned with their category.

To understand how analysts' reactions affect firms' strategies during a technological change it is useful to first understand the nature of their reactions under these conditions. As radical technological changes usher in new competitors and often disrupt the profit models underlying the competition in an industry, they often dampen incumbent financial performance - at least for a time until the eventual shakeout in dominant standards and winning competitors (cf. Anderson & Tushman, 1990). Further, beyond the overall impact of the new technology on incumbents, prior research has explored how analysts react when incumbent firms actually take steps to respond to a new technology. Drawing from research in institutional theory and technological change, Benner (2007) argues that the actions to respond to a new technology are likely to drive firms out of fit with their prior investor and analyst category and associated "stock market identity," triggering decreases in stock price and more negative analysts' reactions. In a subsequent empirical study of firms responding to radical technological changes in two contexts, Benner (2009) compared the nature and direction of analysts' reactions to the specific strategies firms undertook to respond to a radical new technology and strategies that extended or maintained the existing technology. This research, drawing from the content of analysts' reports issued to investors, showed that analysts frequently mentioned the firms' exploitative strategies based on the old technology, while they tended to either ignore or react negatively to the product strategies to respond to the new technology. Benner & Ranganathan (2008) further compared analysts' reactions for different categories of firms entering the new domain created by a radical technological change. They show - in the context of a radical technological change to voice-over-Internet protocol (VoIP) in wireline telecommunications - that similar strategies to respond to the same radical technological change pursued by industry incumbents and entrants from other industries elicited different reactions from securities analysts. The analysts were more positive toward the non-incumbents while they frequently questioned the incumbents' strategies and investments to respond. Taken together, this work suggests that radical

technological change is likely to trigger negative reactions from analysts, arising both from its profit-dampening effects on incumbents still engaged in the existing technology, but further, also stemming from analysts' perceptions of illegitimacy as incumbents respond to the new technology.

> *Hypothesis 1: Analysts' recommendations will be increasingly negative toward the incumbent firms in an industry following a radical technological discontinuity.*

Influence of Analysts' Recommendations on Firms' Strategies

The pressures arising from negative analysts' recommendations are likely to be experienced by firms through two mechanisms. First, as previous research shows, analysts pressures work indirectly, through their mediating effects on stock price (Zuckerman, 2000). Positive or negative recommendations have important implications for investors' stock purchase behaviors, and in turn determine the value of a firm's stock (Rao & Sivakumar, 1999). This idea is further supported by a large body of prior research in finance and accounting that has shown that analysts' recommendations and forecasts influence investors' behaviors and stock prices (e.g. Womack, 1996), echoed in the business press (Nocera, 1997). Further, there is a growing body of evidence in management research that managers are attentive to stock price reactions (Davis, 1991; Rao & Sivakumar, 1999; Davis & Useem, 2001; Useem, 1996).

Second, beyond pressures that arise through analysts' indirect effects on stock prices, analysts' pressures are experienced by managers through direct interactions. Quarterly earnings conference calls between analysts and top management (typically the CEO and CFO) of publicly-traded companies are now common, and are recorded, documented, and provided through publicly available data sources, such as Factiva. These conference calls typically involve a management presentation by the CEO and CFO, followed by questions and answers and general discussion with analysts. Analysts also have direct contact with top management through periodic live meetings with analysts.

We reviewed texts of the documented conference calls and meetings between analysts and managers and found many examples that demonstrate that these interactions are vehicles for analysts to exert direct pressures on management. Through conference calls, analysts clarify and question the quarterly financial performance data provided by the company, and also the firms' strategies that underlie the performance data. An illustration of such pressures is provided by the example of Verizon's October 28, 2004 analyst meeting to discuss third quarter 2004 financial results. At the time, Verizon is making capital investments in fiber (known as FTTP, "Fiber to the Premises" or the product name, FiOS) to respond to Voice-over-Internet Protocol technology that threatens to substitute for the existing copper wireline technology and has triggered increased competition from cable firms. In response to an analyst's question to clarify Verizon's capital investments in this area, CEO Ivan Seidenberg responds:

> Here's what I believe. I think our Company cannot be afraid of you, and not be afraid of the market, in terms of reaching for growth opportunities. Now, we have to be smart and we have to be accountable, but what we don't want to do is start out by limiting what our vision of the market could be. So…I think what we need to do is build the capability to win, and not be afraid to win. That's where we are…if you look at us today, as opposed to us three years ago, we're very different. And yeah, we'll be a lot more different five years out… (Seidenberg, October 28, 2004)

Although this particular comment suggests that Verizon's management is attempting to resist the pressures to retreat from their investments in the new technology, at the same time this excerpt shows that management clearly experiences pressures from analysts to do so.

Additional examples of negative pressures from analysts toward incumbent firms' efforts to respond to VoIP technology are illustrated in the texts of Verizon's conference calls. Analysts suggest that Verizon should retreat from investments to respond to the new technology, specifically by reducing capital expenditures, and instead return cash to shareholders:

> …the company and its shareholders would have been better-off adopting a CZN-type structure (i.e. severely cutting back investments, maximizing short-to-medium term FCF and…returning cash to shareholders) (Deutsche Bank, Verizon, Oct 2005).

Other examples of negative analysts' reactions arise in the texts of reports from an additional setting in our study. Analysts covering Kodak also reacted negatively to Kodak's efforts to develop and commercialize digital technology in the face of the threat of a shift from film photography to digital imaging. The Prudential analyst covering Kodak continually pressured Kodak to cut costs and retreat from investments in digital technology:

> "…we suspect that investors are growing increasingly restless with the gradual pace of cost-cutting… Kodak's not a player in digital imaging...we consider the opportunities for Kodak to materially alter its growth trajectory with digital imaging technology to be relatively slight over the next three to four years…" (Prudential, February 1995)

> "shareholders will revolt once the meager (and distant) potential returns from electronic imaging become clear…we are eager to see shareholders' reactions when they realize how much of their money is squandered on 'digital nonsense' (Prudential Securities, 1994:7).

These quotes clearly reflect a view that Kodak's efforts to develop knowledge and capabilities to respond to the new technology are wasteful, low-return managerial investments.

Beyond the negative reaction to incumbents, the texts also suggest that the specific nature and direction of the pressure in these settings of technological change is to encourage incumbent firms to abandon their strategies to respond, reduce investments, and increase cash flow to improve stock price (e.g. Benner, 2009; Benner & Ranganathan, 2008). For example:

> …difficult secular issues facing the US telecom sector. The troubled state of the US telecom industry is not news to anybody…the most supportive valuation measures continues to be dividends and free cash flow yield…we are recommending a switch from Verizon to BellSouth…there are several arguments favoring BellSouth…cash yield at BellSouth is greater than at Verizon… we like the clear policy of returning cash to shareholders that we see at BellSouth (Morgan Stanley report on Verizon, April 3, 2003)

> …Investors are forcefully questioning the wisdom of inflicting earnings and FCF pain through rebuilding of core consumer businesses. If the competitive environment is to remain subdued, then one should clearly reduce the speed of new product roll-outs, contain investment and maximize short term ROIC (Deutsche Bank report on Verizon, January 26, 2006)

Since stock price is the discounted value of future cash flows (e.g. Brealey and Myers, 1984), the link between improvements in cash flow and increased stock price is well established in research and practice. Thus, focusing on how firms can increase cash flow by reducing investment is consistent, at

least in the short term, with analysts' recommendations to managers about changes in strategies and actions that will trigger increases in stock price.

These pressures from analysts are further heightened by analysts' influences on investors. Conference calls and meetings shape analysts' recommendations to investors and resulting stock prices (i.e. firm market value). Subsequent to these conference calls and meetings, analysts issue reports to investors that provide updates on the firm's activities discussed in the meetings. These reports often reiterate the questions and issues the analyst raised during the interaction with management. For example, extending the example from the Verizon conference calls, the discussions with management are echoed in the resulting reports to investors. For example, the Morgan Stanley analyst covering Verizon issued a report prior to the third quarter 2004 earnings conference call with Verizon management, outlining the issues and questions he planned to raise with management:

> Questions for management: …Free cash generation and utilization – Where is cap-ex headed in 2005? Are we likely to see increased dividends or buybacks? (Morgan Stanley, report on Verizon, October 27, 2004)

Following the analyst meeting, the analyst issued an additional report with a section that included a subtitle "Concerns," and questioned Verizon's strategy:

> …More questions than answers …Verizon's analyst meeting provided some interesting insight into the company's strategy, but given the lack of 2005 guidance we came away with more questions than answers. Some of the key issues include: …How high can capex go in 2005?... One comment that gave some insight into management thinking was a comment around the fiber build: 'I think our company cannot be afraid of you, and not be afraid of the market, in terms of reaching for growth opportunities….' We would interpret from this a view that if Verizon decides it needs to accelerate its FTTP build-out, then that is what management will do, even if it means a short term cost in terms of free cash flow or EPS…overall we are very much in a show me mode on FTTP and prefer the incremental approach of fiber to the node…much less capital is at risk… What about dividends or buybacks? …rising capex could well eat up some flexibility…the company's major priority is investing for growth (Morgan Stanley, October 28, 2004)

Thus, it is clear that managers face pressures to respond to technological threats while also facing pressures from analysts. Interactions between managers and analysts provide a mechanism for analysts

to question firms' financial performance, strategies, and investments. These questions and subsequent commentary are further reflected in reports that influence investors' behavior and firm market value.

In turn, the reactions and interpretations that arise from analysts during periods of technological change are likely to influence incumbents' subsequent strategies. A central theme of the institutional theory research stream since DiMaggio and Powell (1983) is that the pressures from external institutions cause firms to change their activities to conform to pressures for legitimacy (Greenwood and Hinings, 1988:2; Burns and Wholey, 1993). Negative analysts' recommendations are an indicator of growing perceptions of illegitimacy by important stakeholders. Managers seeking to regain legitimacy with important stakeholders are likely to conform to pressures and alter their strategies and actions (Rao & Sivakumar, 1999; Zuckerman, 2000). Thus, we hypothesize that in the face of negative recommendations from analysts, firms will respond by reducing strategic future investments:

> *Hypothesis 2: Increasingly negative analysts' recommendations will be associated with a decrease in incumbents' strategic investments during periods of radical technological change.*

Uncertainty and Variation in Analysts' Recommendations

The setting of technological change serves a dual purpose in our study. First, we are interested in the nature of pressures from analysts specifically during major technological changes, critical events for firms that have elicited attention from scholars in a large body of existing research. There is a need to expand the research on technological change to better understand how external institutional pressures heighten these critical challenges for managers. Moreover, the influence of institutional pressures from analysts is likely to be even greater during the era of technological ferment following a radical discontinuous change. Such periods are associated with high uncertainty, characteristics that increase the importance of social factors in decision making (e.g. Haunschild & Miner, 1997), and spur increased reliance on cognitive categories to assess the legitimacy of firms' actions.

Second, from an empirical standpoint, the features of a technologically changing environment offer additional benefits. Studying technological change provides an ideal natural experiment, i.e. a potential source of exogenous variation in analysts' ratings that allows for more robustness in studying the causal relationship between analysts' recommendations and subsequent firm actions, rather than just correlations. The uncertainty associated with new technologies leads to multiple models or theories of value held by analysts and investors (e.g. Zuckerman & Rao, 2004; Beunza & Garud, 2007). As a result, during a period of technological change, analysts' recommendations on the firms they cover may vary widely simply due to these differing theories of value, and not necessarily due to differences or changes in firms' behaviors and strategies. We therefore hypothesize that there will be greater variation in analysts' recommendations during the eras of ferment that characterize periods of radical technological change (Tushman & Anderson, 1986).

> *Hypothesis 3: Following a technological discontinuity, there will be greater variation in analysts' recommendations of incumbent firms in industries threatened by the new technology.*

Dividends and Share Repurchases: Increasing Legitimacy through Cash Payouts

Beyond pressures to reduce investments and increase cash flow to improve stock price, recent research has highlighted the increasingly taken-for-granted nature of cash payouts to shareholders, for example, in the form of share repurchases or stock buybacks for signaling alignment with shareholders and improving stock price (e.g. Zajac & Westphal, 2004). Two mechanisms for paying cash to shareholders that have been widely discussed in research and in the popular press are dividend payments and share buybacks or repurchases (Ofer and Thakor, 1987). A dividend is a periodic cash payment to shareholders, while a share buyback or stock repurchase is an announcement that the firm will buy back its own shares at a price above the current market price (e.g. Zajac & Westphal, 2004; Oyon, Markides, & Ittner, 1994). Research in finance and accounting has consistently found that both dividends and stock

repurchases trigger increases in stock price and market value (e.g. Chan, Ikenberry, and Lee, 2004; Lee, Mikkelson, and Partch; Vermaelen, 1981; Ofer and Thakor, 1987; Medury, Bowyer, and Srinivasan, 1992). Moreover, the advantages of cash payouts to shareholders are widely discussed in textbooks and in management practice literature (e.g. beginnersinvest.about.com; Vermaelen, 2005; McKinsey Quarterly, 2005). These approaches have become increasingly taken for taken-for-granted ways to trigger increases in stock price and as a result, are a widely accepted approach for signaling commitment to shareholders (e.g. Zajac and Westphal, 2004). This is also illustrated by managers of the firms in our contexts, for example, in a recent conference call with analysts:

> "…While there are challenging aspects in the near term, I am convinced that these actions will create significant shareholder value over the intermediate to long term…we are focusing even more intensely on returning capital to Belo's shareholders. We have begun a review of planned major capital projects, the timing and magnitude of future dividend increases, and the pace of share repurchases…" (Robert Dechard, President & CEO of Belo Corp, conference call with analysts, April 2006)

Westphal & Zajac (2001) show further that firms' stock prices increased on announcement of buybacks, even if no shares were actually repurchased. Stock price did not revert in the cases where there were no actual buybacks, providing evidence that share repurchases are associated with increased perceptions of legitimacy by shareholders, even when they have no actual technical benefits.

The traditional view of the appropriateness of cash payouts to shareholders, particularly share buybacks or repurchases, has been that these activities should be undertaken in situations where firms possess a high level of cash, but lack appropriate alternatives for investment (e.g. Zajac & Westphal, 2004). Recently, however, research has argued for two alternative views about why cash payouts to shareholders trigger positive stock market reactions that depart from the traditional view. The first is that managers initiate cash payouts to shareholders, e.g. stock repurchases, when they believe their shares are undervalued by the stock market (D'Mello and Shroff, 2000; Brav, Graham, Harvey, and Michaely, 2005). The second predominant reason underlying cash payouts to shareholders stems from Jensen's

(1986) agency theory view, that cash payouts signal that managers are returning cash to shareholders rather than undertaking wasteful empire-building projects that are not aligned with shareholder interests.

Thus, we argue that in addition to pressure to reduce investments, firms will also face pressure from analysts to return cash to shareholders, both to improve stock price and to signal alignment with shareholder interests. We hypothesize that greater negativity in recommendations from analysts will spur firms to increase cash payouts through dividends and share repurchases.

> *Hypothesis 4a: Increasingly negative recommendations from analysts will be associated with increases in dividend payouts.*
> *Hypothesis 4b: Increasingly negative recommendations from analysts will be associated with a greater likelihood of share repurchases.*

Offsetting Illegitimacy

Although a predominant view in institutional theory research has been that firms will seek to regain legitimacy by changing actions to respond to institutional pressures, a stream of research since DiMaggio and Powell (1983) has challenged the view of organizations as highly constrained by institutional pressures, and has argued that firms will not necessarily conform. Researchers have found that firms pursue divergent approaches to respond to pressures from external institutions (cf. Oliver, 1991; D'Aunno et al, 2000) and that environmental pressures for technical survival may attenuate responsiveness to institutional pressures (Kraatz & Zajac, 1996). The pressures for adaptation and survival are particularly strong when firms are faced with radical technological changes. Although we hypothesize a central tendency that firms will reduce strategic investments and increase cash payouts to shareholders when facing pressures from analysts to do so, some firms are likely to persist in maintaining or increasing investments to respond to the significant technical pressures for survival. Yet such firms will face pressures to regain legitimacy with analysts and shareholders (cf. Suchman, 1995).

The situation of technological change presents an interesting context in light of prior research on the possible reasons firms pay cash to shareholders. During periods of technological change, managers may believe there are important, appropriate investments to make, for example in new technological knowledge and capabilities to ensure survival in the face of technological substitution. Although such investments are critical to firm survival, there is heightened potential during an era of technological ferment for increased investments to be difficult to value and appear as wasteful uses of cash that undermine shareholder value. These concerns are reflected above in our quotes from analysts covering Verizon and Kodak, in response to Verizon's and Kodak's investments to respond to new technologies. Periods of technological flux and uncertainty, in which the (discounted future) value of a firm is extremely difficult to calculate, raise the potential for greater institutional pressures for legitimacy.

Under these circumstances, firms may face substantial pressure to retreat from their investments. But to the extent firms persist in strategic investments to respond to the strong technical pressures for survival, they will seek approaches to mitigate the pressure in ways that do not directly dampen investments in operational strategies (cf. Oliver, 1991). We argue that in response to analysts' pressures coupled with strong technological pressures, some firms will simultaneously address the technological pressures by maintaining their strategic investments, while increasing activities that are viewed as taken-for-granted ways to increase stock price and improve value for shareholders. That is, firms are likely to try to offset the growing illegitimacy of responding to the new technology by undertaking repurchases and dividends as ways to signal managerial commitment to shareholders.

> *Hypothesis 5a: Firms that maintain or increase investments in the face of negative analyst pressure will have a greater likelihood of cash payments to shareholders though dividend increases (i.e. dividend increases will be more likely when investments are high and analysts' recommendations are negative)*
> *Hypothesis 5b: Firms that maintain or increase investments in the face of negative analyst pressure will have a greater likelihood of cash payments to shareholders though share buybacks*

(i.e. share repurchases will be more likely when investments are high and analysts' recommendations are negative)

This situation is counter-intuitive given the traditional view of cash payouts to shareholders, i.e. if firms have worthwhile investments to make with cash, they would be less likely to repay cash to shareholders through repurchases or dividends. In this case, however, it is when high or increasing levels of investment are perceived as necessary by management, but illegitimate by analysts (i.e. if analysts' reactions are negative when investment is high or increasing) that firms are more likely to undertake mechanisms for paying cash to signal commitment to shareholders.

We illustrate these relationships further in the 2 by 2 matrix shown in Figure 1. The horizontal axis represents how positive or negative analysts' recommendations for a firm have been in an earlier period, and the vertical axis is the level of investment (i.e. capital expenditures or R&D expenses to respond to a new radical technology) in the current period. Based on ideas about institutional pressures generally and the potential role of analysts in conferring legitimacy, we expect firms in the right side of the matrix, i.e. in quadrants 2 and 4, i.e. those experiencing negative analysts' reactions in an earlier period, to be more likely to undertake cash payouts to shareholders in a later period. Conversely, the left hand side of the matrix, quadrants 1 and 3, represents firms that have received relatively positive ratings from analysts in an earlier period. We hypothesize generally that they will be less likely to need to overcome challenges of legitimacy by paying cash to shareholders. These general ideas, illustrated in the matrix, about the influence of relatively negative analysts' recommendations on firms' tendencies to return cash to shareholders are reflected in hypotheses 4a and 4b. For hypothesis 5a and 5b, our focus is quadrant 4. These firms have experienced relatively negative reactions from analysts in an earlier period, but instead of responding to these reactions with lower levels of investment to regain legitimacy, they engage in higher levels of capital expenditures in the later period. For these firms, consistent with 5a and

b, we hypothesize that they will have an even greater likelihood of returning cash to shareholders than the firms in the other quadrants of the matrix.

The predictions concerning firms in quadrant 4, the firms "offsetting illegitimacy," echo work in institutional theory that describes how organizations decouple symbolic responses to institutional pressures from substantive operational activities (Meyer and Rowan, 1977). In such research, firms' respond to pressures for legitimacy through actions in a related but separate domain. Here, however, the mechanisms are likely to trigger tangible, measurable increases in stock price and shareholder value - but they are decoupled from the central operational activities in question. Cash payouts through dividends and repurchases may provide mechanisms for firms to buffer their operational environment from the pressures of financial institutions that arise from increasing illegitimacy (cf. Thompson, 1967).

EMPIRICAL CONTEXT

Our goal is to address the question - how pressures from analysts influence firms' actions and strategies in the important context of radical technological change – using a large sample statistical study based on archival data. Undertaking a large sample archival data study of firms during radical technological changes is complicated by the fact that such changes, while important for understanding firm adaptation and success, are relatively rare events. Further, some industries affected by radical technological change are characterized by oligopolistic competition prior to the change, resulting in a small number of incumbent firms. In response to these common research challenges, researchers have often used in-depth studies of a single context and a few firms to explore instances of technological change (e.g. Tripsas, 1997; Tripsas & Gavetti, 2000; Benner, 2009; Klepper & Simons, 2000). Our interest in understanding pressures from analysts further reduces our sample specifically to publicly traded firms, and even further, to the subset of those covered by analysts.

We overcome the sample size challenges by including multiple settings faced with the challenges of responding to radical technological changes during roughly the same period. Further, we compare firms in those contexts with a baseline set of firms in contexts not faced with impending technological substitution. Beyond our direct interest in studying the forces affecting firms during a period of challenging technological change, we take advantage of these empirical settings as a natural experiment. The radical technological changes likely trigger exogenous variation in analysts' ratings due to the increased uncertainty. Further, there is evidence in our settings that investment in responding to the new technology, i.e. future growth, during these periods of uncertain technological ferment may be perceived as illegitimate by important stakeholders (e.g. Benner, 2009; Benner & Ranganathan, 2008), in part we propose, because of the difficulty of assessing the future value of the investments given high uncertainty about the outcomes of the technological change.

Our study includes three settings undergoing radical technological change that have been studied in prior research: Photography (SIC 3681), faced with the threat of digital technology as a substitute for silver halide film technology (Benner & Tushman, 2002; Benner, 2009), Wireline Telecommunications (SIC 4813), involving the incumbent telephone companies faced with the threat of Internet telephony as a substitute for copper wireline technology (Benner, 2009; Benner & Ranganathan, 2008), and Newspaper Publishing (SIC 2711), faced with the Internet and the threat of on-line media substituting for printed media (e.g. Gilbert, 2005). In addition, for comparison with a non-changing environment, we included firms in industries within the broad 2-digit SIC code 20 – food and kindred products, which includes many firms categorized within several four digit food and beverage SIC codes.

Echoing prior work, the incumbent firms in the three technology change settings face radical technological changes, i.e. technological changes that threaten to substitute for the technology underlying the products in the industries and render existing capabilities and profit models obsolete (e.g.

Gatignon, et al, 2002; Utterback, 1994). Further, the technological changes require the incumbent firms in these settings to develop new capabilities and knowledge, likely to require investments into new technological domains (cf. Lavie, 2006).

The photography industry is undergoing a shift from silver halide film to digital imaging, involving digital chips that convert images to binary data and allow for image capture without the use of film. The technological discontinuity and unfolding change has ushered in new competitors from multiple industries, including consumer electronics and computers. The era of ferment in photography is characterized by rapid innovation and continued increases in performance of digital cameras (the image resolution, measured in pixels) coupled with decreasing prices. The discontinuous change has created challenges for the incumbent firms trying to respond (e.g. Tripsas & Gavetti, 2000; Benner, 2009).

In the second setting, wireline telecommunications, the traditional phone company incumbents are challenged with the advent of voice over Internet telephony (VoIP), which has increasingly threatened to substitute for traditional wireline technology since the early 2000s (Latour, 2003; Brown & Latour, 2004). Internet telephony allows telephone calls to be made through the internet, bypassing the incumbent wireline phone companies' traditional technology and source of profits. A marked improvement in the performance of internet telephony was the introduction of Vonage's internet phone service in 2002. Similar to the photography setting, the technological change has ushered in new competitors from outside the telephone industry, including cable television firms and new firms like Vonage or Skype (e.g. Benner & Ranganathan, 2008). Again, as in photography, the incumbents have taken steps to respond to the new technology with increased investments in new products and services incorporating the new technology.

In the third setting, newspaper publishing, incumbent firms are also faced with a major technological change from the Internet (e.g. Gilbert, 2005). Similar to the other settings of radical

technological change, this technological change also renders incumbents' existing resources less valuable. Firms in newspaper publishing have struggled to respond to the threat of new competition triggered by the new technology, in many cases by increasing investments to develop their own on-line services and offerings.

We also include data from an additional industry setting, Food and Kindred Products, SIC code 20. We selected this industry because in contrast to the other three settings, it was not undergoing radical technological change. Thus, the relationships between analysts and firms in this setting provide a baseline comparison for evaluating the results from the technological change settings. In addition, studying this broad industry setting provides a large set of publicly-traded firms that are covered by analysts, including firms like General Mills, Pepsi, Coke, Tyson, and Hormel, among many others. As we discuss in more detail in subsequent sections, although we compare across these industries, our study findings do not depend on including a contrast with this category of firms. Similar findings result in a stand-alone sample comprising only the firms in the three technological change contexts.

SAMPLE, DATA, AND METHODS

Sample

We combined data for firms in our selected industries from several sources. We collected data from the linked Compustat/CRSP (Center for Research on Security Pricing) dataset available from Wharton Research Data Services on firms' financial data and stock price. Following prior research (Haunschild and Miner, 1997; Jensen, 2006), we used the I/B/E/S (Institutional Brokers Estimate System) for data on analysts' recommendations and earnings forecasts for firms. We accessed data on repurchases from Securities Data Corporation and Thomson Research, and also supplemented these data with searches on Factiva to identify additional repurchase announcements for firms that were not

included in the SDC data. We used the frequent listing of recent repurchases reported by the Dow Jones News Service.

We selected data by two-digit SIC code for our industries of interest. Data were available from Compustat for 205 firms in our selected industries, and the analyst recommendation information was available for 159 of those firms. Analyst recommendation data is available starting in 1993, so in general our analyses run from 1993 through 2007. Firms that have missing data are excluded in our analyses, and as a result, most of our models include 126 firms. Our dataset also includes firms that are in the broader 2-digit industry categories beyond our specific 4 digit industries. For example, Newspaper Publishing (SIC 2711) is the specific industry undergoing technological change, but our sample also includes firms more broadly in publishing (SIC 27), which also includes book publishing.

In addition, we also used qualitative data from analysts' reports and earnings conference call texts to get specific insights into the dynamics of analysts' influences on firms' strategies in our settings. In two of our settings, the shift to voice over Internet telephony in the telecommunications industry, involving multiple regional bell telephone companies (RBOCs), and the threat of the Internet for the incumbent firms in newspaper publishing, we also accessed the detailed qualitative texts of earnings conference calls, specifically for Verizon and Qwest in the wireline telecom industry, and McClatchy and Belo in newspapers. Our goal in using the qualitative data was to understand the nature of the analysts' comments as indications of the specific pressures on firms to curtail investments or initiate other shareholder value-increasing activities. Studying these interactions allowed us to pinpoint the pressures from analysts on the incumbent firms, and identify the instances where analysts specifically encourage the incumbent firms to abandon investments or engage in repurchasing shares or increasing dividends. The conference call texts are available from Thomson Research and Factiva. We also use

these sources illustrating the influences of analysts to highlight specific examples of the phenomenon throughout the paper.

Variables

Independent variables. Our independent variable in this study is *analysts' recommendations* from the I/B/E/S summary (consensus) file. It is important to note that because we use robust panel data models with firm fixed effects in our analysis (i.e. that condition on the within-firm variation over time), we are modeling the *change* in these variables compared to *change* in the dependent variables. We describe this in more detail in our discussion of the models, below. Our main measure of *analyst recommendations* is the mean consensus recommendation averaged across analysts by firm/year. The I/B/E/S mean recommendation variable is coded as follows: 1=Strong Buy, 2=Buy, 3=Hold, 4=Underperform, and 5=Sell. Thus, an increase in this variable indicates more *negative* analysts' recommendations. In our models, this variable is lagged one year. We also created an alternative measure of analyst recommendations to allow us to assess the robustness of our findings. We created the variable using the quintiles of the analyst mean recommendation variable. In models using this variable, the omitted variable is the first quintile (i.e. the most positive recommendations). Using this measure avoids the implicit assumption that the distances between the I/B/E/S recommendation categories (in our mean recommendation variable) are consistent (i.e. the distance between recommendations with values 1 and 2 are the same as the distance between recommendations with values 4 and 5), and instead assesses those distances from the actual data. Thus, it allows us to understand the effects that occur at different levels of the variable and also allows us to determine whether the effects are linear and not mainly driven by outliers. This variable is constructed from the lagged mean recommendation variable.

Dependent variables. Following prior research on firms' strategies and strategic investments (e.g. Maritan, 2001; Kotha and Nair, 1995), we use measures of capital investment and research and

development expenses to measure firms' strategic investments. Because these investments occur during a major technological change, it is reasonable to consider these measures proxies for investments in responding to the technology. In addition, we have qualitative evidence from the texts of the conference calls (for example, in the discussions of Verizon's investment in its fiber (FTTP) offering, and Kodak's investments in digital technology discussed earlier, that firms' increases in these measures during such times are taken specifically to respond to the new technology. Measures of firm/year *capital expenditures* and *R&D (Research and development) expenses*[1] were accessed from Compustat to assess changes in firms' strategic investments. Our dependent variables also include measures of cash payments to shareholders. To measure dividends, we used data on *dividends per share* from Compustat. To measure *share buyback or repurchase announcements,* we collected repurchase announcement data for firms in our sample from SDC and Factiva (as described above).

As we describe below, including these variables in our study design based on longitudinal panel data with fixed effects and year controls allows us to capture the effects of *changes* in analysts' ratings and stock prices on *changes* in our dependent variables. Using fixed effects controls in a longitudinal panel design conditions on the within-firm changes over time (essentially the change in both the independent and dependent variables), rather than the between-firm variation. This is an important distinction, and allows us to more closely attribute causality to change in both independent and dependent variables, rather than to the differences between firms as in the case of a cross-sectional study design.

Control variables. Our models include several variables to control for the other factors affecting firms. As discussed above, our models include firm fixed effects, which control for the characteristics of firms that are stable over time. We also use year dummy variables to control for events or trends that

[1] Data on R&D expenses were available on a small subset of the companies in our sample (n=44).

affect all firms in the panel in a particular year. We also control for the lagged dependent variable in our models (with the exception of the models that use the repurchase announcement event as the dependent variable, since there may not be a repurchase event in prior years). We control for *revenue* and *earnings per share*, to account for changes in a firm's financial health (or in cross sectional models, differences in size and performance across firms), and we also control for *cash*, as firms with greater amounts of cash might face less pressure to curtail investments, and more pressure to return it to shareholders through dividends or repurchases. We obtained measures of revenue and cash from Compustat. We use the earnings per share measure from the I/B/E/S data. I/B/E/S leaves earnings per share unadjusted to better reflect the actual earnings analysts were seeing at the time of their recommendation, which is also appropriate for our purposes. We also control for *stock price,* measured as the closing price at year-end from the CRSP data. Finally, we control for the average number of analysts covering a firm in the prior year. In our models, all control variables are lagged one year.

Technological Change. We are interested in how the relationship between analysts' reactions and firms' strategies unfolds, particularly during periods of technological change. We operationalize technological change in two ways: First, we run separate models on the full sample of firms, the technology change firms (i.e. firms in our three settings undergoing radical change), and the comparison group of firms (SIC 20) to assess the differences in results across these groups. Second, we also run the full sample with an interaction variable that isolates the effect of analysts' ratings specifically for the firms facing radical technological changes; in this case, the coefficient on the interaction term indicates whether and how the effect on the technology change firms differs from the overall sample. In operationalizing the technological change, we also run these models over the time period from 2000 and after, to approximate the period when the challenge of technological change was affecting the firms in

the changing industries.[2] We run a similar interaction model for the firms in the non-technological change industry categories.

Models

Our model to test hypothesis 1 - that analysts are increasingly negative toward firms in industries faced with a radical discontinuous technological change – is a regression of the mean recommendation from analysts on the technological change industry dummy variable (equal to 1 if firms are in the technological change industries and 0 otherwise). This is identical to running a test of means between the average recommendations in the technological change categories compared to the categories not facing a technological change. We did the analysis in two ways. First we ran the analysis for different sets of years to capture how the recommendations changed over time. In addition, we ran a regression of the analysts' mean recommendation on the year variable, to assess how overall reactions change over time. Finally, we ran the analysis with an interaction term (year x technological change industry dummy) that allows for capturing the change in reactions over time for the technological change firms compared to other firms. These alternative approaches allow for determining whether the recommendations are consistently more negative (i.e. higher) for the firms in the technological change categories, and how they change over time, as the technological change unfolds.

To test hypothesis 2, that pressures from analysts result in changes in strategic investments, we developed models that assess how changes in analysts' ratings affect firms' investment strategies. We ran two sets of models, first using measures of capital expenditures as the dependent variable, and second, using measures of research and development expenses. These models utilize annual data to

[2] The choice of 2000 as the start year of the technological change period arises from our attempt to capture a time period when all three industries were in technological flux, but the choice is somewhat arbitrary. The era of ferment began in the photography industry a few years earlier, while it was triggered by VoIP in wireline telecommunications a few years later. Our results do not depend on the specific start year chosen for the technological change period. We ran separate analyses, not shown here, and the findings and significance are similar to those reported in the results section for alternative timeframes including starting earlier (back to 1998) and later (from 2001 forward).

assess the effects of changes in analysts' ratings and control variables on firms' investments during the periods of technological change. These are panel data models that incorporate both year dummy variables and firm fixed effects (using the *xtreg* command in STATA, with the fe option). In these models, we lag all of the independent and control variables one year, and use the natural log of capital expenditures and research and development expenses, the dependent variables. The models control for the lag of the dependent variables, firm size (revenue), firm performance (earnings per share), cash, stock price, and the number of analysts' recommendations, as well as controlling for firm fixed effects and years. The equation for this model is represented by:

$$y_{it} = y_{it-1}\beta_1 + rec_{it-1}\beta_2 + X_{it-1}\beta_3 + \mu_i + o_t + \varepsilon_{it} \quad (1)$$

Where y_{it} is capital expenditures or research and development expenses for firm i in year t, rec_{it} is the mean analysts' recommendation in year t for firm i, X_{it-1} is a vector of characteristics of firm i in year t-1 (control variables), μ_i is a time-constant control that captures unobserved factors for firm i that are stable over time (fixed effect), o_t are effects that vary with time but are common across all firms, and ε_{it} is an error term.

We further assessed whether the effect on capital expenditures and R&D was different for the firms in the industries undergoing technological change. As discussed above, we did this in two ways: First, we separately ran the models on a subset of the firms in the technological change categories to see how the influence of analysts' recommendations on strategic investments compared to the results in the full sample. Second, we ran the full-sample model with an interaction that isolates the effect of the analysts' recommendations for the firms in technologically changing industries (analyst recommendation variable x the technological change industry dummy variable), allowing us to compare differences between the technological change firms and non-changing firms in the sample. The coefficient and significance on the interaction term indicates whether the effects are stronger or weaker for the firms in the technological change contexts. The equation including the technological change interaction term is:

$$y_{it} = y_{it-1}\beta_1 + rec_{it-1}\beta_2 + X_{it-1}\beta_3 + (rec_{it-1} \text{ x tech change})\beta_4 + \mu_i + o_t + \varepsilon_{it} \quad (2)$$

Since membership in an industry undergoing technological change (indicated by the technological change dummy variable) is a stable characteristic that is fixed over time, it is already controlled in the firm fixed effect. As a result, the technological change dummy variable drops out of the model and our interest is specifically in the coefficient on the interaction term.

We tested hypothesis 3 by comparing the average variation in analysts' ratings (measured as the standard deviation provided by I/B/E/S, averaged for each year) over time for the technologically changing categories compared to the non-changing categories. We did this by regressing the standard deviation of the ratings on the technological change industry dummy variable (coded 1 for firms in the technology change industries, 0 otherwise) with different sets of years included in the analyses to assess the standard deviations for earlier and later time periods.

Our models to test hypothesis 4a and 4b involve separate models to test the effects of analysts' ratings on both dividend payouts to shareholders and share repurchase announcements. These hypotheses suggest that under negative pressure from analysts, firms are likely to undertake cash payouts to shareholders to signal alignment with shareholder interests and boost stock price.

In the models to test H4a, we assessed the effects of analysts' ratings on dividends. These models assess how analysts' ratings and several control variables affect changes in dividends, using year dummies and firm fixed effects. This equation is similar to equation 1, above, and also use the *xtreg* command in STATA, with firm fixed effects and year controls. These models also control for the lagged dependent variable as well as revenue, financial performance, stock price, and the number of analysts' recommendations. The equation for this model is:

$$\text{dividends per share}_{it} = \text{dividends per share}_{it-1}\beta_1 + rec_{it-1}\beta_2 + X_{it-1}\beta_3 + \mu_i + o_t + \varepsilon_{it} \quad (3)$$

Where rec_{it-1} is the mean analysts' recommendation for firm i in year t-1, X_{it-1} is a vector of control variables, μ_i is a time-constant control that captures unobserved factors for firm i that are stable over time, o_t are effects that vary with time but are common across all firms, and E_{it} is an error term.

The second set of models to test H4b involves repurchase announcements, which are events, coded 1 in the year when a repurchase in announced, and 0 otherwise. Following prior research (e.g. Haunschild & Miner, 1997; Tucci & King, 2002), we used a panel data logistic model for this analysis, using the *xtlogit* command in STATA. Since there are typically one or fewer of these events for each firm during our time period, there is little within-firm variation over time on the dependent variable for a fixed effects model. A random effects specification allow us to account for the non-independence of firm/year observations), as well as rely in part on the variation between firms as suggested in Figure 1 (e.g. in quadrant 4 of Figure 1, the interpretation is that firms that have negative analysts ratings and high capital expenditures are more likely to undertake repurchases than firms in other quadrants). The equation for this model is:

$$P_{it} = F(\mu_i + o_t + X_{it-1}\beta) \quad (4)$$

Where P_{it} is the probability of a repurchase announcement for firm i in year t, μ_i is a random effects control, X_{it-1} is a vector of characteristics for firm i in year t-1, and o_t are effects that vary with time but are common across all firms.

The tests of hypotheses 5a and 5b include an additional interaction term to capture increasingly high capital expenditures and increasingly negative analysts' ratings. Hypotheses 5a and b suggest that in the cases where firms do not reduce their investments in the face of negative analysts' reactions, they are even more likely to engage in activities to offset their increasing illegitimacy by pursuing the taken for granted activities to improve value, including dividends and share repurchases. That is, when the values of the interaction term are at high levels (when capital expenditures are high and analysts are negative toward these investments – measured as higher values of the analyst recommendation variable), we expect a stronger positive effect on repurchases and dividends. The equation is represented below:

$$\text{dividends per share}_{it} = \text{dividends per share}_{it-1}\beta_1 + \text{rec}_{it-1}\beta_2 + (\text{capital expenditures})\,\beta_3 + (\text{analysts' recommendations x capital expenditures})\,\beta_4\, X_{it-1}\beta_5 + \mu_i + o_t + \varepsilon_{it} \quad (5)$$

Where rec_{it} is the mean analysts' recommendation for firm i in year t-1, X_{it-1} is a vector of control variables, μ_i is a time-constant control that captures unobserved factors for firm i that are stable over time, o_t are effects that vary with time but are common across all firms, and ε_{it} is an error term.

Similar to the tests of H4a and H4b, the dividend model with the interaction term uses a linear panel data regression (*xtreg* in STATA) with fixed effects and year dummy variables. The model with repurchases as the dependent variable involves a logit model with year dummy variables and random effects controls (*xtlogit* in STATA with the re option).

RESULTS

Table 1 shows the descriptive statistics and correlation coefficients. Our tests of H1 are shown in Table 2. In Table 2, the coefficients on the technological change dummy variable (denoting the firms in the technologically changing settings) indicate the difference in analysts' between the technology change firms and other firms. Higher values of the analyst recommendation variable indicate greater analyst negativity, thus, a significant positive coefficient on the technological change dummy variable indicates significantly more negative recommendations from analysts. Model 1 shows the results of the comparison for the early period in the data, 1994-1999. Models 2 through 5 show the comparison for progressively later years, as the technological changes unfold. As shown in the table, the analysts' recommendations are more negative for the technology change firms (with greater significance) in later periods. Alternatively, Model 6 in Table 2 shows the results of regressing analysts' recommendations on a time variable (to directly measure the change in recommendations over time) and the technological change dummy variable. The coefficient on the year variable (positive and significant at $p<.01$) shows that analysts are more negative over time for all firms. Models 7 and 8 show the results with the interaction term (technological change dummy variable x year variable), to capture the comparison between the technological change firms and other firms over time. As the coefficient on the interaction

term in Model 8 shows (for later years), analysts' recommendations are even more negative toward the technological change firms over time ($p < .01$). These results provide support for H1, that analysts become increasingly negative toward incumbent firms faced with radical technological change.

The results of our models to test H2, with capital investments (capital expenditures) as the dependent variable are shown in Table 3. These models all include firm fixed effects and year dummy controls. The top portion of Table 3 displays the results of models of the influence of analysts' recommendations on capital expenditures for the full sample of firms for both the full time period, and the period 2000-2007, corresponding to the technological change. The lower part of the table focuses on the effects specifically in the technological change settings. Models 2 and 5 include the mean recommendation variable. Model 2 shows that increasing (i.e. more negative) analysts' recommendations are associated with significantly decreasing capital expenditures ($p < .01$) in the full sample, and Model 5 shows similar results for the full sample for the later period. Model 8 shows a similar negative effect of recommendations on capital investment ($p < .01$) in the technology change sample. To make a direct comparison of these effects, Model 9, includes the full sample of data with the interaction term (technological change firms x analysts' recommendations) to isolates the effect of changes in analysts' ratings specifically on firms in the technologically changing industries during the period of technological change. The coefficient on this interaction term is negative and significant ($p < .01$), indicating that the negative effect of analysts' reactions on future investments is stronger for the technological change firms than the rest of the sample.[3] In this model, the dummy variable indicating the technological change firms (which do not change across years) drops out due to the fixed effects controls that already control for stable firm characteristics. Models 3, 6, and 10 show the results of

[3] This comparison suggests that the effect for the non-technologically changing firms will also be different from the full sample. In results from separate analyses, not shown here, the coefficient on a similar interaction term (non-technological change firms x analysts' recommendations) is positive and significant. Thus, as expected, of analysts' recommendations have less effect on capital expenditures for the non-technologically changing firms than for the technological change firms.

similar analyses using the quintiles of the mean recommendation variable. These analyses provide an additional perspective on the influence of recommendations from analysts on capital expenditures, allowing us to assess not only the central tendencies, but the effects of increasingly negative recommendations (the first quintile category is the omitted variable).[4] The results are generally consistent with results using the mean recommendations. The coefficients on the quintiles of the recommendation measure are consistently negative across all samples and timeframes, suggesting a consistent dampening effect on capital expenditures as analysts' ratings are increasingly negative. In addition, analysts' recommendations in the 5th quintile, the most negative, have a strong and significant negative effect on capital expenditures ($p < .01$).[5] Taken together, these results provide strong support for H2 – that increasingly negative analysts' recommendations do affect firms' subsequent investments in strategies, and further, the effect of these reactions on strategies is even stronger in settings of radical technological change.

Table 4 shows results of similar analyses using research and development (R&D) expense measures as our dependent variable. R&D data were available for only 44 firms in our full sample, and for only 13 firms in the technological change categories, reducing the sample size considerably. The models in Table 4 include year dummies and firm fixed effects controls. Model 2 includes the mean analysts' recommendation variable. The coefficient is negative, similar to the results for capital expenditures, but is not significant. As shown in Model 4, for the technological change sample, the

[4] The means (and ranges) of the quintile categories are: quintile 1: 1.56 (1-1.9), quintile 2: 2 (1.9-2.2); quintile 3: 2.3 (2.2-2.5); quintile 4: 2.7 (2.5-2.9); quintile 5: 3.2 (2.9-5). Much of the recommendation data falls between strong buy and hold, which may reflect the analysts' optimistic bias described in prior research (Michaely & Womack, 1999; Francis & Philbrick, 1993). Our methods condition on the changes within firm, so account for relative negativity apart from overall levels.

[5] In most of these models, the coefficient on the stock price variable is not significant. This may arise because analysts' recommendations would be expected to already incorporate information on stock prices, and are likely to correlate with stock price. We removed stock price from the models reported in the tables, and the results in all the models are consistent in sign, direction and significance.

coefficient on the analysts' recommendation variable is again negative but not significant. For space reasons, we excluded the full sample results for the technological change time period (2000-2007), but they are similar to the results in Models 1 and 2. Model 5 shows results including the interaction term that allows for comparing the effect of analysts' recommendations for the firms undergoing technological change. The negative and significant coefficient on the interaction term ($p<.05$) indicates that the negative influence of negative analysts' recommendations on R&D expenditures is again stronger for the technological change firms compared to the baseline firms not undergoing radical technological shifts. Again, results are identical excluding the stock price variable. In Models 6 and 7, we again show results using the quintiles of the analysts' mean recommendation variable. These results show that the coefficients are not significant for the full sample, but are consistently negative for the technological change sample and are significant for the third and fifth quintiles ($p<.01$ and .05, respectively). Taken together, the results for both the capital expenditure and R&D models provide general support for H2, that negative analysts' reactions will spur firms to reduce their subsequent strategic investments, particularly during periods of technological change. The models using the quintile variable show further that our results for the average recommendation variable are not generally driven by outliers, but are significant at higher (more negative) levels of the recommendation variable.

We tested H3 by analyzing the differences in the variation in analysts' ratings of the technological change firms and other firms, and over time. The results are shown in Table 5. The coefficient on the technological change dummy variable (denoting the firms undergoing technological change) indicates whether variation in analysts' recommendations is greater for the firms in the technological change settings. Model 1 shows the results from regressing the analysts' recommendations on the technological change dummy variable for the full sample for the full period, Models 2 through 5 show the results for progressively later years in the sample. The results suggest that variation in

analysts' recommendations is generally higher for the technological change firms, but those differences begin around 2000. The results further suggest that these differences may lessen in significance over time. These results support H3, and are consistent with ideas in prior technological change research, that the advent of technological change triggers uncertainty indicated by greater variation.

Table 6 shows the results from analyses to test H4a, assessing the main effects of changes in analysts' recommendations on dividends per share. Models 1 and 2 in Table 6 show the results for the full sample over the full time period. Model 2 includes the analysts' recommendation variable. The results show that increasingly negative analysts' recommendations (within-firm) have a positive influence on payouts to shareholders in the form of increased dividends ($p < .05$). Models 3 and 4 show the results for the technological change sample, during the relevant period from 2000-2007. Although the coefficient is positive it is not significant for the technological change firms. In results not shown here, the coefficient was similar to Model 2 for the full sample over the 2000 to 2007 time period. Model 5 includes the interaction variable to isolate the differences in the effects of analysts' recommendations on dividends for technological change firms compared to the full sample. The coefficient on the interaction term is in the expected (positive) direction but is not significant. Thus, the results provide some evidence that in general, firms may increase cash payouts to shareholders in the form of dividends when analysts' recommendations are more negative. However, there is not a greater influence of analysts on the firms undergoing technological change. Models 6 and 7 show results of the analysis using the quintile recommendation variable. Model 6 shows that dividend payments appear to increase (with increasing significance) as analysts' recommendations become more negative, but only to a point. At the 4^{th} quintile the effect of analysts' recommendations on dividend payouts is positive and strongly significant ($p<.01$) but at very high (negative) levels of analysts' recommendations, the effect is marginally significant. This is echoed in the results for just the technological change sample, shown in

Model 7. The signs on the coefficients are consistent with the full sample results, and again the coefficient on the 4th quintile of the recommendation variable is significant ($p<.05$). Again, for space reasons, we omit the comparison for the full sample from 2000-2007, but results are similar to the full period results in Models 1 and 2. These findings generally suggest that dividend payouts are more likely with greater analyst negativity, but this effect lessens at the highest (most negative) analysts' recommendations. These findings are consistent for firms in the technological change sample. Taken together, these results suggest some support for H4a that dividend payouts to shareholders are more likely with increasing analyst negativity.

Table 7 shows the results of logit models to assess the influence of analysts' recommendations on share repurchase announcements. The results are not significant for the full sample (Model 2) or for the technological change sample (Model 4). Results for the full sample in the 2000-2007 time period, not shown here, are similar to Model 2, and the coefficient is also not significant. The coefficient on the analysts' recommendation variable in the technological change sample is also negative, which is counter-intuitive, although not significantly different from zero. In Model 5, the coefficient on the interaction term that isolates the effect on the technological change firms is also not significant. Thus, H4b is not supported. An interesting result shown in this table is the strong positive effect of the number of analysts covering a firm on the likelihood of repurchases, significant at $<.01$ in both the full sample and the smaller technological change sample of firms. It appears that repurchases may indeed be spurred by pressures from analysts, but rather than the content of the analysts' recommendations, it may be the number of analysts that creates the pressures. Models 6 and 7 show results using the quintile recommendation variable. These results show that for the full sample, more negative analysts' recommendations positively influenced repurchases, and these effects were significant for recommendations in the 2nd and 4th quintiles ($p<.05$). Echoing the results of the analysis of dividend

payouts, the effects became insignificant for the most negative recommendations. However, the effects were not significant in the smaller technological change sample. These findings suggest some support for H4b for the full sample of firms, but not in the technological change settings.

Finally, we tested our hypotheses concerning firms' actions to offset illegitimacy (H5a and H5b), as described in quadrant 4 of Figure 1. In results not shown here for space considerations, there was no effect of the interaction term (analysts' recommendations$_{i,\,t-1}$ x capital expenditures$_{i,t}$) on changes in dividends per share, either for the full sample or for the technological change sample, suggesting that H5a is not supported. Table 8 shows the effect of the interaction of analysts' ratings and capital expenditures on the likelihood of repurchase announcements. Models 1 and 2 show results for the full sample of firms for the full time period, while Models 3 and 4 show results for the full sample over the shorter technological change time period. The coefficient on the interaction term in these models (analysts' ratings$_{i,t-1}$ x capital expenditures$_{i,t}$) is positive but not significant for the full sample of firms. However, as shown in Model 6, the coefficient on the interaction term for the technological change sample of firms is positive and significant ($p<.05$). These results indicate that the more firms undertake capital investments while also experiencing negative analysts' ratings, the more likely they are to announce a stock repurchase. Again, the effect of the number of analysts covering a firm on the likelihood it announces a repurchase is also strongly positive and significant ($p <.01$). These results provide support for H5b, suggesting that higher levels of investment coupled with negative analysts' ratings may drive firms to pursue taken for granted actions to offset their increasing illegitimacy.

Addressing the Risks of Endogeneity and Unobserved Heterogeneity

As in much firm-level research in organization theory or strategy, there are possible limitations in this study due to concerns about endogeneity or unobserved heterogeneity. A potential confound in our study, particularly in our analyses of the effects of increasingly negative analysts' recommendations

on strategic investments, is that the same unobserved factors might lead managers to conclude they lack appropriate investment opportunities, and also lead to negative analysts' recommendations. Thus, there is a risk that both the dependent and independent variables to be driven by a third unobserved factor. Our study design addresses this potential risk in several ways: First, we lag all our independent and control variables, mitigating the risk of reverse causality (or simultaneity) and making it more likely that our findings of change in investments is at least in part due to a change in analysts' recommendations occurring in the prior period. In addition, we control for other factors which affect both the level of capital expenditures and the recommendations of analysts, including firm revenues, performance, stock price, cash, and the number of analysts covering a firm's stock each year. Further, these models use a robust panel design with firm fixed effects and year controls. Such panel data models specifically address the risks of unobserved heterogeneity, i.e. they provide an "ability to control for all stable covariates, without actually including them in a regression equation" (Allison & Waterman, 2002: 247). These models condition on the changes in independent and dependent variables year-to-year within firms (rather than differences in levels of both variables across firms), making it more likely that the increase in analysts' recommendations (i.e. more negative recommendations) causes the subsequent decrease in firms' investments. Moreover, in this study we have taken advantage of a natural experiment, radical technological change in each of our study settings, and have explicitly modeled technological change both by restricting our sample to the technological change firms, and by modeling the effects on the technological change firms with an interaction term within our larger sample of firms. Such technological changes provide an exogenous source of variation for testing our hypotheses. Finally, we have included data on a set of baseline industries not influenced by technological change during the period. Our analyses comparing the technological change firms with the full sample shows that there are significant differences between the technological change firms and our baseline set of non-

changing firms, and show further that the effects are generally stronger and more significant for the technologically changing firms. These steps do much to mitigate concerns about endogeneity and unobserved heterogeneity and provide some assurance that the relationships between analysts' recommendations and investments that we observe in this study are causal.

DISCUSSION

We address an important question that has not been studied in prior research: how do institutional pressures influence organizational strategies when firms are faced with a radical technological change? Existing research has studied the influence of internal organizational factors on incumbents' challenges responding to new technologies, but such work has generally not explored the role of external institutional pressures. We examine how sell-side securities analysts affect firms' strategies during periods of radical technological change.

We find that analysts' recommendations are increasingly negative for firms that are undergoing a radical technological change, and we also find that greater variation in analysts' ratings of incumbent firms following a technological discontinuity. In addition, we find a consistent and significant effect of analysts' recommendations on subsequent firm investments: the more negative the analysts' recommendations, the greater the subsequent decrease in strategic investments (through both capital expenditures and research and development expenses). We further find that these negative effects on capital investments and R&D tend to be strong at the highest (i.e. the most negative) levels of analysts' recommendations. Moreover, we find that the negative effect of analysts' worsening recommendations on strategic investments is more significant and pronounced for firms undergoing periods of dramatic technological change. These findings are important as they are the first empirical evidence of the critical role of external institutional pressures on firms as they are challenged with radical technological change.

It may be that during the periods of high uncertainty associated with radical technological change, incumbents' investments are particularly hard to value and more likely to appear as value destroying diversification (cf. Amihud & Lev, 1981) or wasteful uses of cash that could be returned to shareholders (cf. Jensen, 1986). Our results suggest that firms mitigate such pressures by subsequently reducing their investments. Our analyses use robust panel data statistical techniques and also take advantage of an exogenous natural experiment, mitigating many of the risks of endogeneity and unobserved heterogeneity.

In a second set of analyses, we examine the influence of analysts' recommendations on other taken-for-granted strategies, in particular cash payouts to shareholders in the form of dividends and share repurchases. We find that as analysts' recommendations worsen, firms are more likely to pay out cash to shareholders in the form of dividends. However, dividend payouts are more likely at moderate levels of negativity from analysts, and not in the cases of the most negative recommendations. Similarly, the likelihood of share repurchases increases with greater negativity in analysts' recommendations, but is less likely at the most negative recommendations. We also find that repurchases are strongly influenced by the number of analysts covering the firm, further evidence that analysts play a role in institutional pressures on firms to announce share repurchases, but not necessarily through the content of their recommendations. Although we find these relationships generally in our full sample of firms, we did not find that these pressures were significant for the firms experiencing technological change.

Finally, we examined whether, under strong pressures for adaptation to technological change, some firms will continue to invest, but will offset the heightened institutional pressures with other, taken-for-granted actions that signal alignment with shareholders. We find no statistical evidence that firms increase their dividend payouts under these conditions. However, we find that firms experiencing technological change were more likely to announce share repurchases under conditions of negative

analysts' recommendations coupled with high capital expenditures. That is, firms appear to use repurchases as a substitute for conforming to the pressures from analysts to change strategy.

The differences in the use of dividends and repurchases may indicate support for prior research. Although dividends and repurchases are both common ways to return cash to shareholders and are often considered substitutes, prior work suggests that firms may be more reluctant to increase dividends than to announce repurchases (e.g. Brav et al, 2005). Dividends are viewed as sticky and hard to reduce once shareholders expect them. In contrast, stock repurchases are one-time events that provide managers with greater flexibility. Moreover, in our context of technological change, stock repurchases may have benefits for managers beyond returning cash to shareholders and boosting stock price. If shares are repurchased, control of the company shifts away from shareholders, and as a result, may reduce the subsequent pressures from shareholders and analysts to curtail investments. Thus, repurchases may serve as an additional strategy that better enables response to a new technology.

This work makes several important contributions to research at the intersection of organization theory, strategy, and technological change. It makes an important empirical contribution by providing evidence based on a large sample, longitudinal statistical study using robust methods that analysts affect firms' strategies during periods of technological change. Our overall results about the relationship between analysts' recommendations and changes in investments in the full sample of firms suggest that analysts' recommendations influence firms' innovation strategies even more broadly, outside the context of technological change. Our use of panel data statistical models that condition on changes within-firm over time ensures that it is not merely differences across firms in their levels of investment and analysts' recommendations that drive our findings, but changes in analysts' recommendations within firm that cause a subsequent change in that firm's level of investments. In addition, the results suggest that even in the face of strong pressures to adapt to new technologies, it seems that the institutional pressures from

analysts to improve cash flow and stock price by cutting investments may generally outweigh the technical pressures. These pressures are also in evidence in the text of analysts' reports and conference calls between managers and analysts that we reviewed to provide deeper insight in this phenomenon.

In addition, this work contributes to organization theory. We propose how firms, in the context of public equity markets and the securities analysts who mediate them, respond to institutional pressures even as they face strong technical pressures for adaptation. Further, we propose how some firms decouple these responses to institutional pressures from operational activities to respond to technical pressures – by adopting taken-for granted institutional mechanisms as a possible way to offset the increasing illegitimacy of their operational activities. Further, this research contributes to institutional theory. Although a large body of work in has explored the effects of institutional pressures on organizations (e.g. Thornton & Ocasio, 1999; Tolbert, 1985; Meyer & Rowan, 1977; DiMaggio & Powell, 1983), research in the technological change literature has generally not studied the role of external pressures on the challenges of incumbent response.

These findings provide insight into how the external pressures on firms faced with technological change might encourage or reinforce the apparent managerial and organizational inertia documented in previous research (e.g. Tripsas & Gavetti, 2000; Henderson, 1993). Our findings have further implications for understanding the relationship between value creation and firm adaptation and survival, central topics in strategy and organization research. A firm's market value is constructed through investors' reactions to firms' actions (mediated by securities analysts). This study provides possible insights into the relationship between firms' challenges in responding to technological change and the creation of value for shareholders. The strategies required for adaptation and survival in the face of technological obsolescence may be at odds with the actions associated with increasing value perceived by analysts and investors, especially given the high uncertainty associated with radical technological

change. This study also provides more insight into the possible socio-cognitive factors that affect value creation for firms (cf. Rindova & Fombrun, 1999).

Finally, this research contributes to practice. Radical technological change triggers high uncertainty and important challenges for managers of incumbent firms. Managers interested in adaptation and survival of their organizations must take steps to respond to a new technology before the uncertainty about technological standards or new profit models is resolved. The future value of such investments may be difficult to know during periods of technological change, and may appear as wasteful uses of cash that are misaligned with shareholder interests. It is important for managers to understand that these contrasting pressures are particularly likely under the conditions of high uncertainty associated with radical technological change.

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FIGURE 1

Analysts' recommendations for firm *i* at time *t-1*

Level of investment for firm *i* at time *t*	More positive	More negative
Lower	Quadrant 1 Positive recommendation $_{t-1}$ Lower investment $_{t}$ •Less likely to return cash to shareholders	Quadrant 2 Negative recommendation $_{t-1}$ Lower investment $_{t}$ •Obedient – lower spending in later period to respond to negative pressures •More likely to return cash to shareholders
Higher	Quadrant 3 Positive recommendation $_{t-1}$ Higher investment $_{t}$ •Legitimate - later investments after more positive recommendations •Less likely to pay cash to shareholders	Quadrant 4 Negative recommendation $_{t-1}$ Higher investment $_{t}$ •Illegitimate – investments high after more negative recommendations •More likely to pay cash to shareholders

TABLE 1 – Descriptive Statistics and Correlation Coefficients
Correlations are within-panel

	Mean	SD	1	2	3	4	5	6	7	8
1. Capital expenditures ($ millions)	926.4	914.0								
2. Revenue ($ millions)	8211.3	5854.4	0.6019							
3. Analysts mean recommendation	2.3	0.5	-0.1537	0.0084						
4. Earnings per share ($)	1.5	1.3	0.1165	0.2369	-0.0831					
5. Stock price ($)	40.0	27.3	0.0063	-0.0494	-0.1292	0.5128				
6. Number of analyst recommendations	8.9	2.9	0.0885	0.1205	0.0635	0.0736	-0.0365			
7. Cash ($)	515.8	795.5	0.1	0.292	0.0957	-0.0358	-0.0659	-0.0386		
8. Stock repurchase announcements (equal to 1, zero otherwise)	0.2	0.4	0.0562	0.0588	0.0104	0.0338	-0.0122	0.0728	0.0212	
9. R&D expense ($ millions)	267.6	294.5	0.044	0.41	-0.1527	0.4159	0.1319	-0.0858	-0.183	0.0164

TABLE 2 - Comparison of mean analysts' ratings for technological change firms over time versus other firms
Dependent variable is analysts' mean recommendations

VARIABLES	Model 1 1994-1999	Model 2 > 1999	Model 3 > 2000	Model 4 > 2001	Model 5 > 2002	Model 6 Changes over time	Model 7 With interaction, 1994-99	Model 8 With interaction, > 1999
Tech change industry dummy	-0.07(.05)	0.05(.04)	0.09*(.04)	0.15***(.05)	0.17***(.05)	0.03(.03)	.15(.2)	-0.88***(.2)
Year (1993=1)						0.03***(.003)	-0.03(.02)	0.03***(.01)
Interaction (tech change dummy variable x year)							-0.04 (.04)	0.08***(.02)
Constant	2.3***(.03)	2.41***(0.02)	2.44***(.03)	2.45***(.03)	2.47***(.03)	2.11***(.04)	2.46***(.11)	2.09***(.11)
Number of observations	526	951	851	753	654	1550	444	951

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

TABLE 3 - Effect of analysts' recommendations on capital expenditures.
Panel data models with firm fixed effects and year dummy variables.
Dependent Variable: natural log of capital expenditures for firm i at time t

	Full sample, 1994-2007			**Full sample, 2000-2007**		
VARIABLES	Model 1 controls only	Model 2 with mean recs	Model 3 with quintile variable	Model 4 controls only	Model 5 with mean recs	Model 6 With quintile variable
Analysts' mean rec $_{t-1}$		-0.07***(0.03)			-0.11***(0.04)	
2nd quintile (1st quintile excl.)			-0.06 (0.04)			-0.08* (0.05)
3rd quintile			-0.08* (0.04)			-0.11** (0.05)
4th quintile			-0.08* (0.04)			-0.07 (0.06)
5th quintile			-0.15*** (0.05)			-0.22*** (0.06)
Cap. exp $(log)_{t-1}$	0.44***(0.03)	0.43***(0.03)	0.43*** (0.03)	0.40***(0.04)	0.38***(0.04)	0.38*** (0.04)
Revenue $(log)_{t-1}$	0.3*** (0.04)	0.3*** (0.04)	0.30*** (0.04)	0.07 (0.07)	0.08 (0.07)	0.08 (0.07)
Closing stock price $_{t-1}$	0.001 (0.00)	0.001 (0.00)	0.00 (0.00)	0.002**(.001)	0.002**(0.001)	0.002* (0.001)
Earnings per share $_{t-1}$	0.04***(0.01)	0.03***(0.01)	0.03*** (0.01)	0.02* (0.01)	0.02 (0.01)	0.02* (0.01)
Cash $(log)_{t-1}$	0.06***(0.01)	0.06***(0.01)	0.06*** (0.01)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
ln(#analysts covering)$_{t-1}$	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)	0.02 (0.05)	0.02 (0.05)	0.02 (0.05)
Constant	0.16 (0.24)	0.36 (0.25)	0.27 (0.24)	1.98***(0.50)	2.56***(0.52)	2.14*** (0.50)
Firm-years (#firms)	1187 (124)	1187 (124)	1187 (124)	723 (123)	723 (123)	723 (123)
R-squared	0.541	0.544	0.546	0.316	0.326	0.333

Technological change - 2000-2007				
	Model 7- controls only	Model 8 – with mean recs variable	Model 9 – full sample with tech change interaction	Model 10 with quintile variable
Analysts' mean rec $_{t-1}$		-0.20*** (0.07)	-0.03 (0.05)	
Interaction (tech change dummy variable x analysts' recs$_{t-1}$)			-0.23*** (0.07)	
2nd quintile (1st quintile excl.)				-0.21** (0.09)
3rd quintile				-0.34***(0.10)
4th quintile				-0.20* (0.10)
5th quintile				-0.37*** (0.12)
Cap. exp $(log)_{t-1}$	0.54***(0.06)	0.49*** (0.06)	0.35*** (0.04)	0.50*** (0.06)
Revenue $(log)_{t-1}$	-0.17 (0.12)	-0.11 (0.12)	0.10 (0.07)	-0.09 (0.12)
Closing stock price $_{t-1}$	0.001 (0.001)	0.001 (0.001)	0.002** (0.001)	0.00 (0.001)
Earnings per share $_{t-1}$	0.03* (0.02)	0.03 (0.02)	0.02 (0.01)	0.03 (0.02)

Cash (log) $_{t-1}$	-0.03 (0.03)	-0.03 (0.030)	0.02 (0.02)	-0.005 (0.03)
ln(#analysts covering)$_{t-1}$	-0.005 (0.09)	0.004 (0.09)	0.03 (0.05)	-0.01 (0.091)
Constant	3.88***(0.99)	3.732***(0.96)	2.58*** (0.52)	3.23*** (0.95)
Firm-years (#firms)	247 (42)	247 (42)	723 (123)	247 (42)
R-squared	0.490	0.509	0.337	0.528

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

TABLE 4 - Effect of analysts' recommendations on R&D expenses
Panel data models with firm fixed effects and year controls
Dependent Variable: natural log of R&D expenses for firm i at time t

VARIABLES	Model 1-Full sample, controls only 1994-2007	Model 2-Full sample with rec. vars., 1994-2007	Model 3-Tech. change sample, controls only 2000-2007	Model 4-Tech. change sample, rec. vars., 2000-07	Model 5 Full sample with tech. change interaction 2000-2007	Model 6- Full sample, quintile variable, 1994-2007	Model 7-Tech. change sample, quintile variable, 2000-2007
Analysts' mean rec. $_{t-1}$		-0.03 (0.04)		-0.08 (0.08)	0.11* (0.07)		
Interaction (tech change dummy variable x analysts' recs$_{t-1}$)					-0.20** (0.09)		
2nd quintile (1st quintile excluded)						0.022 (0.064)	-0.227* (0.118)
3rd quintile						-0.046 (0.061)	-0.340***(0.123)
4th quintile						0.024 (0.067)	-0.055 (0.118)
5th quintile						-0.055 (0.073)	-0.384**
R&D expense (log)$_{t-1}$	0.69***(0.05)	0.70***(0.05)	0.43** (0.19)	0.49**(0.20)	0.63*** (0.06)	0.696***(0.046)	0.402** (0.181)
Revenue (log)$_{t-1}$	-0.01 (0.04)	-0.02 (0.04)	0.49 (0.29)	0.40 (0.30)	0.03 (0.08)	-0.017 (0.044)	0.257 (0.272)
Closing stock price $_{t-1}$	0.003* (.001)	0.002* (.001)	0.009**(0.004)	0.01 (0.01)	0.01*** (0.002)	0.002* (0.001)	0.005 (0.004)
Earnings per share $_{t-1}$	0.04** (0.02)	0.04** (0.02)	0.03 (0.03)	0.02 (0.03)	0.01 (0.02)	0.043** (0.018)	0.026 (0.025)
ln(# analysts covering) $_{t-1}$	0.012 (0.07)	0.01 (0.07)	0.16 (0.10)	0.17 (0.10)	0.12** (0.06)	0.028 (0.018)	0.064 (0.045)
Cash (log) $_{t-1}$	0.03 (0.02)	0.03 (0.02)	0.04 (0.05)	0.04 (0.05)	0.003 (0.02)	-0.004 (0.070)	0.122 (0.096)
Constant	0.94***(0.31)	1.07***(0.35)	-2.28 (1.79)	-1.51 (1.95)	0.55 (0.60)	1.014***(0.327)	-0.070 (1.788)
Firm-years (#firms)	284 (38)	284 (38)	59 (12)	59 (12)	176 (35)	284 (38)	59 (12)
R-squared	0.768	0.769	0.714	0.723	0.712	.771	0.792

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

TABLE 5 - Variation in analysts' ratings: Comparison of firms in technological change industries versus other firms
Dependent variable is the standard deviation in analysts' mean recommendations

	Model 1 – 1994-1999	Model 2 - years >1999	Model 3 - years >2000	Model 4 - years >2001	Model 5 - years >2002
Tech industry dummy	0.04(0.03)	0.05**(0.03)	0.06**(0.03)	0.06**(0.03)	0.04(0.03)
Constant	0.66***(0.02)	0.66***(0.02)	0.66***(0.02)	0.67***(0.02)	0.68***(0.02)
Observations	526	951	851	753	654

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

TABLE 6 - Effect of analysts' recommendations on dividends - Panel data models with firm fixed effects and year controls
Dependent variable is dividends per share for firm i at time t

VARIABLES	Model 1-Full sample, controls only 1994-2007	Model 2-Full sample with rec. variables, 1994-2007	Model 3-Tech. change sample, controls only 2000-2007	Model 4-Tech. change sample, rec. variables 2000-2007	Model 5 - Full sample with interaction, 2000-2007	Model 6 - Full sample, quintile variable, 1994-2007	Model 7 – Tech. change sample, quintile variable, 2000-2007
Analysts' mean recs. $_{t-1}$		0.09** (0.04)		0.06 (0.19)	0.05 (0.10)		
Interaction (tech change dummy variable x analysts' recs$_{t-1}$)					0.09 (0.14)		
2nd quintile(1st quint. excl)						0.103* (0.06)	0.31 (0.25)
3rd quintile						0.14** (0.06)	0.33 (0.27)
4th quintile						0.28*** (0.07)	0.60**(0.29)
5th quintile						0.12* (0.07)	0.17 (0.32)
Dividends per share $_{t-1}$	0.05 (0.03)	0.04 (0.03)	-0.01 (0.07)	-0.01 (0.07)	-0.07* (0.04)	0.04 (0.03)	-0.008(0.07)
Revenue(log) $_{t-1}$	0.04 (0.05)	0.04 (0.05)	0.02 (0.33)	0.01 (0.33)	-0.09 (0.14)	0.04 (0.05)	-0.06 (0.33)
Earnings per share $_{t-1}$	0.07*** (0.02)	0.08*** (0.02)	0.07 (0.05)	0.07 (0.05)	0.12***(0.03)	0.08*** (0.02)	0.08* (0.05)
ln(#analysts covering)$_{t-1}$	0.10** (0.05)	0.10** (0.05)	0.37 (0.25)	0.37 (0.25)	0.16 (0.10)	.003***(.001)	0.002 (0.003)
Stock price $_{t-1}$	.003***(.001)	0.003***(.001)	0.002 (.003)	0.002 (.003)	0.001 (0.002)	0.09* (0.05)	0.36 (0.25)
Cash (log) $_{t-1}$	0.03 (0.02)	0.03 (0.02)	.17** (.08)	0.17**(0.08)	0.05 (0.03)	0.03 (0.02)	0.14 (0.08)
Constant	-0.12 (0.38)	-0.40 (0.40)	-1.06 (2.59)	-1.09 (2.56)	0.55 (1.09)	-0.26 (0.39)	-0.56 (2.60)
Firm-years (# firms)	1197 (126)	1197 (126)	249 (42)	249 (42)	728 (125)	1197 (126)	249 (42)
R-squared	0.112	0.116	0.111	0.112	0.089	0.128	0.138

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

TABLE 7 – Effect of analysts' recommendations on stock repurchase announcements
Logit models with random effects and year dummies
Dependent Variable: Stock repurchases (=1 if firm 'i' announced a repurchase in year 't', =0 otherwise)

VARIABLES	Model 1 - Full sample, controls only 1994-2007	Model 2 - Full sample with recs., 1994-2007	Model 3 – Tech. change sample, controls only 2000-2007	Model 4 – Tech. change sample with recs. 2000-2007	Model 5 – Tech. change sample with interaction, 2000-2007	Model 6 – Quintile variable, full sample 1994-2007	Model 7 – Quintile variable, tech change sample 2000-2007
Analysts' mean rec. $_{t-1}$		0.23 (0.17)		-0.44 (0.49)	0.44 (0.28)		
Interaction (tech change dummy variable x analysts' recs$_{t-1}$)					-0.46 (0.46)		
2nd quintile(1st quintile excluded)						0.60** (0.29)	1.17 (0.83)
3rd quintile						0.37 (0.31)	-0.01 (0.95)
4th quintile						0.67** (0.30)	0.24 (0.94)
5th quintile						0.46 (0.31)	-0.03 (0.93)
Revenue(log) $_{t-1}$	-0.09 (0.10)	-0.09 (0.10)	0.09 (0.30)	0.08 (0.29)	-0.25* (0.15)	-0.10 (0.10)	0.05 (0.29)
Stock price $_{t-1}$	-0.01* (0.003)	-.006* (0.003)	-0.02 (0.015)	-0.02 (0.01)	-0.01* (.005)	-0.01* (0.003)	-0.02 (0.015)
Earnings per share $_{t-1}$	0.14** (0.07)	0.14** (0.07)	0.16 (0.16)	0.14 (0.15)	0.20* (0.11)	0.14** (0.07)	0.20 (0.16)
Cash(log) $_{t-1}$	-0.09 (0.06)	-0.09 (0.06)	-0.34* (0.19)	-0.33* (0.188)	-0.05 (0.09)	-0.08 (0.06)	-0.30 (0.19)
ln(# analysts covering) $_{t-1}$	0.44*** (0.15)	0.44*** (0.15)	1.32***(0.47)	1.38***(0.47)	0.80***(0.21)	0.41*** (0.15)	1.332***(0.45)
Technology change dummy variable					0.64 (1.15)		
Constant	-1.65***(.56)	-2.11***(0.66)	-3.82** (1.49)	-2.77 (1.85)	-2.09* (1.07)	-1.98***(0.59)	-3.53** (1.46)
Firm-years (# firms)	1306 (129)	1306 (129)	287 (43)	287 (43)	837 (128)	1306 (129)	287 (43)
Log-likelihood	-531.0	-529.5	-87.42	-86.82	-311.4	-527.0	-84.93

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

TABLE 8 - Effect of interaction of capital expenditures and negative analysts' ratings on repurchase announcements.
Logit models with random effects and year controls
Dependent Variable: Stock repurchases (=1 if firm i announced repurchase in year t, =0 otherwise)

VARIABLES	Model 1 - Full sample, contrls only, 1994-2007	Model 2 - Full sample with interaction variable, 1994-2007	Model 3 - Full sample, controls only, 2000-2007	Model 4 - Full sample with interaction variable, 2000-2007	Model 5 – Tech. change sample, controls only, 2000-2007	Model 6 – Tech. change sample with interaction variable 2000-2007
Capital expenditures (cap. ex.)		-0.0004 (0.0003)		-0.0003 (0.0003)		-0.0008*(0.0004)
Interaction: cap.ex x analysts'recs$_{t-1}$		0.0002 (0.0001)		0.0002 (0.0001)		0.0004**(0.0002)
Revenue(log) $_{t-1}$	-0.09 (.10)	-0.09 (0.10)	-0.19 (0.14)	-0.24 (0.16)	0.08 (0.29)	-0.17 (0.36)
Stock price $_{t-1}$	-0.01* (.003)	-0.01* (0.003)	-0.01* (0.01)	-0.01 (0.005)	-0.02 (0.01)	-0.02 (0.014)
Earnings per share $_{t-1}$	0.14** (.07)	0.13* (0.07)	0.18* (0.11)	0.19 (0.12)	0.14 (0.15)	0.28 (0.20)
Cash (log) $_{t-1}$	-0.09 (.06)	-0.09 (0.07)	-0.06 (0.09)	-0.07 (0.10)	-0.33* (0.19)	-.39** (0.20)
ln(# analysts covering) $_{t-1}$	0.44*** (.15)	0.49*** (0.16)	0.69***(0.20)	0.87*** (0.23)	1.38***(0.47)	1.63*** (0.55)
Analysts' mean rec. $_{t-1}$	0.23 (.17)	0.15 (0.19)	0.25 (0.23)	0.23 (0.28)	-0.44 (0.49)	-0.86 (0.59)
Constant	-2.11***(.66)	-1.71** (0.72)	-1.97**(0.97)	-2.94***(1.10)	-2.77 (1.85)	.17 (1.95)
Firm-years (#firms)	1306 (129)	1191 (124)	837 (128)	726 (123)	287 (43)	249 (42)
Log-likelihood	-529.5	-483.1	-313.6	-266.9	-86.82	-71.96

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1