

Securities Analysts and Incumbent Response to Radical Technological Change: Evidence from Digital Photography and Internet Telephony

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A large body of research has explored the factors that impede established firms' responses to radical technological changes. While it is widely acknowledged that managers face pressures from financial markets to choose strategies that maximize shareholder value, little work in the technological change literature has considered the possible influences of public equity markets and the securities analysts who mediate them on incumbent firms challenged with technological change. In this paper, I begin to address the topic by empirically exploring how securities analysts react to the different strategies undertaken by incumbent firms faced with radical technological change. I study the question in two settings: the shift to digital technology in photography and the advent of Voice over Internet Protocol (VoIP) technology in wireline telecommunications. I find evidence that analysts are more attentive and positive toward incumbents' strategies that extend and preserve the existing technology than toward strategies that respond directly to the new technology. In these settings, analysts largely ignore incumbents' strategies that directly incorporate the new technology for several years following the discontinuity. This study provides insights into the nature and direction of analysts' reactions to firms' strategies in the context of technological change, and is a first step toward better understanding of the potential role of analysts' and financial markets in incumbent adaptation.

Key words: technological change; innovation; incumbents; institutional theory; analysts; photography industry; telecommunications industry

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Radical technological change often challenges incumbent firms that have accumulated knowledge and capabilities in the prior industry technology. The challenge of adapting to technological change has been studied in a large body of organization and strategy research (e.g., Levinthal 1992, Henderson and Clark 1990, Tushman and Anderson 1986). Major technological changes can require incumbents to make dramatic changes in strategy and develop entirely new sets of knowledge and capabilities (e.g., Tushman and Anderson 1986). Researchers studying these technological transitions have explored the reasons underlying incumbents' often reluctant or ineffective responses (e.g., Henderson 1993, Reinganum 1983). For example, stable routines or capabilities can constrain a firm's ability to acquire new technological knowledge and develop new capabilities required for a changed environment (cf. Leonard-Barton 1992, Henderson and Clark 1990). Established firms' innovation may be hampered by ineffective innovation processes or systems (Dougherty and Hardy 1996). Organizational tendencies to favor exploitation at the expense of exploration may further restrict search and innovation into new technologies (e.g., March 1991; Levinthal and March 1993; Benner and Tushman 2002, 2003). In addition, managers' outdated mindsets can constrain

innovation and response to technological change (Tripsas and Gavetti 2000). In response to these documented challenges, recent research encourages managers to be more responsive to technological change, for example, by developing dynamic capabilities to help their organizations adapt (e.g., Teece et al. 1997, Eisenhardt and Martin 2000) or creating ambidextrous organizations that balance exploitation and exploration (e.g., Tushman and O'Reilly 1997). This work further suggests that incumbents can and should respond to technological changes in their environments to ensure survival (see also Christensen 1997).

Despite the numerous challenges for incumbents faced with technological transformations, they often respond successfully by entering new technological subfields (Mitchell 1989) or developing innovations and capabilities that allow them to survive these critical technological transitions (e.g., Ahuja and Lampert 2001, Tripsas 1997, Rothaermel 2001). Prior research has shown that the incumbent firms in a prior technology can emerge as the eventual winners after a major technological change, because of complementary assets or dynamic capabilities (e.g., Teece 1986, Tripsas 1997).

Although some research on the challenges of technological change has considered the influence of customers

on firms' response to technological change (e.g., Christensen and Bower 1996, Sull et al. 1997), research in this stream has largely overlooked the potential role of external institutional pressures. It is clear from prior research that pressures from financial markets, in particular the public equity markets in the United States, influence firms' actions and strategies (e.g., Zuckerman 2000, Davis and Robbins in press, Rao and Sivakumar 1999, Davis and Useem 2002, Useem 1996). In part this influence unfolds through the opinions of "sell side" securities analysts who mediate public equity markets (e.g., Zuckerman 1999, 2000). Securities analysts specialize in single industries and issue periodic reports and recommendations for investors about whether to buy, hold, or sell a firm's stock (Schipper 1991). Prior research has demonstrated that these recommendations influence investors' behaviors and corresponding changes in stock prices and stock market value (e.g., Womack 1996, Zuckerman 1999, Moreton and Zenger 2005).

In this paper, I take a first empirical step toward better understanding of the possible influences of financial markets by specifically exploring how securities analysts react to incumbent firms' strategies during a radical technological change. This paper is a descriptive, in-depth empirical study of the text of hundreds of securities analysts' reports during radical technological changes that threaten to replace the existing technology in two settings: the technological shift from film to digital in photography, and the advent of Voice over Internet Protocol (VoIP) technology in telephone services (wireline telecommunications). I explore whether securities analysts react positively or negatively as incumbent firms respond to these radical technological changes, and compare the reactions toward the more exploitative and exploratory strategies incumbents pursue.

Two main findings emerge from the study. First, I find that analysts were markedly more attentive to incumbents' offerings that extended the old technology, i.e., film technology in the photography setting and wireline technology in telecommunications, than to incumbents' products based directly on the new technology. In the early years of the technological change, securities analysts largely ignored incumbents' new products that responded directly to the advent of a potential substitute technology. It is clear that during that time public information about both the threat of the new technology for incumbents and the incumbents' strategies to respond was widely available from news articles and industry newsletters. Second, I find in a careful analysis of the texts of the reports and justifications for turning points in recommendations that the analysts were also more positive about incumbents' product offerings that extended the old technology than about products incorporating only the new technology. These positive sentiments toward the old technology were further reflected in the justifications analysts provided for

numerous upgrades to "Buy" recommendations during the study period.

This study documents the nature and direction of securities analyst reactions as incumbents take steps to respond to new technologies. The findings suggest that analysts' reactions encouraged a continued focus on strategies to preserve and extend the old technology, and did not encourage incumbents' response to the new technologies.¹ Because analysts' recommendations influence investor behaviors, associated stock prices, and the stock market values of firms, this study has implications for further understanding how market value is constructed as firms respond to technological change. This study also has potential implications for how analysts' reactions affected incumbents' subsequent strategies. Existing research on the influences of financial markets has argued—and found—that the reactions of analysts and investors influence firms' strategies (e.g., Zuckerman 2000, Rao and Sivakumar 1999, Bushee 1998, Useem 1996). Documenting the nature and direction of the reactions is the first step toward understanding how these influences on strategy unfold. In addition, while this study focuses specifically on the context of technological change, these findings may also have broad implications for how financial markets react to organizations' innovation and adaptation. It may be that securities analysts' reactions, reflecting financial markets, encourage exploitation over exploration or favor incremental innovation over more radical innovation (cf. March 1991, Levinthal and March 1993).

The paper is arranged in four sections. First, I review prior research on technological change as well as research on securities analysts and their influences on firms' strategies. Drawing on this prior research, I hypothesize about the nature and direction of analysts' reactions to different strategies undertaken by incumbents faced with a radical technological change. In the next section, I describe the two study contexts and the specific strategies incumbent firms pursued to respond to the technological change in each context. I then present the results of the in-depth longitudinal study of analysts' reports to assess how their reactions unfolded as incumbents pursued these different types of strategies in the face of a radical technological transformation. I conclude with a discussion and implications for research and management practice.

Radical Technological Change and Securities Analysts' Reactions

Radical technological change in an industry entails a discontinuous shift to an entirely new base of technological knowledge and a potentially superior price/performance trajectory (e.g., Dosi 1982, Tushman and Anderson 1986, Abernathy and Utterback 1978, Gatignon et al. 2002; see also Dahlin and Behrens 2005). Radical technological

changes further threaten to replace the existing industry technology and render obsolete the incumbent firms' associated knowledge and capabilities. Examples of radical technological changes described in prior literature include the shift to quartz from mechanical escapement technology in the watch industry (Landes 1983, Glasmeier 1991), to diesel electric technology from steam in locomotives (Cooper and Smith 1992), and to mechanical refrigeration technology from ice harvesting (Utterback 1994). To the extent these dramatic shifts in technology are "competence destroying" (Tushman and Anderson 1986), survival requires incumbent firms to make major transformations, including acquiring new knowledge and changing capabilities (Tushman and Anderson 1986, Gatignon et al. 2002, Lavie 2006). Researchers have also found that these discontinuous technological innovations usher in "eras of ferment," characterized by rapid innovation, entry of new competitors, and high uncertainty (e.g., Tushman and Anderson 1986). Technological discontinuities often change the profit model in an industry, i.e., whether and how firms make money. Eventually one or a few dominant technological standards may emerge, often with only a few winners (Utterback 1994). But certainty about the new profit model and the ultimate winners in the new technology may be unresolved for many years during the era of technological ferment that follows a technological discontinuity.

Despite the potentially disastrous effects of radical technological change for the financial prospects of the existing firms in an industry, there has been little research on how financial markets react when firms are faced with technological change. A small and growing body of research, primarily in economics, has recently begun to explore the effect of major technological changes on stock prices. Hobijn and Jovanovic (2001) argue that stock prices decreased in the 1970s and 1980s because of radical new information technologies that incumbent firms were slow to adopt. Mazzucato (2003) found that stock prices of incumbent firms were likely to experience greater volatility the more radical the technological change. Similarly, other work has shown that new technologies tend to be associated with decreases in incumbent firms' stock prices (e.g., Pastor and Veronesi 2005, Laitner and Stolyarov 2003). This research generally indicates that technological change influences incumbents' stock prices, i.e., the behaviors of investors. However, these studies generally assume that stock prices of incumbents decline following major technological changes, because the firms fail to adopt the new technologies. They do not consider financial market reactions that result when incumbent firms actually respond to the technological change in spite of the challenges.

The reactions of financial markets, i.e., the buying and selling behaviors of investors and resulting stock prices, are influenced by "sell side" securities analysts,

who play an important role as mediators in public equity markets (e.g., Schipper 1991, Bradshaw 2004, Womack 1996, Zuckerman 1999, Beunza and Garud 2007, Hong and Kubik 2003, Nocera 1997). Securities analysts forecast the future financial performance and stock prices of the firms they cover,² and issue periodic reports and recommendations on whether to buy, hold, or sell a firm's stock (e.g., Zuckerman 1999, Rao and Sivakumar 1999, Schipper 1991). Securities analysts typically specialize in covering firms within a single industry (e.g., Schipper 1991, Zuckerman 1999, Zuckerman and Rao 2004). Research has shown that within an industry category, analysts rely on shared valuation models for anticipating the future profitability and cash flows of firms within the category (Zuckerman 1999, Zuckerman and Rao 2004, Hong et al. 2000, Bradshaw 2004). Prior research has also shown that these valuation models reflect taken-for-granted ideas about the appropriate strategies for generating profits for firms in the category as well as metrics for assessing them, such as price/earnings ratios (Bradshaw 2004, Zuckerman and Rao 2004).

A large body of research in accounting, economics, and finance has studied securities analysts' behaviors and their influences on investors. This research generally has concluded that analysts' recommendations are an important influence on changes in the stock prices of the firms they cover, i.e. securities analysts' recommendations influence investor behaviors (e.g., Womack 1996, Barber et al. 2001, Frankel et al. 2006; see also Ramnath et al. 2008 for a review of the literature on analysts). The predominant view in this literature is that securities analysts are sophisticated users of information who have more and better information on the firms they cover than is publicly available to investors (e.g., Frankel et al. 2006, Lys and Sohn 1990, Amir et al. 2003). This research further reflects the general belief that analysts improve the informational efficiencies of financial markets (cf. Moreton and Zenger 2005, Lys and Sohn 1990).

Although the main role of securities analysts is to provide information and recommendations to investors, evidence from other research has shown that beyond influencing investors, analysts also influence managers' and firms' behaviors (Zuckerman 2000, Rao and Sivakumar 1999). Analysts' effects on investors' stock purchases and corresponding stock prices suggest they play a role in whether value, i.e., stock market value, is created in reaction to firms' strategies. It is therefore critical to understand the nature and direction of analysts' reactions as incumbent firms respond to a technological change.

Prior research provides insights into the likely direction of these reactions. Zuckerman (1999) shows that the industry categories and associated models of valuation used by analysts affect analysts' and financial market reactions. As firms' unrelated diversification strategies deviated from a single industry category, the firm's

stock was more difficult for analysts to cover, triggering decreases in stock price as analysts dropped coverage. Similarly, Moreton and Zenger (2005) show that strategies that are unique or complex and require higher than usual levels of information processing by analysts can also trigger stock price discounts. Similarly, these analysts' categories and associated valuation models that influence the perceived legitimacy of firms' strategies are also likely to influence analysts' reactions as incumbents respond to a technological transformation.

Successfully responding to a new technology often requires major changes in incumbents' strategies, increasing the likelihood that a firm's activities will deviate from the traditional valuation models associated with existing industry technology. A radical technological change in an industry is also likely to trigger a need to change the theories of valuation underlying the stocks in the industry, but as Zuckerman and Rao (2004) show, the valuation models held by investors and analysts are slow to change. As a result, to the extent an incumbent's new strategies to respond to a new technology deviate from relatively inertial beliefs about how firms' stocks should be valued in a particular industry, these strategies may be perceived as akin to value destroying unrelated diversification (cf. Berger and Ofek 1996, Zuckerman 1999, Amihud and Lev 1981) and thus elicit negative reactions.

More specifically, incumbents' short term financial performance is negatively affected by the increased investments required to develop new technological knowledge and keep up with the rapid innovation and improvement in the new technology during an era of technological ferment. Beyond their costs, activities in the new technology, i.e., commercializing new products incorporating a new technology, are also typically unprofitable for a time, because of the increased competition from many new entrants (cf. Utterback 1994, Anderson and Tushman 1990). Furthermore, during an era of technological ferment, the profit model and future value of an incumbent firm are both highly uncertain, and this uncertainty may persist for many years. The new domain created by the technological change is typically a much less attractive market at the outset compared to the historical financial performance of the incumbent firm based on the traditional technology.

Thus, prior research guides the prediction that analysts' reactions are likely to be more positive to strategies that extend the old technology and have a positive effect on financial performance viewed through the existing valuation model, and more negative toward strategies that respond directly to the substitute technology and cannot easily be assessed within traditional valuation models. Efforts to respond directly to a new technology during an era of ferment are both more difficult to value and financially less attractive than the efforts in the old technology until substitution occurs and a dominant design emerges. Taken together, these ideas suggest the following general hypothesis:

HYPOTHESIS. *Securities analysts' reactions will be more negative toward incumbents' strategies that depart from the existing technology and valuation model and more positive toward incumbents' strategies that extend the existing technology and valuation model.*

Empirical Settings, Data, and Methods

Study Settings

The study involves two empirical settings faced with radical technological changes: the photography industry during the shift to digital technology from chemistry-based film, and the wireline telecommunications industry (telephone services) with the advent of Internet telephony (VoIP).

In the photography industry, digital technology involves charge-coupled devices (CCDs) that convert light images to binary data and offer the potential for a dramatic price/performance improvement over film technology. For incumbent firms in film technology, digital is a radical and potentially competence-destroying technological change (cf. Tripsas and Gavetti 2000, Tushman and Anderson 1986, Gatignon et al. 2002). Digital technology has been viewed as a likely substitute for film since its advent in the early 1990s, although the precise timing of substitution was uncertain (e.g., *Future Image Report* 1993–2001; Dingman 1991). Early digital cameras, targeted mainly to professional photographers, were priced in the \$20,000–\$30,000 range and were initially too expensive to threaten consumers' use of film. Thus, the earliest instances of digital technology in commercial form spurred increasing expectations of technological substitution and speculation about its timing, but did not trigger immediate substitution. Echoing the technological change literature, digital technology had to undergo technological improvement, i.e., resolution performance measured in pixels, and reductions in price before achieving parity with film (cf. Utterback 1994).

An important innovation for the technological progress of digital technology occurred in April 1994, with the introduction of Apple QuickTake, priced at \$749. QuickTake was the first digital camera available for less than \$1,000—the prevailing definition of the breakthrough that would spur faster diffusion of digital technology (*Future Image Report* 1994, p. 6). Following this innovation, many new competitors entered digital imaging, accelerating improvements and substitution (*Future Image Report* 1993–2001). The resulting technological improvements continually advanced the price/performance frontier for digital photography throughout the decade, as the performance of digital cameras increased rapidly while prices continually fell. This technological progress was rapid and visible: Video graphics array (VGA) resolution cameras were available for under \$400 by mid-1996; one megapixel (million pixel) cameras were available for less than \$1,000 in 1997

and less than \$500 by 1998; two megapixel cameras were available in 1998 and for less than \$500 by 1999; three megapixel cameras were available for under \$1,000 in 2000; four megapixel cameras were available for under \$1,000 in 2001, and so on (*Future Image Report* 1993–2001). These continuous improvements in the price/performance frontier of digital technology accelerated the shift toward purchases of digital cameras by consumers and away from purchases of film and analog cameras.

In the second empirical setting, wireline telecommunications, VoIP technology converts analog audio signals (traditional land-line calls) into digital data to be transmitted over the Internet. VoIP technology thus provides a method for phone calls that bypasses the incumbent wireline phone companies' (the Regional Bell Operating Companies, or RBOCs) telecommunications networks and also bypasses the prior source of profits. The potential effect of VoIP technology on wireline firms is comparable to the potential impact of digital technology on film incumbents. Also similar to digital photography, VoIP technology underwent marked improvement in performance and price over several years. Notably, Vonage's DigitalVoice VoIP service, introduced in March 2002, was discussed in the press as an important breakthrough in Internet telephony performance. "Since its launch in March, the Vonage service has redefined the quality and ease of use of digital Internet telephony... it could pose the first real threat from this quarter to traditional phone companies," (Taylor 2002, p. 7). In August 2003, Skype introduced free Internet telephony software.

The technological discontinuities in these two settings share many characteristics consistent with prior research in technological evolution and, in particular, characteristics of eras of technological ferment. In both cases the new technologies offer the promise of a superior price and performance trajectory that threatens to substitute for the existing technology. Although the new innovations did not immediately result in the obsolescence of the old technologies, they marked an improvement in technological performance that triggered widespread expectations of substitution, while also ushering in many new entrants. In the mid-1990s, many firms entered the nascent digital camera market, including Canon, Minolta, Nikon, Agfa, Toshiba, and Sony along with other digital camera developers such as Leaf Systems, Dycam, and Logitech (*Future Image Report* 1993–1999). Similarly, improvements in VoIP technology triggered the entry of many firms into Internet telephony including the incumbent phone companies, cable companies, and other entrants such as Skype (Latour 2003, Brown and Latour 2004). This increased competition and corresponding improvement in technological performance further spurred diffusion of the technology, making substitution increasingly certain. During the study periods, numerous articles in the general news media predicted

the demise of film in the face of digital technology, and similarly, the likely obsolescence of wireline telecommunications with increasing adoption of Internet telephony. For example, a 1991 headline reads: "Electronics Takes a Big Step Closer to Replacing Film" (Dingman 1991). Similarly, a 2003 headline notes: "Internet Phone Service Threatens Industry's Giants" (Latour 2003). Echoing prior work (e.g., Cooper and Smith 1992) the incumbents' future profit streams were threatened by new competitors and products incorporating a new and potentially superior technology. From the time of the earliest technological discontinuities, managers in these industries were challenged with determining how to respond to the likely event of future substitution (cf. Cooper and Smith 1992).

Methods and Data Collection

To understand how securities analysts reacted to incumbents' strategies in the face of these technological transformations, I study analysts' reports covering the publicly traded incumbents in both industries: Polaroid and Kodak in the photography industry, and Verizon, Qwest, SBC Communications, and BellSouth (the four RBOCs, or "Baby Bells") in the wireline telecommunications industry. The study period for the photography industry is the 12 years from 1990 to 2001; Polaroid declared bankruptcy in October 2001. The study period in the wireline telecommunications industry is from 2002 (marking Vonage's introduction) until 2005, when SBC merged with AT&T.

I collected information from several sources to (1) understand the strategies incumbents pursued in the face of the technological threat, and (2) assess the reactions of securities analysts covering the incumbent firms. I characterize incumbents' strategies in two categories. First, incumbents generally responded to the technological change directly by introducing products that incorporated the new technology. In the photography setting, Kodak and Polaroid both introduced digital cameras, while in the wireline telecommunications setting the incumbents also introduced phone services based on VoIP technology. Second, the incumbent firms simultaneously pursued strategies that extended or preserved the old technology. In the photography industry, both incumbents developed and introduced "hybrid" and film products that preserved a role for film technology in image capture. In the wireline telecommunications setting, the incumbents began to take advantage of regulations that allowed them to provide long distance services based on the existing wireline technology. I consider the film-related offerings in the photography setting and the long-distance offerings in the wireline telecommunications setting more exploitative strategies relative to the firms' traditional skills, capabilities, and sources of profit, because they continue to incorporate film or wireline technology. I consider the new products based directly on the new technology to be more

exploratory strategies, as they depart from the existing technologies and firms' traditional valuation models.

Data on Incumbents' Strategies. I collected data on the incumbents' products to respond to the new technology from several sources. In photography, I accessed information on digital camera product introductions from multiple years of the *Future Image Report*, a photography industry newsletter published 10 times a year beginning in 1993. The *Future Image Report* provided information on all digital imaging-related products introduced. In addition, for both industries, I accessed data from all English-language news sources available on Lexis-Nexis for articles on the new product introductions. I also consulted incumbents' websites for the texts of previous press release announcements of new products. These data document the nature and timing of the different types of products commercialized by the incumbents against the backdrop of the unfolding technological change.

Between 1990 and 2001, Kodak introduced 45 digital cameras and five hybrid products. Kodak was also involved in a joint effort with Apple, resulting in the Apple QuickTake digital camera, which incorporated Kodak's CCDs. Kodak's hybrid products, i.e., offerings that allowed for image capture with film but provided a link between film inputs and digital formats, included Photo CD, the Advanced Photo System (APS) camera, Picture CD, You've Got Pictures, and PhotoNet. Photo CD allowed for the transfer of film images into a digital format provided on a CD, which could be viewed with a special player on a consumer's television. The APS camera (or Kodak's brand, Advantix) was developed in conjunction with Fuji Photo, Nikon, Minolta, and Canon. The APS camera used film for image input, but was considered an improvement over traditional analog cameras in several ways, including easier film loading and transfer to digital image files. Picture CD was a joint effort with Intel that allowed for image capture with film and transfer to digital image files by a photofinisher. You've Got Pictures was a joint effort with America Online (AOL) that allowed consumers to drop off rolls of film for processing and have their photos delivered to their AOL email accounts. Similarly, PhotoNet (beginning with Kodak's acquisition of PictureVision) allowed for film as the image input medium, but facilitated viewing, storing, transferring, and downloading digital image files. Kodak also introduced a new Max film brand and reintroduced its Gold film as part of rationalizing its film product lines. Tables 1 and 3 list the Kodak products introduced during the study period, categorized according to whether they were pure digital technology products or products that incorporated or linked to film technology.

Between 1991 and 2001, Polaroid introduced 13 digital cameras, most under the "PhotoMax" brand. Polaroid also introduced three hybrid products linking digital

and film technologies: a hybrid digital instant camera, a digital printing camera,³ and the I-Zone Webster, a portable digital scanner that allowed for transferring instant film photos to digital files. At the same time, Polaroid introduced several instant film cameras (neither digital nor hybrid digital/film), including the Popshots camera, a single-use instant film camera; the I-Zone brand of instant film cameras for children, including the PocketCam; and the JoyCam instant camera. Polaroid's products introduced are listed in Table 5.

In the wireline telecommunications setting, the RBOC incumbents introduced VoIP telephony offerings to respond directly to the new technology. In 2004, Qwest introduced OneFlex, a VoIP product aimed initially at businesses and later expanded to include residential service, and Verizon introduced its VoiceWing VoIP offering. SBC Communications introduced U-verse, which included VoIP phone service, in January 2005.⁴ The RBOCs' products and dates of introduction are listed in Table 7. In addition, beginning in 2002, the wireline incumbent firms began to pursue approvals from both the Federal Communications Commission (FCC) and individual states to provide long-distance wireline telephone services. This required "Section 271" applications and approvals, referring to Section 271 of the Telecommunications Act of 1996 (see <http://www.ntia.doc.gov/ntiahome/staffpapers/section271/summary.htm>). The RBOCs were able to enter the long-distance market if they could demonstrate that they had met guidelines allowing for competitive entry in their local telephone service area. As long-distance services use wireline technology, such products represent strategies that extend or preserve the existing technology, similar to the film-based products in the photography setting.

Data on Analysts' Reactions. To assess the securities analysts' reactions to the incumbents' strategies, I collected information from securities analysts' reports available online from Investext. The study includes five analysts covering the photography industry: Morgan Stanley, Prudential, Smith Barney (later Salomon Smith Barney), Paine Webber, and Credit Suisse First Boston, including 814 securities analysts' reports and 8,166 pages of coverage between 1990 and 2001. Reports for the four wireline telecommunications incumbents were collected from two brokerage firms, Morgan Stanley and Deutsche Bank, including 420 reports with 3,298 pages between 2002 and 2005. Although I attempted to find multiple analysts who consistently covered all the incumbents over the timeframe, the coverage is not complete. For example, there were no reports available from Investext covering Polaroid until 1997, and no reports available from Paine Webber on Kodak after 1993. Deutsche Bank did not initiate coverage on Qwest until 2005, and there are no reports from Morgan Stanley available on SBC Communications.

I assessed the analysts' reactions in three steps. First, I used the Adobe pdf search function to count all mentions of the products in analysts' reports.⁵ Second, I analyzed the specific texts associated with the product mentions to understand whether analysts' reactions were generally positive or negative. Third, I also noted the turning points in analysts' ratings (e.g., an upgrade from "Hold" to "Buy")⁶ and noted the justifications provided for the rating change in the first paragraph of the reports. I analyzed these texts to better understand whether and how the incumbents' responses to the technological change affected analysts' recommendations.

Findings—How Do Analysts React to Incumbents' Strategies?

Photography and Digital Technology

The results in the photography setting fall into two time periods. Between 1990 and 1996, reports from Investext were accessible only for Kodak, so I first consider the securities analysts' reactions to Kodak's response to digital technology. Following that, I discuss the analysts' reactions to both Kodak and Polaroid from 1997 to 2001.⁷

Reactions to Kodak's Strategies, 1990–1996. Table 1 shows counts of analysts' mentions of Kodak's products. While the Photo CD product is mentioned in the analysts' reports 38 times and the APS camera system (or Kodak's brand, Advantix) is mentioned 144 times, there are no mentions of Kodak's first digital camera,

Table 1 Analysts' Mentions of Kodak Products 1990–1996

Product name	Introduction date	Times mentioned in analysts' reports
Digital products		
DCS 100	May 1991	0
DCS 200	August 1992	0
NC 2000	February 1994	0
QuickTake	April 1994	1
DCS 420	June 1994	0
DCS 460	September 1994	0
DCS 465	October 1994	0
EOS DCS 1	February 1995	0
EOS DCS 5	February 1995	0
DC 40	March 1995	0
DC 50	January 1996	0
DC 20	May 1996	1
DC 25	September 1996	0
DCS 410	September 1996	0
Total times mentioned		2
General mentions of Kodak digital cameras		10
Film-based hybrid products		
Photo CD	1990: announced 1992: introduced	38
Advanced Photo System	January 1996	144
Total times mentioned		182

the DCS 100, in any securities analysts' reports. There is only one mention of any Kodak digital camera in any securities analyst's report near the end of this period, in June 1996. Smith Barney notes simply that: "Kodak introduced a digital still camera priced at less than \$350, the DC 20" (Smith Barney 1996b, p. 2). Similarly, there is only one mention of the Apple QuickTake camera, in April 1995, a year after its introduction, in a report from Morgan Stanley. It is clear from this comparison that securities analysts mention the digital products much less than the film-extending hybrid products.

One question that arises from this comparison is whether public information was available about Kodak's digital products. I searched the category of "All English-Language News" on LexisNexis and counted the number of news articles that discussed Kodak's digital cameras between 1990 and 1996. Kodak's digital cameras are mentioned by name in 493 news articles, with an average of 29 news articles covering each product. There are hundreds of news articles on the Apple Quicktake, and 116 of these articles specifically mention Kodak within the same article. For example, in April 1994, a *MacWeek* article notes that the QuickTake was developed with Kodak, and compares it to "Kodak's groundbreaking Brownie camera, which brought film photography to the masses..." (Hall 1994).

Information on Kodak's digital efforts also was available from the *Future Image Report*, which noted in October 1994: "Kodak's digital camera product line is now as extensive as it is impressive..." (Strickland 1995, p. 6). In all, Kodak's digital cameras were mentioned in the *Future Image Report* 645 times between 1993 and 1996. Thus, it appears that analysts' relative inattention to Kodak's entry and ongoing participation in digital technology did not stem from a lack of public information.

I also considered the possibility that although the securities analysts discuss each of the hybrid products frequently by name, they might refer to Kodak's digital camera activities more generally. I conducted a broader search for mentions of "digital," "electronic," or "filmless" in the text, specifically referring to Kodak's own camera offerings, to assess the frequency of discussions about Kodak's entry or participation in digital cameras. In all there were just 10 of these general mentions of Kodak's participation in digital cameras in the analysts' reports between 1990 and 1996. For example, in a 20-page report issued by Morgan Stanley in March 1995, there is one line referring to Kodak's digital camera activities: "The company now offers electronic cameras ranging in price from \$27,000 to \$700..." (Morgan Stanley 1995b, p. 3).

Yet at the same time, there are over 1,400 articles in the general news media between 1991 and 1996 that mention "digital camera" and "Kodak" within the same article, suggesting that information is widely available. In addition, numerous articles discuss the importance

of technological progress in digital photography and its potential implications for digital substitution and the demise of film. For example, a 1996 article with the headline “Cameras go Digital: Prices for Filmless Cameras Are Falling Fast” further notes: “One day in the not-too-distant future your point-and-shoot camera may go the way of the home movie camera and record turntable” (Henricks 1996, p. 97). Similarly, discussions about the likelihood of technological progress, eventual substitution, and Kodak’s visible efforts to respond are available to analysts at the time from *Future Image Report* (1993–1996):

Now it’s “taken the plunge” with its own DC 40. Clearly, a Kodak-branded product brings further legitimacy to the entry-level market. Kodak’s entry validates the under \$1,000 segment. (Shippey 1995, p. 2)

The DC 20 breaks new ground for Kodak in two ways: With an expected street price under \$350, it’s their first digital camera to be clearly targeted at consumers... clearly signals the company is willing to do what it takes in order to participate rapidly in what it perceives as emerging markets. (Shippey 1996, p. 6)

Thus, for several years after Kodak’s entry into the substitute technology, securities analysts covering Kodak pay much more attention to film-extending strategies and very little attention to the technological change overall and to Kodak’s ongoing participation with digital technology-based products. It is clear that information is widely available on both the increasing threat of digital technology and Kodak’s specific efforts to respond.

Beyond the comparison of counts of mentions, the content of the texts associated with the mentions of Kodak’s products also shows that securities analysts are consistently positive toward the hybrid products. For example:

Kodak’s introduction of the CD Photo system has contributed to better price performance for the stock. (Smith Barney 1990, p. 1)

We remain positive on the long-term prospects for the new Photo-CD... (Morgan Stanley 1991a, p. 3)

...there are excellent opportunities for Kodak and other film manufacturers to develop hybrid systems that combine the best characteristics of chemical and electronic imaging. The Photo CD is a good example of a hybrid system that we believe will extend the life of 35 mm film substantially. (Smith Barney 1991b, p. 12)

The Advanced Photo System... will be the most important development in the photography industry in 20 years. (Smith Barney 1996a, p. 3)

We believe the new camera and film system [Advantix Advanced Photo System] will stimulate higher-than-historical spending in the consumer photographic market in the developed world. (Credit Suisse First Boston 1996, p. 1)

These positive views of the strategies are further reflected in the justifications provided for upgrades in recommendations on Kodak’s stock. Although there are some downgrades in recommendations on Kodak’s stock, by 1996 the analysts are generally issuing “Buy” recommendations. Table 2 shows the justifications for the 12 upgrades to “Buy” or “Strong Buy” recommendations between 1990 and 1996. Echoing the content of the reports more generally, these justifications for more positive ratings rarely mention digital technology or Kodak’s efforts to respond to it. Instead, the justifications for rating changes reflect the positive views of the APS camera and the Photo CD, and further, the potential for stock buybacks, cash flows, and dividends associated with the film business.

In contrast to the positive sentiments about the hybrid strategies, securities analysts are more critical of Kodak’s pure digital products that provide no links to film. There is particularly strong evidence of a negative sentiment in the Prudential analyst’s reaction to Kodak’s digital strategies:

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 1994a, p. 7)

...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... (Prudential Securities 1995, p. 3)

...Longer term, Kodak should benefit from its strong cash flow, share buyback, APS rollout, and cost cutting measures. We are less impressed with its efforts in digital products... (Prudential Securities 1996a, p. 3)

While the Morgan Stanley and Smith Barney analysts are less critical than Prudential about Kodak’s digital technology efforts, there is also evidence from their reports that they perceive benefits from Kodak cutting costs and curtailing investments in digital strategies.

Thus, the findings suggest that securities analysts covering Kodak are attentive to—and approving of—activities that preserve and extend film technology. Analysts mention the hybrid, film-based products by name numerous times and provide positive assessments of their likely effects on Kodak’s stock. The film-extending products are mentioned frequently in the justifications for upgrades on Kodak’s stock. Yet the analysts rarely mention Kodak’s pure digital efforts, either by specific product name or more generally. These nonreactions are surprising, because Kodak’s efforts are likely to affect the current and future value of its stock as technological substitution unfolds. It is also clear that the lack of attention to digital technology does not reflect an absence of public information about the new technology.

Table 2 Excerpts from Analysts' Reports on Kodak—Justifications for Upgrades to Buy or Strong Buy Recommendations, 1990–1996

Date	Justification for rating
July 1991	...there is a good chance that Eastman Kodak will introduce a new consumer photographic system in 1992 or 1993. This system would be the first new format in the industry in 10 years. Historically, such new products have caused Kodak's stock to outperform the market on both an absolute and relative basis for a period of several years...we believe that this new system could significantly boost Kodak's share of the amateur photography market and stimulate demand.... (Smith Barney 1991a, p. 1)
December 1991	...belief that this company is really changing its stripes and that its cost-cutting efforts should improve margins in 1992 and again in 1993...investors should dwell on Kodak's determination to lower expenses. (Morgan Stanley 1991b, p. 1)
January 1992	We are raising our rating on EK...The rating change and the estimate increase reflects the following: A change in management's strategy to a moderate-growth low-spending approach, the impact of a sharp decline in the dollar in late December. Falling interest rates. The announcement of a larger-than-expected restructuring charge of \$1.476 billion...EK's valuation is attractive...EK is an inexpensive stock...a slower growth strategy should help build investor confidence.... (Prudential Securities 1992, p. 1)
January 1993	Chris Steffan joining as CFO...Signal a quantum leap in cost cutting and asset disposition...we have long contended that Kodak should nurture its cash cow instead of spending millions to try to grow.... (Prudential Securities 1993)
August 1993	Board fires Whitmore and we see cost cutting till the cash cows come home...We now believe...deeper cuts will be announced and implemented over the next 18 months. (Prudential Securities 1993, p. 1)
May 1994:	...we believe that the company's fundamental strength and 10% plus earnings growth should allow the stock to sell at a 10% premium to the market...on the strength of a new focus and aggressive leadership of the company, we have upgraded the stock...digital imaging accounts for almost none of the consumer photography market today, but Photo CD is a very attractive hybrid strategy for that market longer-term. (Smith Barney 1994, p. 1)
November 1994	EK has fallen to a level where we see sufficient upside...restructuring announcement and cost cutting program could bolster shares.... (Prudential Securities 1994b, p. 1)
January 1995	We remain believers that George Fisher and his new management team will be able to improve margins...Kodak has spent perhaps \$5 billion on R&D in digital imaging over the past decade and is applauded by industry observers for having top technology in several areas, including charge-couple devices (CCDs) which capture images in electronic cameras.... (Morgan Stanley 1995a, p. 1)
April 1995	Upgrade...on substantially higher estimated earnings. Very strong results in 1Q95 showed benefits of balance sheet restructuring, ongoing cost cutting, and favorable currency translations. (Smith Barney 1995, p. 1)
January 1996	Despite a dismal quarter—we think EK has become more attractive as a safe haven stock in a difficult economic environment...share gain will occur over the next 3–6 months as the hype surrounding the launch in APS starts in earnest...the rollout could cause a moderate increase in film sales...Olympics and election year should bolster film demand...stock buyback and strong cash flow...we also expect Kodak to increase the dividend. (Prudential Securities 1996a, p. 1)
December 1996	Massive market move makes Kodak's relative valuation attractive, especially against a decelerating economy...As a result, we believe the relative valuation of Kodak has become more attractive...we suspect Kodak will be able to keep the attention focused on the consumer arena, the relaunch of the Advanced Photo System...Kodak continues to be a huge cash flow story...those kind of numbers give investors comfort during times of uncertain economic outlook. (Prudential Securities 1996c, pp. 1–3)
December 1996	...the new camera and film will stimulate higher-than-historical spending in the consumer photographic market in the developed world...Kodak has cleaned up its balance sheet and is using free cash flow to benefit shareholders. (Credit Suisse First Boston 1996, p. 1)

Notes. EK = Kodak's stock ticker; CFO = chief financial officer; R&D = research and development; CCD = charge-coupled devices.

Reactions to Kodak's Strategies, 1997–2001. As shown in Table 3, during this period analysts mentioned Kodak's digital cameras by name 156 times. This increased attention compared to the earlier period does not occur until the last year of the study, however, when the Smith Barney analyst begins issuing a monthly "Digicam Directions" report covering market shares and sales in digital cameras, and mentions Kodak's cameras 113 times in that year. Thus, greater attention to Kodak's digital efforts begins to appear in analysts'

reports seven years after Kodak began commercializing digital cameras.

Despite the greater attention to Kodak's digital efforts during this later study period, there is still a marked contrast when compared to analysts' attention to the hybrid products. As shown in Table 3, between 1997 and 2001 the products based on film technology are mentioned by name over 2,600 times. Again, similar to the findings from the earlier period, there is extensive publicly available information about each of Kodak's digital

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Table 3 Analysts' Mentions of Kodak Products 1997–2001

Product name	Introduction date	Times mentioned in analysts' reports
Digital products		
DC 120	April 1997	3
DC 210	September 1997	4
DC 200	February 1998	0
DCS 520	February 1998	0
DC 220	May 1998	2
DC 260	May 1998	4
DCS 315	June 1998	0
DCS 560	September 1998	0
DCS 620	February 1999	0
DC 200 Plus	March 1999	1
DC 240	March 1999	2
DC 265	March 1999	2
DCS 660	June 1999	0
DCS 330	July 1999	0
DC 215	August 1999	15
DC 280	August 1999	4
DC 290	August 1999	3
DC 5000	June 2000	0
DC 4800	August 2000	12
DC 3400	August 2000	13
EZ 200	September 2000	4
DCS Pro Back	September 2000	1
DC 3200	October 2000	20
DC 3800	November 2000	0
MC3	February 2001	8
DCS 760	March 2001	0
DX 3500	May 2001	19
DCS 720X	June 2001	0
DX 3600	July 2001	13
DX 3900 Zoom	August 2001	6
DX 3215	September 2001	12
DX 3700	October 2001	6
Total times mentioned		156
Film and hybrids		
Advanced Photo System	January 1996	1,917
PhotoNet	February 1998	153
Picture CD	September 1998	212
You've Got Pictures	November 1999	105
Max or Gold film		246
Total times mentioned		2,639

technology products. During the same period, Kodak's digital cameras are mentioned by name in 932 news articles on LexisNexis, and also 924 times in the *Future Image Report*.

Here, as in the earlier period, the positive reaction toward film-extending strategies is further reflected in the analysts' justifications for positive recommendations. Table 4 shows excerpts of the justifications for the seven upgrades to a "Buy" or "Strong Buy" rating on Kodak's stock.⁸ Because a "Buy" recommendation reflects a positive outlook and the expectation that stock price will increase, these justifications highlight the factors believed to contribute to an appreciation in stock price and market value. With the exception of Credit Suisse First Boston, the upgrades are frequently justified with a discussion of film performance or the cash

flows, dividends, and share buybacks supported by the film business.

During this later period, despite relatively little mention of Kodak's specific digital efforts, there is a notable positive shift in the analysts' reactions to Kodak's efforts in digital technology, particularly by the Prudential analyst. The positive view of Kodak's digital efforts is generally consistent across the analysts. For example:

In our opinion, Kodak has the potential to dominate digital photography in the same way it has dominated traditional photography. (Credit Suisse First Boston 1999b, p. 3)

We believe that the company is moving in the proper direction . . . (Salomon Smith Barney 2000b, p. 1)

Although the analysts become more positive toward Kodak's digital strategies, these views are rarely included in the justifications for positive ratings on Kodak's stock. Moreover, despite the positive statements, the analysts still question Kodak's ability to compete profitably in this changed technological environment:

Despite our more positive stance, we still hold that longer-term fundamentals are shaky. Digital imaging is and will continue to cannibalize Kodak's highly profitable film business . . . we do not believe that profitability will match Kodak's film business. (Morgan Stanley 1999b, p. 2)

Reactions to Polaroid's Strategies, 1997–2001. The results of the analysis of attention to Polaroid's new- versus old-technology offerings are similar to the findings from the Kodak analysis. Table 5 shows Polaroid's products and counts of analysts' mentions. While Polaroid's digital camera products are mentioned 16 times, its film-related products are mentioned by name 629 times in analysts' reports. For example, the PDC-3000 digital camera is never mentioned in any securities analyst's report during this period, even though this camera is highly visible, winning industry awards for digital imaging from the Photo Marketing Association for the "best image/print quality, production level, features, and price" (*PR Newswire* February 20, 1998). In contrast, the C-211 Zoom (a hybrid product) is mentioned 41 times by name by analysts and is featured in a report by Salomon Smith Barney (2000c). Even more striking, the Popshots, JoyCam, and I-Zone PocketCam instant film cameras are mentioned by name 561 times in analysts' reports.

As in the Kodak findings, it is clear from these data that the securities analysts covering Polaroid attend to Polaroid's digital activities much less than they attend to Polaroid's film-based products. In addition, the relative lack of attention to Polaroid's digital offerings does not arise from a lack of publicly available information. There are 302 news articles discussing Polaroid's digital cameras by name between 1997 and 2001, and Polaroid's 13 digital cameras are mentioned 217 times by name in the *Future Image Report*.

Table 4 Excerpts from Analysts' Reports on Kodak—Justifications for Upgrades to Buy or Strong Buy Recommendations, 1997–2001

Date	Justification for rating
February 1997	We expect the shares of Eastman Kodak to continue to appreciate as a result of healthy EPS and cash flow growth.... (Morgan Stanley 1997a, p. 1)
May 1998	Our digital impact model demonstrates that the transition to digital should be manageable for Kodak... We believe the market is overacting to both the intensifying competition in the U.S. film market and the impact of digital imaging... we expect the stock to move on announcements that will clarify Kodak's digital strategy and in anticipation of improved financial performance in the second half of 1998. (Credit Suisse First Boston 1998b, p. 1)
May 1998	Advanced Photo System film and processing sales seem to have improved year on year. Most important we believe the company's cost cutting initiatives will be much deeper than anticipated.... (Salomon Smith Barney 1998, p. 1)
July 1998	... based on better than anticipated 2Q98 results and our increased conviction in Kodak's ability to improve operating returns over the near-to-intermediate term. (Morgan Stanley 1998b, p. 1)
July 1998	For the 1st time in over a year, Kodak took U.S. film market share... this should bode well for near-term price stability. (Prudential Securities 1998, p. 1)
February 1999	We believe Kodak is poised to dominate digitization and digital photography. It has increased its digital camera market share by 18% since its innovative new products were released in June.... We believe the imminent launch of Picture CD... and launch of "You've Got Mail" with AOL this summer will highlight the company's growth potential. (Credit Suisse First Boston 1999a, p. 1)
April 1999	This quarter's announcement suggests better use of cash with the announced buyback... and solid growth in the U.S. film business. (Morgan Stanley 1999b, p. 1)
May 1999	Kodak surprised the street with 1Q99 revenues up 4.7%, marking the first time EK has achieved a top-line gain in eight quarters. The longer-term outlook seems increasingly positive. We are raising our rating. (Salomon Smith Barney 1999, p. 1)

A closer analysis of the texts shows further that the securities analysts' reactions are also explicitly positive toward the strategies that extend film. For example:

We view the introduction of the C-211 Zoom as encouraging in that it exemplifies Polaroid's adaptation to the convergence of traditional (silver halide) and digital

imaging.... Moreover, with several more new products slated for introduction over the next 12 months, the ability to sustain top line growth going forward is enhanced.... (Salomon Smith Barney 2000c, p. 1)

Securities analysts are even more positive toward Polaroid's new instant film cameras. The analysts include lengthy reviews of Polaroid's new products in their reports, with particular attention to the instant film products (e.g., Credit Suisse First Boston 1997, 1999c; Morgan Stanley 1998a, 2000). Analysts further anticipate that these products will positively influence stock prices:

Polaroid plans to introduce 50 new products... Some of the more intriguing ideas that have captured our attention are a one time use instant camera [and] differentiated film products.... (Morgan Stanley 1997b, p. 2)

New products and new market segments should drive near-term growth in the core instant consumer photography business. The products that we saw give us confidence.... (Credit Suisse First Boston 1998a, p. 2)

A key driver of Polaroid's stock price will be the success of the new products, particularly the Pop-Shot Instant single-use camera.... (Credit Suisse First Boston 1998c, p. 2)

Based on the current trajectory of these new product launches, it's becoming clear that Polaroid is poised to deliver solid revenue growth over the next several years.... (Prudential Securities 1999a, p. 1)

We are upgrading Polaroid to Outperform from Neutral... based on new product performance.... (Morgan Stanley 2000, p. 1)

Table 5 Analysts' Mentions of Polaroid Products 1997–2001

Product name	Introduction date	Times mentioned in analysts' reports
Digital products		
PDC-2000	November 1997	4
PhotoMax PDC 300	November 1997	1
PDC-3000	August 1998	0
PhotoMax PDC 640	July 1998	3
PDC 700	May 1999	1
PhotoMax PDC 1000	August 1999	0
PhotoMax PDC 1100	February 2000	0
PDC 2300Z	September 2000	1
Fun Flash 320	September 2000	1
Fun Flash 640	September 2000	2
PhotoMax MP3	September 2000	1
PhotoMax PDC 640	February 2001	2
PhotoMax Fun! 620	July 2001	0
Total times mentioned		16
Hybrid and film products		
Popshots	February 1999	102
JoyCam	February 1999	159
iZone/ PocketCam	June 1999	300
C-211 Zoom	July 2000	41
I-Zone Pocket Combo	September 2000	18
Webster	December 2000	9
Total times mentioned		629

Although the securities analysts mention Polaroid's digital product offerings less frequently than hybrid or film camera products, analysts are generally positive regarding Polaroid's efforts in digital technology during this period. For example:

We believe the digital camera impact on the instant market has been overblown by the market. New instant products and strong digital offerings in commercial businesses should drive short-term top-line growth for Polaroid. (Credit Suisse First Boston 1997, p. 1)

Digital Is Nothing but Net for Polaroid... we continue to believe that instant is less susceptible to digital inroads, as the demographic profile of the typical instant camera user is significantly biased toward low-income users. (Credit Suisse First Boston 1998a, p. 2)

Digital continues to be a key driver for Polaroid. In fact, digicams should more than double this year, contributing to very strong growth... (Salomon Smith Barney 2000d, p. 4)

The positive view of Polaroid's instant film and digital businesses is further reflected in upgrades by three of

the analysts to "Buy" or "Strong Buy" recommendations in 2000, even as Polaroid is reporting negative earnings early in that year. Although Credit Suisse First Boston maintains a "Hold" rating during the period, the texts of the reports suggest the analyst is also quite positive about Polaroid's prospects in the face of digital substitution. The December 1997 Credit Suisse First Boston report on Polaroid includes a Porter's Five Forces Analysis listing conventional film photography as a potential threatening substitute, but does not mention digital technology:

In our opinion, Polaroid's consumer instant business is less vulnerable to digital imaging... consumer applications of digital photography will likely have a smaller impact on the instant photography market than on the conventional photography market. (Credit Suisse First Boston 1997, p. 2)

Table 6 shows the justifications for the seven upgrades in recommendations on Polaroid's stock between 1997 and 2001. The majority of upgrades are justified with attention to Polaroid's new product introductions and,

Table 6 Excerpts from Analysts' Reports on Polaroid—Justifications for Buy Recommendations, 1997–2001

Date	Justification for rating
March 1997	Polaroid plans to introduce 50 new products between July 1997 and December 1998... Some of the more intriguing ideas that have captured our attention are a one-time-use instant camera... The success of these new products and others like them is the linchpin of our investment thesis... Our outlook envisions Polaroid's instant film benefiting from the migration of original-image capture from silver halide films to digital technologies... Polaroid should be able to find a meaningful platform in the digital world. This digital evolution, combined with Polaroid's newfound focus on marketable product development, should translate into some intriguing product introductions (not limited to digital technology, however) beginning in the second half of 1997... catalysts to expand Polaroid's valuation parameters. (Morgan Stanley 1997b, p. 2)
December 1997	We are initiating coverage of Polaroid Corporation with a Buy rating... Recent weakness in Polaroid Corporation's stock price and the photography group as a whole reflects market concerns regarding the growing impact of digital imaging. We believe that investors are inappropriately grouping Polaroid's position relative to digital imaging along with that of Eastman Kodak. In our opinion, Polaroid's consumer instant business is less vulnerable to digital imaging based on the demographic profile of the typical instant user. Furthermore, we believe the company is poised to translate modest top-line growth into double-digit EPS and economic profit growth... Consumer applications of digital photography will likely have a smaller impact on the instant photography market than the conventional photography market. (Credit Suisse First Boston 1997, p. 1)
February 1998	New products and new market segments should drive near-term growth in the core instant consumer photography business. The products that we saw give us confidence... Our underlying growth assumption calls for 2%–3% growth in the instant business in developed markets... report is devoted to discussing the new products, mainly instant products... (Credit Suisse First Boston 1998a, p. 2)
July 1999	... with Polaroid right on the cusp of finally executing its new product rollout strategy... if the new products are ramping strongly, Polaroid could benefit from improved results over the next several years... (Prudential Securities 1999a, p. 1)
October 1999	... the realignment of Polaroid's noncore business is progressing... 2000 estimates are a lay-up—earnings increases appear likely... with the turnaround underway, we believe shares of PRD have substantial upside. (Prudential Securities 1999b, p. 1)
January 2000	We are upgrading based on the company's new product performance, improved balance sheet and current valuation. So... welcome to the I-Zone... we believe that I-Zone, along with other new products, may offer us revenue and earnings growth as well as continued improvements in cash flow generation. While Polaroid's I-Zone instant camera is the smash hit, several of the other new products are also doing well. (Morgan Stanley 2000, p. 1)
February 2000	... we expect new consumer products to continue to boost the top line, digital focus in mass merchant channels to pay off, and restructuring efforts to provide substantial operating leverage going forward. This is our first upgrade of PRD in five years. (Salomon Smith Barney 2000a, p. 1)

specifically, the new instant film products. Again, as with Kodak, it appears the analysts' optimism toward film-extending strategies translate further into "Buy" or "Strong Buy" recommendations.

Thus, in the photography setting, for several years during the unfolding technological substitution, analysts appear positive and enthusiastic particularly toward incumbents' efforts that extend the old technology. In both cases, the positive view toward film-based products is further reflected in justifications for several upgrades to "Buy" or "Strong Buy" recommendations even toward the end of the period as technological substitution is increasingly certain. The analysts rarely mention the incumbents' strategies to respond directly to digital technology.

The nonreaction to digital is surprising for several reasons. First, digital strategies required sizeable investments, likely to negatively affect current financial performance. Second, incumbent entry into the digital camera market is a direct response to the underlying and potentially disastrous threat of technological substitution, which further affects incumbents' prospects for survival and future financial performance. While an incumbent's entry into a new technology might signal increased chances of survival in the face of technological substitution, sales of products incorporating the new technology (i.e., digital cameras) also directly cannibalize the film profit stream. In addition, in this setting, many of the incumbents' products represent important technological improvements in price or performance that are likely to accelerate the adoption and diffusion of digital technology. For example, Kodak's DC 120 camera is an early entrant in the one megapixel category, marking an improvement in resolution performance for the consumer market. The DC 215 is a one megapixel camera for under \$400, marking an important improvement in price in the same market. These cameras also frequently have leading market share and win several awards, further suggesting that they are highly visible among consumers and other observers (e.g., Credit Suisse First Boston 1998b). An incumbent's direct participation in digital technology contributes to faster obsolescence of revenues and profits from a highly profitable film business. Given that securities analysts are charged with informing investors of events that affect a firm's current and future financial performance and stock price, we would expect analysts to provide opinions about the implications and appropriateness of incumbents' new technology efforts.

A possible explanation for the analysts' relative silence is that they might wait to mention the new technology products until revenues and profits materialize. Yet the analysts frequently mentioned the old technology products before those revenues or profits materialized. Similarly, one might question whether analysts typically mention a firm's individual products by name.

However, in the case of the photography incumbents, the analysts frequently mention the Photo CD, the APS (or Advantix) camera, and the Popshots, JoyCam, and I-Zone pocket cameras by name even before they are introduced. In both cases, analysts further propose (even before the products are available) that they will have a positive effect on stock price. In light of these tendencies, it is surprising that there is no corresponding commentary on the digital products. These contrasts further reinforce the overall finding that there is simply much more attention toward the incumbents' old technology efforts than toward the strategies incorporating the new technology.

Moreover, the securities analysts' optimism toward the incumbents' film based products was not generally associated with successful outcomes of these products or, more generally, with adaptation to the technological change. Industry observers questioned the appropriateness of the Photo CD and APS products as a response to digital technology as they were being developed. The products were discontinued shortly after introduction and considered failures, both as products in their own right and, more generally, as strategies to respond to digital technology.

Similarly, the analysts' attention to Polaroid's instant film products and optimistic recommendations do not reflect successful adaptation to the shift to digital technology. Polaroid's bankruptcy in October 2001 is attributed to its relatively late and inadequate response:

We believe that a variety of secular forces will continue to weigh on Polaroid, including cannibalization by rapidly emerging digital technologies...and slowing demand for some of the company's newer products.... (Salomon Smith Barney 2001, p. 2)

Polaroid Corp., which revolutionized photography with its instant cameras, filed for Chapter 11 bankruptcy Friday after failing to catch the latest wave in picture-taking technology—digital imaging...In recent years it struggled to adapt to the rising popularity of digital cameras as its instant film business slumped. (Pope 2001)

The Cambridge Massachusetts company, which introduced instant-imaging photography in 1947, still needs to find a way to recover from management errors that caused it to miss most of the digital-photo revolution. (Frieswick 2003)

Wireline Telecommunications and Voice Over Internet Technology

In the second empirical setting, wireline telecommunications, the results are similar. The incumbents' offerings and counts of analysts' mentions between 2002 and 2005 are listed in Table 7. There are no mentions of either Qwest's OneFlex or SBC's U-verse products in any of the analysts' reports and just one mention of Verizon's VoiceWing VoIP offering, one year after its introduction:

Table 7 Analysts' Mentions of Telecommunications Incumbents' Products, 2002–2005

Company	Product	Introduction date	Times mentioned in analysts' reports
VoIP-based products			
Verizon	VoiceWing	July 2004	1
SBC Communications	U-verse	2005	0
Qwest	OneFlex	June 2004	0
BellSouth	NA	NA	NA
Total times mentioned			1
General mentions of incumbents' VoIP-based offerings			16
Wireline products			
Section 271 (or long distance)			775

With Verizon's VoiceWing VoIP priced from \$30 (unlimited) to \$20 (500 min) per month, users can assemble a DSL/VoIP package for \$50–\$60/month, which compares favorably to offers from standalone VoIP providers like Vonage (\$25/month unlimited, but no broadband) and MSOs like CVC (\$60 HSD/telephony) and Time Warner (\$85 HSD/telephony). (Deutsche Bank 2005b, p. 1)

As in the photography setting, this lack of attention to the incumbents' strategies that respond directly to the new technology does not arise from a lack of publicly available information from the news media about the incumbents' specific offerings. Verizon's VoiceWing product is mentioned by name in 379 news articles, Qwest's OneFlex product is mentioned in 93 articles, and SBC Communication's U-verse product is mentioned in 87 articles by 2005. Moreover, dozens of these articles also discuss the general threat of VoIP technology for the RBOC incumbents. For example:

Calling via Internet has suddenly arrived. (Davidson 2003)

Internet phone service explodes in popularity, seen as threat to Bells. (Howe 2003)

Internet Phone Service Threatens Industry's Giants; Fearing Being Left Behind, Bells Develop Own Low-Price Plans that Transmit Calls over the Net. (Latour 2003)

For Whom the VoIP Bell Tolls; Failure to quickly respond to Internet telephony's rising popularity—at home and at work could cost incumbent telcos plenty. (Kharif 2004)

A disruptive technology: how the rise of internet telephony is shaking up America's communication giants. (Sevastopulo and Taylor 2004)

Heavy Toll: Phone Industry Faces Upheaval as Ways of Calling Change Fast—Cable, Internet, Wireless Hurt the Value of Old Networks, Threaten a Business Model—Echoes of Railroad's Ordeal. (Brown and Latour 2004)

I considered the possibility that analysts' discussions of the RBOCs' VoIP responses did not refer to specific products by name, and I searched more generally

for mentions of VoIP in relation to incumbents' product or service offerings. In all, VoIP was mentioned once in 2003, nine times in 2004, and six times in 2005 in the specific context of incumbents' offerings. These mentions appear primarily in the reports from Morgan Stanley covering Qwest. In general, these discussions of incumbents' VoIP-based offerings are very brief and are not linked to any assessments of the strategies or possible effects on financial performance or stock price. For example:

On VoIP, aside from its moves to spur deployment (eliminating access fees and providing local facilities to VoIP providers), Qwest plans its own business VoIP deployment. (Deutsche Bank 2004b, p. 4)

I further compared these reactions to the VoIP-based strategies with the analysts' reactions to the Section 271 applications and approvals for provision of long-distance services. In contrast to the 17 total mentions of the four incumbent's VoIP technology-based offerings, as shown in Table 7, there were 775 mentions of incumbents' Section 271 applications or efforts to provide long-distance services during the study period.

I then analyzed the content of the texts mentioning the strategies to determine if analysts were generally positive or negative. The findings are again similar to the photography setting. The mentions of the new technology strategies are infrequent and brief, but the reactions to the wireline-extending strategies are extensive, positive, and enthusiastic. For example:

...received FCC approval yesterday to enter LD...Big win for BellSouth...pendulum has again swung from the IXCs to the RBOCs... (Morgan Stanley 2002a, p. 1)

More momentum from long distance...Through bundling, we believe long-distance should prove to be an effective hedge against UNE-P. (Morgan Stanley 2002c, p. 2)

The benefit of long distance entry is all ahead for SBC...SBC is expected to become a massive cash generator, churning out \$10 billion-plus of free cash per annum, predividends, and share buybacks...we believe SBC offers by far the best value in the RBOC universe. (Deutsche Bank 2002, p. 2)

100% LD entry achieved...could have the effect of reducing access line losses and moving minutes back to the wireline network...could profoundly change the competitive dynamics in the telecom industry. (Morgan Stanley 2002b, p. 2)

...THE EMPIRE STRIKES BACK...things just got a whole lot more competitive...Verizon launched an unlimited local and long distance calling plan... This confirms our view that we are likely to move away from per minute pricing toward all you can eat buckets of local and LD calling...is a big deal for consumers and is the way of the future...most powerful impact will be to reduce churn and line loss...can now compete...with bundled offers. (Morgan Stanley 2003a, p. 2)

Table 8 Excerpts from Analysts' Reports on Wireline Telecommunications Incumbents—Justifications for Buy Recommendations

Date	Justification for rating
April 2002	We like the company's projected ability to generate solid free cash flow and delever the balance sheet, as well as the attractive 3.6% dividend yield. (Morgan Stanley 2002d)
November 2002	Initiating coverage with a Buy rating. The key message is that this is as bad as it gets. We believe that UNE losses peaked in 2002, with deceleration expected in 2003 and 2004. The benefit of long distance entry is all ahead for SBC...SBC is expected to become a massive cash generator, churning out \$10 billion-plus of free cash per annum, predividends and share buybacks...we believe SBC offers by far the best value in the RBOC universe. (Deutsche Bank 2002, p. 1)
January 2003	We are upgrading the shares of Verizon...the stock looks attractively valued and is showing significantly better operating performance than its peers...our industry view reflects reasonable valuations and strong Bell financials offset by weak demand and competition. (Morgan Stanley 2003a, p. 1)
April 2003	...we believe that BellSouth, with a 3.6% dividend yield, 5% cash yield (dividend and repurchases), and strong balance sheet represents the best value in our space. (Morgan Stanley 2003b, p. 1)
October 2003	We have upgraded our recommendation on Verizon to a Buy, for several reasons: Although VZ Wireless will exhibit similar trends to Cingular this quarter, the degree of diminution of...margins is unlikely to be as severe. We believe Verizon's wireline network will report revenues and earnings in between those of SBC and BellSouth. Pressure on revenue and operating margins should be lower when compared to SBC but greater [versus] BLS...it is unlikely there will be further near term shocks...the recent share price correction has brought VZ shares to a level at which they are trading below our DCF value of just under \$34/share...in the short-term, dividend yields and free cash flow should provide support, and we feel somewhat more comfortable residing in Verizon. (Deutsche Bank 2003d, p. 1)
February 2004	...We are also encouraged by recent cost cutting, headcount reductions, and the focus on portfolio rebalancing. As a result, Verizon is our top U.S. large cap pick. (Morgan Stanley 2004b, p. 1)
January 2005	Following recent sharp decline, we believe that VZ shares are starting to offer value...there appear to be 4 reasons for underperformance...announcement of steeper than expected '05 pension impact; VZ's higher exposure to cable VoIP, VZW although performing strongly faces tougher comps than Cingular, although VZ is more exposed to cable telephony than its peers, this will reverse over the next 2–3 quarters...unless a disaster is looming, we believe that over the next 3–6 months, VZ could deliver 10%–15% return. Longer-term we remain cautious on the RBOCs and continue to believe that competitive pressure will escalate through '05. (Deutsche Bank 2005a, p. 1)
April 2005	Recent share price weakness is gradually placing SBC shares into value territory, in our view...After factoring in 5% dividend yield, shares now offer 15% valuation upside...Catalysts: Cingular improving, UNE-P conversions, AT&T deal looks better...Highlight that over the longer-term, we maintain a negative stance on the RBOCs. The longer term performance of SBC (as well as other RBOCs) will be influenced by: (a) accelerating access line losses, due to cable telephony, nonfacilities based VoIP, and wireless cannibalization; (b) significant increases in operating expenses as RBOCs roll out video and entertainment products, which as we discussed in the past could lead to as much as 300bps–500bps margin erosion; and (c) significant increase in capital expenditure commitments... However, most of these negatives will not affect RBOC P&Ls until late 2005/early 2006, with an accelerating impact through 2006–2007. (Deutsche Bank 2005c, p. 1)

On the positive side...rising contribution from BLS's long-distance business...we continue to believe that longer-term this should be a highly profitable and strategically important business... (Deutsche Bank 2003a, p. 4)

Given that BellSouth has attained section 271 clearance across its entire footprint and is rolling out an increasingly competitive core product, we believe that it should be increasingly well-positioned to defend its core market... (Deutsche Bank 2003b, p. 3)

The FCC announced today that it has approved Verizon's s271 applications in the District of Columbia, Maryland, and West Virginia. With these approvals, Verizon becomes the second of the RBOCs (after BellSouth) to receive 271 approvals in all its home territories... We view the consumer bundle as a major customer retention tool for the RBOCs, something which should allow them to stem access line losses to UNE-P⁹ based competitors. (Deutsche Bank 2003c, p. 1)

As in photography, there are several upgrades to "Buy" recommendations on the four wireline incumbents'

stocks during this period. Table 8 shows several of the justifications for these upgrades. These texts include little mention of either VoIP technology or the incumbents' efforts to respond to it. Instead, they focus on enthusiasm for long-distance service provision, in addition to positive views about the short-term cash flows, dividend payments, and share buybacks enabled by the existing wireline technology. Thus, positive sentiments toward traditional wireline technology products and the associated profits and cash flows appear to translate further into positive recommendations.

Again, as in the photography setting, the general lack of reaction from analysts toward the incumbents' strategies to directly respond to VoIP technology is surprising. Against a backdrop of technological substitution, incumbent entry into providing products based on the new technology is an important event that may enhance survival and future performance, but also spurs faster cannibalization of the incumbents' own wireline revenues, possibly accelerating acceptance of the new technology,

diffusion, and substitution. Incumbent entry thus affects current and future financial performance, stock price, and market value. One would expect securities analysts to discuss these strategies, much as they discuss and assess the expected impact of the long-distance strategies.

Finally, also similar to the photography setting, the analysts' positive reactions to wireline-extending strategies do not reflect the longer-term success of either the offerings or successful adaptation to the technological transition. Despite the attention to and enthusiasm for long-distance, such services are also based on wireline technology, which is also threatened by VoIP technology and associated increasing competition from providers like Skype. Correspondingly, there is evidence that the analysts' positive reactions to long-distance subsided before the end of the study period:

...long distance subscribers are fast approaching saturation for the group. (Deutsche Bank 2004a, p. 3)

...long distance net adds continue to show signs of deceleration... (Morgan Stanley 2004a, p. 2)

...long distance revenue growth is all but over... (Morgan Stanley 2005, p. 2)

Discussion

This descriptive empirical study explores how securities analysts reacted to incumbent firms responding to radical technological changes in two contexts. The findings are consistent across industries, time frames, and multiple incumbents. Analysts were markedly more attentive toward the incumbents' strategies that extended and preserved the old technologies (film and wireline) than strategies that were based directly on the new technology (digital and VoIP). Second, analysts were markedly more positive toward strategies that extended the existing technology, such as Kodak's APS film camera, Polaroid's new Popshots and JoyCam instant film cameras, and the RBOCs' 271 applications for provision of long-distance services. Enthusiasm for these activities was further reflected in the justifications for numerous upgrades to "Buy" and "Strong Buy" recommendations. The findings provide some evidence that analysts were explicitly negative toward strategies to respond directly to the new technology, as in the case of Prudential's early reaction to Kodak's digital investments. However, the main finding is that analysts rarely mentioned the incumbents' participation in products based on the new technologies for several years after the initial technological discontinuities. Yet there were hundreds of news articles that discussed incumbents' new technology-related products by name and the potential implications of incumbent entry into the new technology, suggesting that the non-reaction did not arise from a lack of public information.

This work contributes to research at the junction of institutional theory, technological change, and strategy.

The findings suggest that the incumbents' efforts that complemented and extended existing technologies were viewed more positively by analysts—suggesting greater legitimacy—than the strategies to respond directly to the new technology. Because prior research shows that analysts' recommendations influence investors' behaviors and stock prices (e.g., Womack 1996, Zuckerman 1999), this suggests that incumbents may be rewarded (with increased stock prices) for a focus on strategies that extend and preserve the financial performance and cash flows from the old technology, even in the face of a threatening technological substitute. Because market value is constructed through investors' reactions to firms' actions (mediated by securities analysts), this study provides insights into the relationship between firms' challenges in responding to technological change and the creation of value. The strategies required for adaptation and survival in the face of technological obsolescence may be at odds with the strategies associated with value construction by analysts and investors. This has further implications for understanding the relationship between value creation and firm adaptation and survival, central topics in strategy and organization research.

In addition, this work contributes to institutional theory. Although a large body of work has explored the effects of external pressures on organizations (e.g., Thornton and Ocasio 1999, Tolbert 1985, Meyer and Rowan 1977, DiMaggio and Powell 1983, Pfeffer and Salancik 1978), research in the technological change literature has not studied the role of external factors on the challenges of incumbent response. Financial markets and the securities analysts who mediate them are potentially important sources of institutional pressures that affect managerial and organizational activities. This study thus provides insights into the possible nature and direction of these institutional pressures.

This research also highlights several fruitful directions for future research. First, there is a need to better understand the reasons underlying analysts' relative nonreaction to the new technology. This finding is surprising in light of a large body of research on technological change as well as research on the role of analysts as market intermediaries. A major technological change typically alters the industry profit model and can have devastating consequences for the financial performance of incumbent firms. Moreover, survival in the face of such changes often requires incumbents to make major investments to respond to the new technology. Taken together, these events are likely to have an important effect on short- and longer-term financial performance and survival, and therefore, on a firm's stock price. Given analysts' roles in providing information to investors on events likely to affect current and future stock prices, discussion of these critical events would be expected.

Existing research suggests possible directions for better understanding these nonreactions. It may be that the high uncertainty associated with eras of technological ferment leads analysts to wait until revenues or profits are directly affected. This is consistent with text from the analysts' reports that suggest they were aware of the performance improvements in the new technologies, but deferred their assessments of the financial performance effects until the effects were imminent. For example, texts in several reports illustrate analysts' increasing attention to predicting the performance improvements in digital technology that would accelerate technological substitution:

Due to price/performance issues, up until this point digital photography has not served as a replacement for traditional. On May 19th, LSI Logic announced the DCAM-101...the availability of such products could result in the first real trend toward substitutability of digital for silver halide in the consumer market. (Prudential Securities 1997, p. 6)

Foremost among the trends in the photography industry is the rapid transition from conventional to digital...Fuji unveiled a new 2.3 megapixel digital camera, redefining the high end of the digital camera space. The MX-2700 boasts a 2.3 megapixel CCD sensor... We believe Fuji's latest product introduction should hasten the cannibalization of conventional film technologies in favor of digitization. (Prudential Securities 1999c, p. 1)

Is 1999 the Year of the Digital Camera? Kodak and the industry as a whole witnessed an inflection point in digital camera sales during December 1998. The company sold about 475,000 digital cameras last year, the vast majority in December...we believe that digital camera demand could experience an inflection point over the next 12–18 months as ease of use, quality and cost converge to acceptable levels for the consumer. (Morgan Stanley 1999a, p. 4)

There is also evidence in the coverage of wireline firms that the analysts are increasingly aware of the threat of technological substitution. Although VoIP technology is not mentioned in the analysts' reports until April 2003, a year after Vonage's entry into the market, analysts increasingly note the possibility of technological change. For example, the Deutsche Bank analyst begins to incorporate the following general text in every report starting in 2004: "We believe that technology substitution, cross-platform competition, and changes in the regulatory environment are key investment risks for the stock."

Yet despite analysts' expectations that technological substitution will have negative implications for incumbents' financial performance, the analysts appear to ignore this in their forecasts and assessments of stock prices if short-term performance expectations are positive. For example:

The threat of electronic imaging hovers ominously over silver halide technology... [in another part of the same

report]... We recommend purchase of Kodak stock because of its attractive combined appreciation potential of 35% over the next year... Film sales are doing well, growth in profit is expected over the next several quarters due to cost savings, better pricing, favorable exchanges rates, and a generally better economy, and the dividend of \$2/share is safe. (Morgan Stanley 1992, pp. 1–4, 9)

... given that most of the answers are unlikely to be available for (at least) the next 12–18 months, the market would probably continue to focus on shorter-term news flow and earnings... (Deutsche Bank 2003e, p. 9)

... unless a disaster is looming, we believe that over the next 3–6 months, VZ could deliver 10%–15% return. (Deutsche Bank 2005a, p. 1)

The contrasts in analysts' reactions to the new- and old-technology strategies may also arise because valuing the new technology strategies is difficult within the traditional models used to value firms in the category. For example, APS, Popshots, and long-distance services are easier to incorporate within revenue and profit models based on film and wireline technologies than digital cameras and Internet telephony. In prior work, researchers have noted that the increased difficulty associated with valuation can lead analysts to drop coverage of firms (Zuckerman 1999, Moreton and Zenger 2005). Here it may be that analysts continue coverage, focusing on the strategies that fit the existing valuation model and downplaying strategies that are not easily valued. This approach may be feasible for several years, because technological changes are often a lengthy process and the anticipated decreases in revenue and profits, although increasingly certain, are longer-term.

In addition, other research highlights sources of bias in securities analysts' forecasts (e.g., Hong and Kubik 2003), specifically, the tendency for optimism toward the firms they cover (e.g., Francis and Philbrick 1993, Michaely and Womack 1999). In these empirical settings of technological change and very high uncertainty, it may be that analysts' optimistic tendencies and the influence of the incumbent firms lead analysts to avoid discussing the technological threat or the incumbents' entry into a more competitive and uncertain new technology.

A second promising area for future work is to better understand the appropriate way to value firms through a technological transition. The efficient markets view in finance suggests that all information affecting a firm's future financial performance and stock price will be incorporated immediately into its current stock price (Fama 1970; see also Shleifer 2000), yet a growing body of research suggests that investors and analysts may have a short-term focus that results in underweighting the longer-term sources of value in a stock (e.g., DellaVigna and Pollet 2005, Brav and Heaton 2002, Froot et al. 1992, Bushee 2001). It is important to understand how financial markets' valuation of firms during technological transitions corresponds to future value

after technological change, when the winners in the new technology emerge.

Future research should also assess how analysts' reactions affect incumbents' subsequent strategies in the context of technological change. Prior research has shown that analysts and shareholders influence firms' behaviors (e.g., Zuckerman 2000, Rao and Sivakumar 1999, Bushee 1998). Benner (2007) argues that pressures from the stock market and analysts may affect the strategies incumbents pursue to respond to technological change, e.g., by encouraging firms to spin off efforts in the new technology into a new entity. It may be that incumbents' tendencies, documented in prior research, to focus on extending and improving an old technology even in the face of a threatening substitute (e.g., Landes 1983, Cooper and Smith 1992) are directly encouraged by institutional pressures from analysts and the stock market. In addition, future research should explore how analysts' reactions affect firms' innovation more broadly, beyond the specific context of radical technological change.

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 new technology long before uncertainty about technological standards or new profit models is resolved. The challenges may be even greater than suggested in prior research, however, as analysts (and the investors they influence) may continue to reward firms for strategies that focus on extending and preserving an old technology. 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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Endnotes

¹The arguments and finding in this paper do not require that analysts be wrong or markets be inefficient.

²Where a firm's stock price is the discounted value of future cash flows (see Brealey and Myers 1984).

³The hybrid digital instant camera later became the I-Zone Combo Camera, introduced in September 2000, and the digital printing camera became the C-211 Zoom camera, a joint effort with Olympus, introduced in July, 2000.

⁴BellSouth did not introduce a residential VoIP product until December 2005, at the end of this study period.

⁵I searched on multiple permutations of the product names to ensure that I found all possible mentions.

⁶To facilitate comparison, I use "Buy" to refer to "Buy," "Overweight," or "Accumulate" ratings, "Hold" to refer to "Hold," "Equal-weight," or "Neutral" ratings, and "Sell" to refer to "Sell" or "Underweight" ratings.

⁷During the study period, actual substitution had not yet occurred as worldwide film sales were still increasing by the end of 2001. Industry observers and analysts generally consider 2002 the year that the price/performance of digital technology reached a level comparable to film for most consumers, and digital cameras began to cannibalize film sales (e.g., Rosenzweig 2001).

⁸Although there are downgrades to "Hold" during this period, there are fewer and these are quickly followed by upgrades. In sum, the durations of "Buy" ratings on Kodak are considerably longer. To illustrate, Credit Suisse First Boston rates Kodak a "Buy" or "Strong Buy" consistently from 1997 to the end of the study period. Morgan Stanley downgrades in February 1999, but then upgrades in April 1999, maintaining a Buy until October 2000. Similarly, Smith Barney also downgrades in February 1999, but upgrades a few months later and maintains a Buy rating until December 2000. Thus, recommendations on Kodak are generally positive through the period, so I focus on the reasons for these ratings.

⁹UNE refers to "Unbundled Network Elements," a form of regulatory-inspired competition that requires the RBOCs to allow competition in providing local wireline phone service.

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