Financial market reactions following technological discontinuities: A non-event study in two industries

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Abstract

A large body of literature has explored the challenges of technological change for established firms. Much of this work has focused on factors internal to firms, such as inertial routines or managers’ cognitive limitations that constrain the ability to develop new capabilities and hamper incumbent firms’ responses to new technologies. But institutional pressures arising from financial markets and the securities analysts who mediate such markets likely also play a role in whether and how incumbent firms respond to technological change. Yet we know little about how financial markets and securities analysts react as an incumbent firm is faced with a radical technological discontinuity that threatens to substitute for the technology underlying the current business. Understanding such reactions is critical, as they further influence firms’ subsequent strategies to respond to the technological change. In this paper I explore securities analysts’ reactions to incumbent firms faced by technological discontinuities in two industries: digital technology in photography, and Voice over Internet protocol (VoIP) technology in wireline telecommunications.
Since Schumpeter’s (1942) work on the influence of “creative destruction” on established firms, a large body of research has explored the effects of technological change on firms and industries (cf. Levinthal, 1992). Much of this work has focused on the challenges for incumbent firms faced with responding to radical technological change. This research suggests that much of the difficulty of adapting successfully to technological change arises from factors internal to firms, for example, from the difficulty of changing organizational routines or structures to develop new knowledge and capabilities (Leonard-Barton, 1992; Henderson & Clark, 1990; Cohen & Levinthal, 1990; Christensen & Bower, 1996; Benner & Tushman, 2002), the fear of cannibalizing the existing business (Reinganum, 1983), or managers’ cognitive limitations that further hamper a firm’s willingness to respond to new technologies (Tripsas & Gavetti, 2000).

But an incumbent firm’s response to a radically new technology is likely to also be influenced by factors outside of firms. Organizations may have the potential to adapt to technological change by developing new capabilities, yet firms’ responses are likely to be constrained or legitimated by institutional pressures (cf., DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Tolbert, 1985; Thornton & Ocasio, 1999). In particular, financial markets (and the securities analysts who mediate such markets) are an important source of both financial resources and institutional pressures for public firms in the U.S. (e.g. Rao & Sivakumar, 1999; Zuckerman, 2000). Zuckerman (1999) studied the influence of securities analysts on firms’ stock prices. This worked showed that the categories analysts use to evaluate stocks affect stock prices and the availability of financial resources. In turn, these reactions triggered changes in firms’ strategies to respond to analysts’ pressures (Zuckerman, 2000).
Securities analysts and stock prices can also influence incumbent firms’ responsiveness to a radical technological change. Successfully adapting to radical new technologies requires firms to devote more resources to develop knowledge and innovations in the new technology (e.g. Cooper & Smith, 2992). At the same time, technological discontinuities often disrupt taken-for-granted ways of making profits in an industry and usher in many new competitors (Utterback, 1994; Tushman & Anderson, 1986), dampening the financial performance of incumbent firms. Managers face the dual challenges of navigating a radical technological change while responding to ongoing pressures to “maximize shareholder value.” Benner (in press) argues that these characteristics of technological change lead to an “incumbent discount” when established firms take steps to respond to technological change.

We know little, however, about how public equity markets and securities analysts react as incumbent firms are faced with the first introduction of a potential substitute technology that threatens to destroy the value of existing capabilities. I undertake that task in this paper. I ask how securities analysts and financial markets react to a technological discontinuity in an industry, that is, the first commercialization of a radical technological change. This paper is part of a larger research stream aimed at understanding how financial markets influence incumbents’ strategic responses to technological change. I take a first empirical step in understanding the reaction to the initial technological discontinuity by providing a descriptive account of securities analysts’ reports on incumbent firms in two industries faced with a radical technological change.

Insight into how financial markets react to the technological discontinuities that threaten to destroy competences is important in furthering our understanding of the challenge of technological change for incumbent firms. In retrospect, these discontinuities are the initial triggers for technological substitution that threatens the performance and survival of established
firms. But as these important technological events occur, they necessitate managerial action and decisions to change strategy and respond appropriately. Because a firm’s stock price is viewed as an important signal both to guide managerial action and assess managerial effectiveness, it is critical to understand the signals that managers receive from financial markets and securities analysts in the face of technological challenges. In concurrent work, I empirically examine how financial markets and securities analysts further react as incumbents take steps to respond to the new technology.

The paper proceeds as follows. I first review prior work on radical technological change and in particular, the important features of such changes for thinking about the influence of financial markets. Following that, I draw from work in several fields, including finance, economics, accounting, and organizations to develop alternative views of the likely reactions of financial markets and analysts following a radical technological discontinuity. I then describe the two empirical settings and the study methodology, followed by the results. I conclude with a discussion of the implications of the research and directions for future research.

TECHNOLOGICAL CHANGE AND FINANCIAL MARKET REACTIONS

The large body of previous literature on technological change suggests that the most challenging forms of technological change for established firms are discontinuous, radical changes in technology (e.g. Abernathy & Utterback, 1978; Tushman & Anderson, 1986; Foster, 1984). Radical technological change involves a shift to an entirely new technological trajectory that offers the potential for a superior price and performance frontier for the products in an industry and threatens to substitute for the existing technology (e.g. Gatignon, et al, 2000; Abernathy & Utterback, 1978; Utterback, 1994; Tushman & Anderson, 1986). Examples of
technological substitution by radically superior technologies have been documented in many industries, including the shift from mechanical escapement technology to quartz technology in watches (Landes, 1984; Glasmeier, 1991), from steam to diesel electric in locomotives (Cooper & Smith, 1992), from electro-mechanical technology to electronic in calculators (Cooper & Smith, 1992) and from ice harvesting to mechanical technology in refrigeration (Utterback, 1994), among others. Although the initial discontinuity occurs when the new technology is first available in commercial form, the technological discontinuity does not itself immediately substitute for the existing technology. Instead, it triggers a period of rapid technological improvement marked by high uncertainty, the entry of many new firms, and competing product designs (Utterback, 1994; Tushman & Anderson, 1986).

The challenge for incumbent firms arises as these technological shifts destroy the value of an incumbent’s prior competences, that is, the accumulated knowledge and skills in the old technology (Tushman & Anderson, 1986). While in some cases, incumbent firms can ultimately respond successfully to new technologies (Mitchell, 1989; Tripsas, 1997), in many cases such shifts have disastrous consequences for the established firms that have been successful in the previous technological regime (Cooper & Smith, 1992; Utterback, 1994). The technological change not only triggers a need for new technological knowledge and capabilities appropriate for the new technology, but firm survival and success also requires weathering the period of rapid technological change and uncertainty (i.e. the “era of ferment”) triggered by the initial discontinuity (Tushman & Anderson, 1986). This period of rapid technological change is further characterized by growing financial pressures on incumbent firms, as the need for more and faster innovation requires more financial resources, and as the entry of many new competitors dampens financial performance in the new domain.
During eras of technological ferment, how financial markets react to incumbent firms becomes very important, as stock market signals, analysts’ recommendations, and the associated availability of financial resources affects whether and how incumbent firms respond to the technological change. Managers face pressures to increase the value of the firm’s stock, and such pressures affect firms’ strategies. Yet we know very little about how stock prices or securities analysts react to incumbent firms during periods of technological change.

Drawing from prior research across several fields, including economics, accounting, and finance yields differing views about the likely reaction of financial markets to incumbents faced with an initial threat of technological substitution. A small but growing body of research in economics and finance has begun to explore how financial markets react generally to revolutionary technological change. (Mazzucato, 2003) found that technological revolutions lead to more volatility in stock prices, and this volatility tends to be greater the more radical the technological change. Other researchers have argued that revolutionary technological changes trigger decreases in the stock prices for incumbent firms (Pastor & Veronesi, 2005; Hobijn & Jovanovich, 2001; Laitner & Stolyarov, 2003). For example, (Hobijn & Jovanovich, 2001) argue that the lower stock prices generally throughout the 1970s are explained by the advent of information technology and the failure of incumbent firms to adopt the new technology. Similarly, the efficient markets theory in finance (e.g. Fama, 1970; Malkiel, 2003; see also Zuckerman, 2004) proposes that the stock market is an efficient aggregator of information, and that current stock prices reflect all available information about events that will have an effect on a firm’s future value. These ideas suggest that perceptions of negative effects of technological substitution on incumbent firms’ future possibilities will be incorporated in an incumbent’s current stock price. Although technological substitution typically not a certainty at the time of
the initial discontinuity, the commercial availability of a viable product incorporating the new technology is an important event and provides updated information about the probability of future substitution. As technological substitution is known to often dramatically reduce or entirely destroy the future value of the incumbent firm’s existing knowledge and capabilities, all else equal, this event would be expected to affect the future value of a firm’s stock, and correspondingly, the current stock price of the firm based on discounting this future value. Thus, consistent with an efficient markets view, the initial advent of a radical technological discontinuity believed to be a substitute in the future, would be expected to be reflected in a lowered stock price.

This negative effect on stock prices is likely to be reflected further in how securities analysts rate an incumbent firm’s stock. Securities analysts play an important mediating role in stock purchases in public equity markets (e.g. Zuckerman, 1999; Schipper, 1991; Moreton & Zenger, 2005). “Sell-side” analysts influence investor behaviors by issuing periodic reports on the firms in the industry they cover and recommending whether to buy, hold, or sell a particular firm’s stock. Further, they provide commentary on factors likely to affect both the future financial performance and future stock prices of firms. The discontinuity that portends technological substitution is likely to also dampen analysts’ perceptions of future incumbent performance. These lowered expectations, in turn, trigger more negative ratings as they diminish the potential for a firm’s stock price to appreciate in the future. Moreover, as the technological discontinuity triggers lower current stock prices through its effects on investor behaviors (through the dynamics described above), it is likely to spur more negative ratings as analysts interpret the cause of these decreases. Thus, taken together, this research suggests that (all else
equal) both the stock prices of incumbent firms and analysts’ reactions to the incumbent firms they cover will be increasingly negative following a radical technological discontinuity.

However, other recent research offers reasons why technological discontinuities may not necessarily be reflected in stock prices or analysts’ recommendations when they occur. Recent work by DellaVigna & Pollet (2005) raises questions about whether investors attend to information that affects the longer-term performance of firms. They show that investors underreact to information about future performance, even when the future outcomes are known to be forecastable with high accuracy years in advance. Similarly, other research has also found that some institutional investors have relatively short investment horizons and react mainly to short-term earnings information (Bushee, 1998; 2001; Sharfstein & Stein, 1990) rather than longer-term fundamentals. This work suggests that markets and securities analysts, rather than reacting immediately to the information about potential substitution contained in the discontinuity, may wait until large-scale substitution actually occurs. Still other work suggests that investors and securities analysts may have difficulty valuing technological innovations given high uncertainty about the future (Amir, Lev, & Sougiannis, 2003), and these difficulties may translate into contexts involving general technological change. Researchers have also found evidence of herding behavior by both investors (Chevalier & Ellison, 1999) and analysts (Hong, Kubik, & Solomon, 2000), that is, ignoring ones own earnings forecast of beliefs about the future potential of a stock and following the investment strategies of others. Taken together, this research suggests that it is far from clear how financial markets and securities analysts will react when incumbent firms are faced with a radical technological discontinuity and the threat of substitution.
Prior research thus suggests ambiguous and possibly conflicting predictions about how investors and analysts to incumbent firms faced with technological change. A better understanding of these reactions is critical in providing insights both into the challenges and apparent failings of incumbent response. In the next section, I describe the descriptive exercise to better understand how these reactions unfold.

EMPIRICAL CONTEXT AND METHODS

I study the research question in two settings faced with radical technological discontinuities in recent years: the photography industry with the advent of digital technology, and the wireline telecommunications industry with the advent of Voice over Internet Protocol (VoIP) technology. The nature of technological change in these two settings shares many characteristics and also echoes much of the previous technological change literature. In both cases the new technology has the potential to offer a superior price and performance frontier over the previous technology, and hence, threatens as a substitute for the traditional technologies (film and analog in the photography industry, and wireline in telecommunications.) In addition, in both cases, it is clear that the new technology has the potential to make obsolete the main source of profits for incumbent firms and destroy the incumbent firms’ prior competences.

Digital photography involves charge coupled devices (CCDs) that convert light images to binary data. Digital imaging technology has the potential to dramatically improve the price-performance possibilities in the photography industry as digital technology offers the potential for better image resolution at lower cost, in addition to the added benefits of rapid digital manipulation, transfer, and storage through personal computers and the internet. At the same
time, digital imaging technology does not require film. Thus, the acceptance and diffusion of
digital technology among consumers threatens the profit stream the incumbent firms in film.

In the second empirical setting, the wireline telecommunications industry, incumbent firms face an increasing threat of substitution from VoIP (Voice over Internet Protocol) technology. VoIP converts analog audio signals (traditional hard-line calls) into digital data to be transmitted over the Internet. Thus, VoIP software turns an Internet connection into a method for phone calls that can be cheaper for customers as it bypasses the traditional wireline phone companies’ telecommunications networks. With traditional landline communications, the wireline telephone companies own the network that provides the information infrastructure for communications, creating a local monopoly position for incumbent firms in their respective regions. But with VoIP, customers can utilize internet service providers (ISPs) to make unlimited phone calls at a flat rate, bypassing the incumbents’ source of profits, similar to the impact of digital technology on film incumbents.

In both settings there is also evidence that industry observers and experts noted the importance of the new technologies early on and anticipated that the new technologies would substitute and dramatically challenge the future fortunes of existing firms in both industries (Future Image Report, multiple years, Dingman, 1991; Latour, 2003). In addition, the advent of these new technologies also triggered a flood of new competitors. The introduction of the digital photography ushered in many new entrants into the photography industry with digital camera products in the mid 1990s, including Canon, Minolta, Nikon, Agfa, Toshiba, and Sony, along with other digital camera developers such as Leaf Systems, Dycam, and Logitech (data from the Future Image Report, multiple years). Similarly, the advent of Vonage and its telephone service in 2002 triggered the entry of many firms into VoIP service technology including the incumbent
regional bell companies, cable companies, and other entrants such as Skype (Latour, 2003; Young, 2003).

The discontinuity in the photography industry, that is, the first commercialization of a digital camera product, occurred in May, 1991. Although it is generally accepted by both researchers and industry experts that digital technology represents a radical (i.e. superior substitute) and competence-destroying change, particularly for film manufacturers (Tripsas & Gavetti, 2000; cf. Tushman & Anderson, 1986; Future Image Report, multiple years), early digital cameras were initially too expensive to threaten consumers’ use of film. Early digital cameras offered superior resolution performance and the additional benefits of digital image transfer and storage but they were priced in the $20,000 - $30,000 range and targeted to professional photographers. Thus, the earliest instances of digital technology in commercial form did not trigger the immediate obsolescence of film. Following the initial discontinuity in the early 1990s, industry observers and experts began to speculate that a critical innovation for spurring diffusion of digital would be a digital camera available for under $1,000, a price level accessible to consumers (Future Image Report, 1993). This innovation occurred with Apple’s introduction of the QuickTake digital camera in April, for $749. The advent of the first digital camera for the consumer market triggered renewed speculation and expectations of substitution by digital technology.

The initial discontinuity concerning VoIP technology in the wireline telecommunications industry was the introduction of Vonage’s first product for VoIP telephone services in March, 2002. Following that, Skype entered in September, 2003, offering free software for VoIP telephone services.
Drawing on the idea of analysts as mediators in equity markets, I assume that analysts influence investors’ stock purchase behaviors and also reflect and interpret the factors affecting a firm’s stock value. To get insight into financial market reactions as incumbents face these discontinuities and their associated threat of substitution, I collected and carefully analyzed the periodic reports from securities analysts available on Investext. In addition to analyzing the texts of the equity analysts’ reports, I also compiled data on share prices for each firm, and noted the analysts’ ratings of the incumbent firms by month.

I analyzed reports for the photography industry from 1990 to 1996 to allow for capturing reactions to both discontinuities. As securities analysts cover the stocks traded in public equities markets, I searched for reports on the two public incumbent firms in the U.S., Kodak and Polaroid. Four securities analysts covered Kodak though much of this six year period, including Morgan Stanley, Prudential Securities, SmithBarney, and Painewebber. (Painewebber covered Kodak from 1990-1993, allowing me to capture only their reaction to the first discontinuity in 1991.) Unfortunately, although several analysts covered Polaroid starting in 1997 (allowing me to compare reactions to different firms’ response strategies in a companion piece to this work), no reports were available on Investext covering Polaroid during the period included in this study. Morgan Stanley issued 34 reports covering Kodak over this period, with a total of 551 pages of coverage; Prudential issued 108 reports with a total of 1,360 pages of coverage; Smith Barney issued 26 reports with 209 pages, and PaineWebber issued 28 reports with 433 pages. Thus, I used data from 196 securities analysts’ reports and a total of 2,653 pages of reports on the photography industry.

In the wireline telecommunications setting, I collected analysts’ reports from two investment banks, Morgan Stanley and Deutsche Bank, that covered three of the incumbent firms
(Verizon, Qwest, and BellSouth) from 2002-2004. This analysis involved 260 reports and a total of 2,163 pages of coverage (98 reports with 719 pages issued by Deutsche Bank, and 162 reports with 1,444 pages from Morgan Stanley).

I assessed the analysts’ reactions to these technological discontinuities in three ways. First, I simply searched the reports for mentions of the new technology. In the reports on photography, I searched for “digital” in relation to photography or imaging technology. In the reports on the wireline telecommunication incumbents, I searched for “VoIP” or “Voice over internet protocol” or “internet” in relation to telephone calls\(^1\). I counted the occurrences of mentions of the new technology in addition to carefully reading the context around the mention. This allowed me to understand both the timing of these initial mentions of the new technology, as well as the general reaction to the new technology. Second, I identified the turning points in analysts’ ratings of the incumbent firms (for example, from “Buy” to “Hold” or from “Sell” to “Hold”) and analyzed the justifications provided for these changes. Changes in ratings are noted in the first paragraph of the analyst’s report, followed immediately by the reason given for the decision to change the rating. An analysis of turning points in ratings and associated justifications allowed me to understand whether and how the technological discontinuity influenced analysts’ views of the incumbent firms. Beyond the analysts’ immediate reactions to the new technology, I also reviewed the data on stock price movements over the period and consulted the reports for analysts’ perceptions about the factors triggering such changes. This combination of approaches provided insights into three related issues: (1) how analysts react to the new technology; (2) the extent to which the advent of a new, threatening technology played a role in changes in ratings on an incumbent’s stock; and (3) the analysts’ beliefs about whether the advent of the new technology influenced changes in stock prices. In the next section, I

\(^1\) The text searches were not case-sensitive.
describe the results from these three analytical approaches for both of the industries in the study: photography and wireline telecommunications.

**FINDINGS**

**Digital Technology in the Photography Industry – 1990-1996**

First, I searched for the earliest mentions of digital technology in the reports on Kodak. It is interesting and surprising to note that digital technology was not mentioned in any of the reports by PaineWebber during the period it covered Kodak, from 1990-1993, despite the first introduction of a “filmless” digital camera in 1991. The earliest mentions of digital technology by the other three analysts occur in 1990 and 1991. But these mentions of digital technology pertain not to digital cameras or digital technology generally, but specifically to Kodak’s early announcement, in the fall of 1990, of its Photo CD product (to be available in 1992). The Photo CD was a “hybrid” product allowing for film images to be transferred to a digital file format and provided to customers on CD. The Photo CD offered a link between film and digital technologies and preserved a role for film technology for image capture. The specific texts of these first occurrences of digital are provided below:

At meetings in Tokyo, London and New York, Eastman Kodak introduced a major new imaging system, the Photo CD system. It allows photofinishers to transfer developed 35mm film negative images to a digital CD disk, which customers can then put in a player to display the pictures on TV…Kodak's introduction of the CD Photo system has contributed to better price performance for the stock. (Smith Barney, August 1990)

…The company’s mandate is to remain the world’s leader in imaging. Its strategy for accomplishing this goal is to create products that blend the best of both silver halide (analog) and electronic (digital) image making…The Photo-CD is Kodak’s first major move toward combining chemical and digital imaging… (Morgan Stanley, May, 1991)

Kodak is pinning its hopes on a hybrid imaging strategy that merges the older analog technologies with the newer digital modalities. Kodak hopes the result will be stability and even moderate growth in the analog silver halide businesses…Kodak offers the Photo CD…this strategy combines growth in the newer digital environment with coexisting growth in the older silver halide mediums…(Prudential, June, 1991)
It is interesting that none of the mid 1991 reports focus on the potential threat of digital imaging technology as a substitute for film, despite the advent of the technological discontinuities that threaten to trigger the eventual obsolescence of film. Moreover, each of these first mentions of digital technology appears to be spurred directly by Kodak’s own internal efforts. At the same time, Kodak is also commercializing non-hybrid digital cameras as a more direct response to the potential threat of digital technology. It introduces the DCS 100 digital camera in May 1991. The Associated Press’s article bears the headline: “Kodak introduces a filmless camera.” Yet although the securities analysts mention Kodak’s hybrid Photo CD product 38 times in reports during this period, the Kodak DCS 100 digital camera, likely an even bigger event for the future of Kodak, is not mentioned by any analysts in any reports.

Following the earliest mentions of digital technology in the reports around 1990 and 1991, the securities analysts are largely silent about digital photography for the next few years. Morgan Stanley doesn’t mention digital photography technology again for another three years, despite a total of 379 pages in 19 reports on Kodak between May 1991 and May 1994. Similarly, Prudential doesn’t mention digital technology again for two years, in 62 reports with 997 pages covering Kodak between June 1991 and 1993. Smith Barney mentions digital technology in one report in 1992, but not again until 1994. In the meantime, Kodak develops and introduces more digital (“filmless”) cameras: the DCS 200 in 1992, the NC 2000 in February 1994 (a camera for Associated Press photographers), and the DCS 420 in June, 1994. Other firms also introduce digital cameras during this time: Logitech introduces the Fotoman, Fuji Photo (Kodak’s major competitor in film) introduces the HC 1000 and DS 100 digital cameras in April, 1993 and Sony introduces the DKC 5000 February, 1994. Although the increase in entrants and digital cameras
likely also increases the threat and probability of eventual digital technology substitution, these digital cameras are not mentioned in any reports.

One reason for this relative silence about digital technology in the early years of the 1990s could be that industry participants and observers realized that at prices around $10,000 or very low resolution, the early cameras did not create a real threat for film in the consumer market. But the April, 1994 introduction of the Apple QuickTake represents a major step toward lower prices for digital technology and potential acceleration of technological substitution. The report from Future Image after a demonstration of the camera in February 1994 notes: The QuickTake 100 camera represents a quantum leap in image quality for the dollar in electronic still cameras. From an overall digital imaging perspective, it ushers in the simplicity of “point and shoot” photography…it’s $749 list price positions it as an affordable, fast, and easy-to-use image acquisition device aimed at the mass market…breakthrough price/performance (FIR, February, 1994). To assess the effect of this important innovation on analysts’ and market reactions, I again searched for mentions of this second discontinuity in the analysts’ reports on Kodak from 1994 to 1996. The QuickTake is mentioned only once by any of the four analysts between 1994 and 1996. It appears in a Morgan Stanley report on Kodak in April, 1995, following a presentation by Kodak management on its plans for digital technology, one year after the QuickTake introduction. The evident lack of awareness or interest in the QuickTake digital camera is also surprising because the camera resulted from a joint effort between Kodak and Apple Computer, and the digital chips (the CCDs) were manufactured by Kodak.

In contrast, Kodak’s Advanced Photo System (APS) camera was mentioned by name 144 times in reports by the end of 1996. The APS camera was an improved film camera developed jointly between Kodak, Fuji Film, Minolta, Nikon, and Canon, and launched in January 1996. It
was another element of Kodak’s hybrid strategy as it provided a link between film and digital. The contrast in analysts’ awareness is interesting: Although Smith Barney never mentions the QuickTake camera, it mentions the APS film camera 15 times in its two reports in 1995 and 22 times in its three reports in 1996. Smith Barney’s January 30, 1996 report even states: “Kodak and its partners will unveil the Advanced Photo System which we believe will be the most important development in the photography industry in 20 years.” (emphasis mine).

Again, between September 1994 and the end of 1996, Kodak introduces several new digital cameras, including the DCS 460 in September 1994, the DCS 465 in October 1994, the DCS-EOS 1 and DCS-EOS 5 (the result of a joint development venture with Canon) in February 1995, the DC 40 in March, 1995, the DC 50 in January 1996, DC 20 in May, 1996, and the DCS 410 and DC 25 in September, 1996. Each of these cameras represents improvements in both price and performance in digital photography, and thus accelerates the potential for replacement of film, yet the lone mention of any of these products in any of the analysts’ reports is in one line in a June, 1996 Smith Barney report: “Kodak introduced a digital still camera priced at less than $350, the DC20.” Scholars interested in the effect of technological change on incumbents might argue that the advent of an affordable filmless camera is a potentially more important development for the future of the photography industry than the Advanced Photo System film camera.

Thus, during the period from 1990 to 1996, despite two important discontinuities that increase the potential for digital substitution, analysts rarely mention the threat of digital technology for Kodak’s ongoing film business. Analysts refer to digital technology mainly in reference to specific products Kodak has developed, and in particular, the hybrid products designed to defend against eventual substitution. Even as digital technology is mentioned more
frequently by the analysts from 1994-1996, the vast majority of the analysts’ reports make no
mention of digital technology at all. Concerns about digital technology do not appear to figure
prominently in analysts’ assessments of Kodak’s future prospects between 1990 and 1996,
despite evidence that analysts are generally aware of the threat of substitution from digital
technology as indicated in this 1992 report by Morgan Stanley:

The threat of electronic imaging hovers ominously over silver halide technology, though
management still thinks film units will grow 5-7% per annum over the next several years. The
degree of success of the new miniaturized amateur photography system and the new Photo CD
will obviously influence film growth. (Morgan Stanley, August 1992)

As discussed above, I carefully analyzed the justifications provided for the specific
turning points in analysts’ ratings of the incumbent firms to assess the extent to which the threat
of digital technology appears to influence analysts’ recommendations on the incumbent’s stock.
Changes in ratings for Kodak by the four securities analysts are shown in Tables 1-4. Morgan
Stanley’s four rating changes and accompanying justifications between 1990 and 1996 are shown
in Table 1. The texts suggest both that the threat of digital substitution has very little influence
on the analyst’s recommendations during this period, and that Morgan Stanley is not becoming
increasingly negative about Kodak with increasing certainty of technological substitution. Only
one of the ratings change justifications, in January 1995, includes any mention of digital
technology. Moreover, at the time, Morgan Stanley is upgrading its rating on Kodak from a Buy
to a Strong Buy recommendation, justified by confidence in the new CEO (George Fisher from
Motorola). The more positive rating and the text also strongly indicate that Morgan Stanley
believes Kodak is undervalued relative to its future potential. One of Morgan Stanley’s rating
changes during the period is a downgrade, from a Buy to a Hold, in mid-1991, but the text
provided to justify the decision suggests this downgrade was spurred specifically by concerns
about the strength of the dollar (resulting from a revised Morgan Stanley economics group
forecast) and not by concerns about digital substitution. In addition, this downgrade occurs prior to Morgan Stanley’s first mention of digital technology. Thus, digital technology does not figure prominently in rating changes on Kodak over the period, nor does it seem that Morgan Stanley is incorporating any deep concerns about a threat of future digital substitution in its ratings. In addition, Morgan Stanley also raises also its forecasted annual growth rate for Kodak from 7% to 15%, again reflecting optimism about Kodak’s future.

Smith Barney changes its rating of Kodak five times between late 1990 and 1996, generally consistent with the changes in Morgan Stanley’s ratings and justifications. These changes are shown in Table 2. Only one rating change, in May 1994, refers to digital technology, and again, this is associated with an upgrade to a Buy rating. It is clear the analyst is optimistic about Kodak’s future prospects despite an awareness of digital technology. This rating does include an additional “high risk,” designation, but the specific risk is “uncertainty about the timing and magnitude of proceeds of dispositions and management’s cost cutting efforts,” and the issues surrounding an eventual obsolescence of film technology. In April 1995, Smith Barney again upgrades its rating on Kodak by revising this high risk designation to “medium risk.” Similar to the Morgan Stanley ratings, these changes reflect increasing optimism about Kodak’s future prospects even though Kodak’s stock prices are the highest they have been in five years.

In contrast to the relatively few rating changes of Kodak by Morgan Stanley and Smith Barney, Prudential changes its recommendations 11 times between 1990 and January 1996, as shown in Table 3. Similar to the previous reports, there are very few mentions of digital photography in the text accompanying changes in recommendations. Prudential’s first mention of digital photography technology in conjunction with a rating change occurs in the December 1993 report, when it downgrades from Buy to Hold. Although this downgrade reflects the threat
of digital technology and the potential for new competitors, Prudential’s negativity arises more specifically from Kodak’s own efforts to respond to digital technology rather than from concerns about a general threat of digital substitution for Kodak’s core film business. However, when Prudential upgrades its rating on Kodak from a Hold to a Buy less than a year later, in November 1994, digital technology is not discussed at all. The upgrade arises from expectations of short term benefits from restructuring. Similar to the other analysts’ reports at the same time, the optimism arises specifically from Kodak’s plans to divest its non-imaging related units.

A few months later, in February 1995, Prudential again downgrades Kodak to a Hold and mentions digital technology several times in the report. Yet, again, when it upgrades to a Buy a year later (January 1996, Kodak’s share price is now $67), there are again no mentions of digital photography technology in the report. Thus, it appears that Prudential is aware of the threat of digital technology as a substitute, and includes discussions of digital technology as added justification for downgrades in Kodak’s rating, but does not mention the threat of digital technology when ratings are upgraded. Text from an August 1992 report suggests a possible reason for this asymmetric treatment - positive sentiments about the stock arise from a focus on a short horizon rather than the long term:

We recommend purchase of Kodak stock because of its attractive combined appreciation potential of 35% over the next year... While we have reservations about Kodak’s long-term growth rate (which we tentatively peg at 7%), the company should post excellent double-digit EPS growth over the next several quarters, helped by some unit volume increases, cost savings programs, the divestiture of several losing product lines and favorable exchange rates.

Thus, despite a general awareness that Kodak faces future threats from digital technology, changes to “Buy” recommendations may rely on a shorter time horizon.

PaineWebber’s rating changes are shown in Table 4. As discussed above, PaineWebber does not discuss digital technology in any of its reports on Kodak, so it appears that the threat of digital technology does not influence its ratings of Kodak’s stock. Similar to the other analysts’
reports, however, a more optimistic outlook on Kodak arises from the promise of benefits from restructuring and divestment and a focus on Kodak’s core imaging businesses. Specifically, PaineWebber’s analyst becomes more positive with the increasing belief that Kodak will be restructured into a film-only company. Reports from PaineWebber on Kodak cease after May 1993.

By the end of the study period in 1996, all of the securities analysts are rating Kodak a Buy or Strong Buy. A Buy recommendation generally indicates that analysts believe the stock is undervalued by the market given its future opportunities, despite Kodak’s highest stock price in years. It is clear that the analysts are aware of the potential threat of digital technology for the future of the film business, but their positive recommendations during this period suggest the threat is not weighing heavily in their assessment of the incumbent firm. By 1996, digital cameras are increasingly accessible to consumers at lower prices and higher resolution performance. This continued improvement in price and performance is likely accelerating the shift toward digital. Yet in 1995 and 1996, Kodak’s analysts generally ignore the threat of digital technology and focus on short term reactions to Kodak’s successful efforts in divesting its non-imaging related businesses (for example, Sterling Drug) to allow it to focus more on its core imaging businesses. This seems paradoxical, given the increasing threat of technological obsolescence specifically for this core business. Yet analysts’ optimism and Kodak’s stock price appear to increase as a result of this continually narrowing focus. Prudential even states in early 1996 that Kodak’s stock should be seen as a ‘safe haven’ (see Table 3, Prudential, 1996).

Finally, I analyzed the changes in stock prices over the period and the analysts’ interpretations of these changes. Kodak’s stock price, shown in Figure 1, nearly doubles in value from $40 in 1994 to $80 by 1996. Analysts appear to attribute the growth in stock price to a
positive reaction to Kodak’s divestitures and subsequent narrower focus on the film business. This suggests further that the stock market (i.e. investors) is not yet reacting to the threat of digital technological substitution.

Despite important technological discontinuities in photography, the threat of technological substitution and possible obsolescence of the film business is clearly not at the forefront of analysts’ recommendations or investors’ behaviors concerning Kodak’s stock. These results contrast with a priori expectations that an incumbent’s stock price will decline with an increasing probability of technological substitution and the eventual obsolescence of Kodak’s core film business and profit stream.

Voice Over Internet Protocol (VoIP) technology in the wireline telecommunications industry – 2002-2004

I conducted a similar analysis of the VoIP technological discontinuity in the wireline telecommunications industry. Similar to the photography industry, I first searched for the earliest mentions of Voice over Internet Protocol (VoIP) technology and the contexts of those occurrences. I then looked for evidence of influences of an anticipated future threat of VoIP in turning points in analysts’ ratings. Finally, I analyzed general movements in incumbents’ share prices over this period and looked for insights into the causes from analysts’ interpretations of those changes.

There are no mentions of VoIP technology in any analyst report on the three wireline telecom companies until October 2003, over a year and a half after the March, 2002 discontinuity represented by Vonage’s entry into the market. DeutscheBank mentions VoIP technology at this time in its reports on both BellSouth and Verizon:

The combination of continuing wireless substitution pressure, emergence of cable telephony (from late 2004 onwards) and VoIP (including voice over DSL) … will (in our view) continue to
pressure operating performance and force increasing price discounting, greater marketing expenditure and (potentially) rising capital investment. We maintain our view that there is at least a 50% chance that BLS' free cash flow will actually decline over the next 2-3 years, placing a greater question mark over its ability to continue and/or increase dividend pay-outs. The better than expected 3Q03 result prompted us to revise our 2003-04 forecasts up by around 4%... (Deutsche Bank, report on BellSouth, October 23, 2003)

...We maintain our view that the investment thesis for the RBOC group (including Verizon) essentially boils down to one's view of the degree to which the core wireline business is likely to come under pressure and how well positioned each individual RBOC is to defend its customer base and reshape its business model. On the negative side, we believe that Verizon will continue to suffer from: 1. Erosion of access lines and continuing decline in retail customer base. This will be driven by an ongoing cross-platform (i.e. wireless, cable, broadband) and regulatory-inspired (i.e. UNE-P) competition as well as technology substitution (i.e. cable telephony, VoIP, voice over DSL etc) ... Although it is not clear how the above positives and negatives will play-out, we maintain our view that there is at least 50% probability that we are currently over stating both revenue and earnings potential of the RBOC's (including Verizon) ... (Deutsche Bank, report on Verizon, October 29, 2003)

In these two reports, it is clear that Deutsche Bank views VoIP technology as one potential substitute for the wireline services businesses of the Regional Bell Operating Companies (the incumbents in this industry). However, it is also interesting to note that even though Deutsche Bank’s analyst recognizes this threat and employs cautionary language, the resulting forecasts do not appear to account for the eventual effects of substitution. The apparent threat of new technologies does not appear to affect ratings either. For example, at the time of the above quote, Deutsche Bank is recommending a Buy on Verizon’s stock, indicating optimism about the firm’s future potential and expectations of an increasing stock price.

Morgan Stanley first mentions VoIP even later, in a report covering Qwest in November 2003. In that report, VoIP is mentioned only in a bulleted list of three “positives” from the third quarter: “VoIP – will begin offering services in Minnesota in December with deployment elsewhere throughout 2004.” Morgan Stanley’s first mention of VoIP in a report on Verizon is not until January, 2004, and is again included in a list reflecting activities Verizon has underway. In this report, VoIP is included in a list of questions for management asking for more information: “VoIP...a better understanding of these growth projects within the context of the
overall capital budget. Timing and launch? Pricing?” Morgan Stanley’s initial mentions of VoIP are similar to the photography context described in the previous section, as they appear to result from internal efforts already underway in the incumbent firms to address the threat of the new technology.

Also, similar to the photography context, there are relatively few mentions of VoIP in the years following the discontinuity. The above quotes are Morgan Stanley’s only mentions of VoIP between 2002 and January 2004, (1 report out of 35 on Verizon and 1 report out of 43 on Qwest. Morgan Stanley doesn’t mention VoIP at all in any of its 37 reports on BellSouth in these two years. Similarly, the above quotes from Deutsche Bank are its only mentions of VoIP in 22 reports on Verizon, and 15 reports on BellSouth between 2002 and January 2004. Moreover, although VoIP technology is increasingly mentioned during 2004 by the analysts, still the vast majority of reports (85 out of 109 total reports) do not mention the new technology at all. This indicates that the threat of VoIP technological substitution is not at the forefront of analysts’ discussions about these companies. In fact, there are no mentions of Vonage in any reports in 2002 and 2003 and no mentions of Skype in any reports during the period.

Again, as in the photography industry, I next analyzed the specific turning points in analysts’ ratings of the incumbent firms and the justifications provided. This helps illuminate whether and how the underlying threat of VoIP substitution appears to influence analysts’ ratings of the regional bell companies. The justifications provided by the analysts for the rating changes are shown in Tables 5 through 9. There are no mentions of VoIP technology in any of the stated reasons for changes in recommendations by any of the investment banks between 2002 and 2004, despite the entry of Vonage in the market in 2002, its growing base of internet telephone subscribers during the period (from 7,781 in 2002, to 85,717 in 2003, to 390,566 in 2004, to
1,269,038 in 2005 (Vonage.com timeline), and the advent of the much-lauded (in the business press) introduction of the free Skype VoIP software in 2003.

As shown in Table 5, Morgan Stanley changes its ratings of Verizon three times during the period. Optimism and corresponding Buy ratings appear to be driven by expected cash flows and dividends. The downgrade in Morgan Stanley’s rating in 2002 does not seem to be driven directly by fear of future technological substitution, but by a belief that the market has already driven up the price of Verizon’s stock too high (suggesting that the market is not discounting Verizon on the threat of technological substitution at this time either). In February 2004, Morgan Stanley again upgrades to a Buy rating.

Deutsche Bank’s ratings on Verizon are shown in Table 6. Deutsche Bank starts with a more negative recommendation than Morgan Stanley, a Sell rating in 2002, on a belief that the stock is overpriced because of previous market optimism about Verizon, again suggesting that the market is not discounting the stock for technological substitution. By October 2003 (at the same time as Skype’s introduction of free VoIP software), Deutsche Bank has also upgraded Verizon to a Buy. The reasons are similar to those provided by Morgan Stanley at the same time; driven by a focus on cash flow and dividend yields, coupled with a belief that the current price of the stock undervalues its future potential. Deutsche Bank again downgrades Verizon’s stock to a hold in September, 2004, arguing that the market has driven up the current price of the stock too high. Again, as noted above, none of these changes in ratings involve discussions about technological substitution.

Tables 7 and 8 show the few ratings changes over the 2002-2004 period for BellSouth. Deutsche Bank never changes its recommendations on BellSouth, rating it a Hold throughout the period with the justification that it is fairly valued. Morgan Stanley changes ratings on BellSouth
just twice during the period. Justification for these changes include the upside potential of cash
flow and dividend yields, weighed against the downside of a stock price that is already too high.

Finally, ratings of Qwest by both banks are shown in Table 8. Morgan Stanley maintains
a Sell rating on Qwest throughout the period because “…the company remains under
investigation by the SEC and the DOJ. The Qwest region is experiencing great weakness. We
believe there is significant risk for equity holders.” In contrast, Deutsche Bank raises its rating of
Qwest from a Sell to a Hold in March 2004, with the justification that the stock price has fallen
(and now has upside potential) for reasons not related to fundamentals.

None of these changes in ratings on Verizon, BellSouth, or Qwest appear to be directly
accounting for the future threat of VoIP substitution and eventual obsolescence of the wireline
business. It is clear that the analysts covering the wireline incumbents are aware of VoIP and its
potential threat to substitute for the traditional wireline technology. But it is also evident from the
general absence of mentions of VoIP in the turning points in ratings and the late and relatively
sparse mentions of VoIP in the texts of these reports generally that the longer-term impact of
VoIP is not factored into the companies’ stock valuations or recommendations in the two years
following the first commercialization of the new technology. Optimism about the stocks during
the period arises from expectations about the near term benefits of strong cash flow (from the
traditional wireline business) and dividend payments. A reason for the apparent absence of
interest in technological substitution is suggested in the text of an October 2003 Deutsche Bank
report on Verizon and echoed in many other reports during the period:

…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. In that
respect, we believe that Verizon's 3Q03 result did not provide any shocks and should not lead to
any significant further downgrades to either 2003 or 2004 forecasts…
Thus, there is evidence that although analysts are aware of the potential threat of the new technology, they are focusing on a shorter-term horizon in their recommendations because they believe that the market (i.e. investors) will take a similar approach. The above statement indicates further that the analyst believes the potential longer term impact of VoIP on traditional wireline businesses is not reflected in current stock values. Stock prices appear to reflect investors’ reactions to short term performance, rather than longer term information about new technologies or the threat of technological substitution. Thus, it appears that the recommendations analysts make in the shadow of this longer-term threat are based on the data they believe will drive stock prices in the near term.

Changes in stock prices for the three wireline telecommunications incumbents are shown in Figures 2-4. It appears that there are some declines in the wireline companies’ stock prices in mid 2002, but it seems that these decreases were underway prior to the advent of the Vonage offering. I tried to assess whether analysts attributed this decline to the threat of technological substitution, and specifically, to VoIP by searching the analysts’ reports for their interpretations of the cause of this drop in stock prices. The analysts issued no reports on the RBOCs during the period between April and November, 2002, during these price drops. A single reference to changes in stock prices in 2002 is included in a Deutsche Bank report on BellSouth in November, 2002:

…it clear that there has been a game over the last few quarters whereby the RBOCs have been lowering their forecasts and taken a battering from the market. When these reduced expectations are met at the quarterly reporting stage, the share price then rallies…

This suggests both a reason for the price decreases that is not related to the threat of technological substitution, as well as insights into what the analysts believe is driving stock price changes for the wireline incumbent firms. In addition, since these decreases occur long before
the analysts first mention voice over internet protocol technology, it is unlikely that they would attribute any changes to that event.

There are several striking similarities between analysts’ reactions to the technological discontinuities in photography and wireline telecommunications. First, there is very little attention to the potential future ramifications of the new technology in the years following the discontinuity. This is reflected in the delay in mentioning VoIP technology in the reports on the RBOCS, and relatively few mentions of the new technologies in both industries for several years and in the apparent absence of accounting for the technological change in decisions to upgrade to a Buy or Strong Buy rating. In both industries, there is evidence that although the analysts are clearly aware of the new technology and believe that it will directly and negatively affect the future performance and survival of the incumbent firms, the stocks of these incumbents are generally upgraded to a Buy or Strong Buy in the years following the discontinuity.

DISCUSSION

In this paper, I take a first empirical step in a research program to better understand how financial markets react to, and ultimately influence, incumbent firms faced with radical technological change. I explore analysts’ and stock price reactions to industry incumbents following a technological discontinuity that threatens to substitute for incumbents’ underlying technology and profit model. For managers, technological discontinuities are often dramatic and challenging events, and as they occur and further unfold, managers are challenged to make important decisions about strategic responses to navigate these critical junctures. Yet in these two quite different industries, these major discontinuities appear to play a very minor role (if any) in securities analysts’ perceptions of the future prospects for the firms they cover.
These results are surprising and interesting for several reasons, and have important implications both for research in technological change and management practice. Ideas drawn from efficient markets theories in finance suggest that the information contained in technological discontinuities would be reflected in incumbent firms’ current stock values as they occur. Granted, whether an initial technological change will ultimately substitute in an industry is highly uncertain, even if a product incorporating the technology has been successfully commercialized. But over time, additional information both about the price/performance frontier of the technology and about the diffusion of the technology becomes available and provides greater certainty about the potential for substitution. Yet in this study, the technological threats of digital photography and Voice over Internet Protocol for telecommunications services do not appear to be incorporated into the incumbent firms’ current stock prices even as long as two years after the discontinuity. In both settings, additional information about the improved technology and greater certainty of substitution unfolded during the study period. For example, digital cameras underwent rapid improvement, offering superior resolution at lower prices, and sales of digital cameras grew continually. Similarly, Vonage’s base of VoIP subscribers grew from 8,000 to nearly a million in three years, yet this additional information did not appear to trigger a more pronounced reaction in either stock prices or analysts’ ratings. It is also clear from the evidence that the potential for technological substitution is not incorporated into analysts’ interpretations of incumbents’ future potential or their “Buy” and “Sell” recommendations as very little space is devoted to even mentioning the new technologies in thousands of pages of reports. Analysts, reflecting expected stock market (investors’) behavior, remained generally positive on these incumbent firms in the early years following the discontinuity, driven by strong cash flows, cost cutting plans, and dividend payments. These
results are also surprising because at the same time that there is little attention or apparent awareness from analysts, there is growing attention to the new technologies in the news and business press, and increasing speculation that these technologies threaten the incumbent firms.

The study findings have further implications for how incumbent firms respond to a technological discontinuity. Efficient markets theory suggests that discontinuities will trigger an adjustment in the stock prices of incumbent firms. But the firms in this study do not appear to suffer an adjustment in their stock prices on the event of the discontinuity or subsequent acceleration of technological substitution. These findings are consistent with recent work highlighting the very short term focus of investors and failure to account for the future effect on stock prices of even very certain events before they unfold. An early adjustment in stock prices would serve as a baseline scenario reflecting an incumbent firms’ future performance in the face of the eventual obsolescence of its existing business if it does not make any effort to respond to the new technology. In turn, subsequent response strategies by incumbents would trigger additional stock price changes that could be compared against this baseline. In that case, responding to the new technology might be perceived as beneficial, as even though short-term performance is dampened by investments in the new technology and increased competition, future performance would be enhanced relative to the non-response case. Thus, the absence of an early reaction to the underlying exogenous technological change has further implications for how stock prices and analysts will react to investments or changes in financial performance that result as the technological change unfolds. It is more difficult to determine whether subsequent changes in incumbents’ stock prices are “signaling” a need for a change in strategy, or simply reflecting the underlying base rate of decline in the traditional technology as substitution actually unfolds. Further, the findings from this study suggest considerable uncertainty about when financial
markets and securities analysts will begin to adjust their expectations for incumbents’ future potential with a resulting effect on stock prices.

This work contributes to research by enhancing our understanding of the challenges of technological change for incumbent firms. Researchers have highlighted managerial failings in developing new capabilities or being aware of technological changes, but the role of financial markets and securities analysts has not been studied. The findings in this paper suggest instead that the managers of these incumbent firms have already begun to take steps to respond to the new technologies before the new technologies are mentioned by analysts. In contrast to prior research that highlights the role of inertia in developing new capabilities or managers’ outdated mindsets, (e.g. Tripsas & Gavetti, 2000), managers here are aware and reacting to the new technology long before financial markets and analysts begin to react to the implications of the underlying technological change.

Beyond this empirical work, it is also important to understand how financial markets react specifically to incumbents’ strategies to respond to the technological change. In concurrent work in this research stream I explore this question by analyzing how the stock market and securities analysts react to different strategies adopted by incumbent firms to respond to the technological change. In future work, it is also important to better understand how these reactions constrain or enable incumbents’ subsequent responses. This work also raises many questions for future research about analysts’ and investors’ understanding of technological change and about whether the stock market is an efficient aggregator of information on technological change.

This work also has implications for managerial practice. Managers are faced with pressures to maximize shareholder value and expected to increase share prices and returns for
their shareholders. Stock market reactions are believed to be important signals that make managers more responsive and adaptive to environmental conditions. Yet it is not clear how the stock market or analysts react to incumbent firms faced with major technological discontinuities. Managers must exercise care in interpreting and relying on these signals from financial markets and securities analysts in successfully navigating technological change.
REFERENCES


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Morgan Stanley reports on Kodak, multiple years 1990-1996.
Morgan Stanley reports on Verizon, BellSouth, and Qwest, multiple years, 2002-2004


PaineWebber reports on Kodak, multiple years, 1990-1993.


Prudential Equities reports on Kodak, multiple years, 1990-1996.


SmithBarney reports on Kodak, multiple years, 1990-1996


### TABLE 1
Morgan Stanley’s ratings changes on Kodak – 12/90 – 3/97

<table>
<thead>
<tr>
<th>Date</th>
<th>Rating</th>
<th>Price</th>
<th>Comments or reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/14/90</td>
<td>Hold to Buy</td>
<td>$42</td>
<td>We think the shares are selling at too great a discount to the S&amp;P 400 and continue to think they can rise in value...some technological risk from electronic imaging...</td>
</tr>
<tr>
<td>3/20/91</td>
<td>Buy to Hold</td>
<td>$44</td>
<td>we are now concerned that our 1991 earnings projections may be too optimistic...Morgan Stanley’s economics group now forecasts that the dollar will continue to gain strength, a reversal of its pronouncements earlier this year. A rising dollar hurts Kodak’s reported results...</td>
</tr>
<tr>
<td>12/19/91</td>
<td>Hold to Buy</td>
<td>$45</td>
<td>…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.</td>
</tr>
<tr>
<td>1/26/95</td>
<td>Buy to Strong Buy</td>
<td>$49</td>
<td>We remain believers that George Fisher and his new management team will be able to improve margins, earnings and eventually even sales growth. While turning around this lumbering giant will not be easy, we believe patient investors will be well-rewarded. In fact we still think this stock could double in price by 1998.</td>
</tr>
</tbody>
</table>
### TABLE 2
SmithBarney’s ratings changes on Kodak – 11/90 -7/96

<table>
<thead>
<tr>
<th>Date</th>
<th>Share price</th>
<th>Rating change</th>
<th>Comments/reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/90</td>
<td>$39</td>
<td>Hold</td>
<td>The stock of Eastman Kodak sells at a substantial discount to the market on 1991 estimated earnings. While this is a very reasonable valuation compared with historical averages, we would like to see evidence of improved revenue growth in the company's core businesses before becoming more positive on the stock. Also, with a view to the uncertain market and economic environment, we are maintaining our HOLD rating on the stock.</td>
</tr>
<tr>
<td>7/91</td>
<td>$39</td>
<td>Buy</td>
<td>Although Kodak has fundamental problems in its core businesses, it also has a very strong consumer franchise, proprietary products and sound R&amp;D and marketing. The stock has materially underperformed the market in the past 10 years and in 1991 specifically. Investors' expectations are low, and the stock sells at a steep discount to historical valuations. We believe that 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. That was true regardless of the long-term success of the product, but we believe that this new system could significantly boost Kodak's share of the amateur photography market and stimulate demand worldwide.</td>
</tr>
<tr>
<td>2/94</td>
<td>$45</td>
<td>Hold</td>
<td>Kodak will require a major change in its corporate culture to counter the effects of increased competition, structural pricing pressures and the threat of technological obsolescence. Although the specific strategies are not clear, Kodak's management will emphasize both growth and cost cutting. The company's core consumable products will probably continue to generate slow growth, and we believe that the stock will probably sell at about a market valuation.</td>
</tr>
<tr>
<td>5/94</td>
<td>$47</td>
<td>Buy</td>
<td>The court decision to lift the antitrust decrees against Eastman Kodak prompted a positive response in the stock, but we believe that the fundamental ramifications of the decision are even more favorable than they appear initially. This ruling and the recent, preliminary victory in the anti-dumping suit on photographic paper should allow Kodak to gain market share in its highly profitable, core consumables...The company's decision to dispose of its non-imaging health businesses will result in a very strong balance sheet and an organization that is very focused on the imaging business, in both traditional and digital technologies. We believe that short-term improvements in operating margins and asset turnover, and longer-term programs to improve product development and marketing, will allow long-term EPS growth of about 11% compounded annually. Kodak's fundamental strength of technology, proprietary consumable products, manufacturing and brand name recognition justify a 10% premium to the market on a near-term basis, in our opinion...We are maintaining a 2H (Outperform, High Risk) rating on the stock, with risk level primarily reflecting uncertainty about the timing and magnitude of proceeds of dispositions and management's cost-cutting efforts.</td>
</tr>
<tr>
<td>4/95</td>
<td>$57</td>
<td>Buy</td>
<td>Upgrade to Buy/Medium risk on substantially higher estimated earnings. Very strong results in 1Q95 showed benefits of balance sheet restructuring, ongoing cost cutting and favorable currency translation.</td>
</tr>
</tbody>
</table>
### TABLE 3
Prudential’s ratings changes on Kodak – 8/90 - 6/96

<table>
<thead>
<tr>
<th>Date</th>
<th>Rating</th>
<th>Price</th>
<th>Comments or reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/1/90</td>
<td>Hold to Buy</td>
<td>$40</td>
<td>Kodak’s second quarter results were well ahead of target due exclusively to sharply higher margins in the Imaging and Chemicals sectors…we expect the near-term benefits of the cost-containment efforts and recent weakness in the dollar to mask longer term concerns. Kodak has underperformed the market over the last several years and in our opinion is ready for an upside move.</td>
</tr>
<tr>
<td>12/4/90</td>
<td>Buy to Sell</td>
<td>$42</td>
<td>Time to bail out of EK…we see a brick wall at the end of this roller coaster…increasing competition challenges Kodak’s core businesses…pricing pressures to becomes more clearly defined in 1991.</td>
</tr>
<tr>
<td>1/2/92</td>
<td>Sell to Buy</td>
<td>$48</td>
<td>The rating change and the estimate increase reflect 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…EK’s valuation is attractive…EK is an inexpensive stock…a slower growth strategy should help build investor confidence.</td>
</tr>
<tr>
<td>3/20/92</td>
<td>Buy to Hold</td>
<td>$40</td>
<td>If you feed a cash cow you do not get increased growth – you get a fat cow…management appears to have decided it must sacrifice near-term earnings to invest in longer-term growth…we do not believe this strategy will be successful. In our opinion, the industry is a very mature, slow-growth arena…cannot absorb heavy advertising, promotion, R&amp;D and capital expenditure costs. Instead of increased revenue growth, we believe over-investment leads to lower long-term margins.</td>
</tr>
<tr>
<td>1/18/93</td>
<td>Hold to Buy</td>
<td>$45</td>
<td>Chris Steffan joins as CFO – Signal a quantum leap in cost cutting and asset disposition…we think the company is finally ready to make serious cuts in R&amp;D, SG&amp;A, and capital spending, exit some of its less productive businesses, and maximize cash flow…we have long contended that Kodak should nurture its cash cow, the imaging business instead of spending millions to try to grow earnings in new businesses with less promise.</td>
</tr>
<tr>
<td>5/10/93</td>
<td>Buy to Hold</td>
<td>$49</td>
<td>Steffan’s resignation…reduced visibility for cost-cutting measures at Kodak.</td>
</tr>
<tr>
<td>8/10/93</td>
<td>Hold to Buy</td>
<td>$55</td>
<td>Board fires Whitmore and we see cost cutting till the cash cows come home…we did not believe Whitmore had the stomach for the deep staff cuts needed to cut the fat from this overweight cash cow…we underestimated the strength of the commitment of the board…we now believe deeper cuts will be announced and implemented over the next 18 months.</td>
</tr>
<tr>
<td>12/19/93</td>
<td>Buy to Hold</td>
<td>$56</td>
<td>When the board fired Kay Whitmore, it stated its desire for a more rapid pace of change. However…the board was woosed by Fisher's vision of Kodak as a digital imaging giant with substantial growth potential in the out-years. We believe Fisher's plan is to pare back gradually costs while investing in new digital technologies…We Question This Growth Vision, And We Are Uncomfortable With The Slow Approach. Kodak is a troubled company with poor underlying fundamentals. For years, we have been arguing that the business needs to be managed for slow growth and cash flow…we believe Kodak needs to reduce its cost structure aggressively and massively right away and then continue to cut costs as a way of life to maintain its cash flow and market share…we seriously doubt that Kodak will be able to replace its $11 billion in very-high-margin silver halide-based film businesses with digital imaging products…It is unlikely to beat the more nimble small-cap digital imaging companies to market… Companies like</td>
</tr>
</tbody>
</table>
Pinnacle Micro, Avid, Scitex, SuperMac, Mediavision, International Imaging Materials, MRS Technologies, SoftImage, Electronics For Imaging, and a host of others are already addressing the key niches, establishing standards and developing the next generation of products.

<table>
<thead>
<tr>
<th>Date</th>
<th>Recommendation</th>
<th>Price</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/18/94</td>
<td>Hold to Buy</td>
<td>$47</td>
<td>EK has fallen to a level where we see sufficient upside…restructuring announcement and cost cutting program could bolster shares…Fisher’s announcement of the sale of Kodak’s Health operations, plus the remarkable prices achieved for these units, helped the EK shares produce a solid return by mid-Summer…</td>
</tr>
<tr>
<td>2/95</td>
<td>Buy to Hold</td>
<td>$48</td>
<td>As expected, investors have pushed up EK shares into the restructuring announcement despite modest earnings results…restructuring not enough to offset weak long term fundamentals…we suspect investors are growing increasingly restless with the gradual pace of cost cutting in Kodak’s ongoing operations.</td>
</tr>
<tr>
<td>1/22/96</td>
<td>Hold to Buy</td>
<td>$67</td>
<td>On January 18th, Kodak reported disappointment earnings and despite the poor results, on January 19, with Kodak at $67, we upgraded EK shares to a Buy….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 the Advance Photo system (APS) starts in earnest…the rollout should cause a moderate increase in film sales…Olympics and election year should bolster film demand…Kodak’s valuation and its earnings should benefit from the disposition of its copier business…stock buyback and strong cash flow…we also expect Kodak to increase the dividend over the next quarter or two.</td>
</tr>
</tbody>
</table>
TABLE 4
Painewebber’s rating changes on Kodak - 11/90-6/93

<table>
<thead>
<tr>
<th>Date</th>
<th>Share price</th>
<th>Rating change</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/90</td>
<td>$40</td>
<td>Hold</td>
<td>Third quarter EPS didn't convince us that there isn't an earnings valley after the positives of the 1989 restructuring are anniversaried in the first half of 1991… the question mark relating to the quarter's earnings is definitely the exact impact of currency translation on the reported results.</td>
</tr>
<tr>
<td>1/93</td>
<td>$45</td>
<td>Buy</td>
<td>The upside case in the event of a full restructuring of the company is high - $54-90 or 20-100%. The probability of major restructuring is now nonzero because Kodak hired a CFO who has already helped engineer one turnaround/restructuring. We believe the downside is limited to about 11% in the event 1993 earnings are disappointing and/or the new CFO has limited success. … we outlined a case for full restructuring of the current Kodak into Kodak-the Film Company. By selling all businesses except those related to film, we think Kodak could pay off $8 billion of its $10 billion in debt, still earn $3.70 in 1993 and more important, become a solid consumer products company with consistent earnings growth in the 8-12% range…Kodak-the Film Company's stock would be worth $54-90 in that event based on comparable P/Es and dividend yields of other consumer products companies</td>
</tr>
<tr>
<td>5/93</td>
<td>$51</td>
<td>Hold</td>
<td>Asset sales plus major cost reduction at core film needed to justify higher stock price. We attended the Eastman Kodak annual meeting recently. The one bit of real news related to the significant shareholder support for an amendment to remove the staggered board. Although the amendment did not pass, it received more than 42% of the vote. This is a clear sign to the board of directors that shareholders expect dramatic improvement in the company's performance.</td>
</tr>
</tbody>
</table>
### TABLE 5
Morgan Stanley’s rating changes on Verizon – 2002-2004

<table>
<thead>
<tr>
<th>Date</th>
<th>Share price</th>
<th>Rating change</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/02</td>
<td>$44</td>
<td>Buy</td>
<td>We reiterate our Overweight rating on Verizon, within the context of our overall Cautious view on the wireline telecom services industry. Our price target of $52 per share reflects the average of the value implied by several methodologies, including trading multiples, sum of parts, and discounted cash flow analysis. 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.</td>
</tr>
<tr>
<td>10/02</td>
<td>$37</td>
<td>Hold</td>
<td>Equal-weight rating on Verizon shares within the context of our overall In-Line stance on the wireline telecom industry. We recently reduced our stock ratings on all of the Bells to reflect the recent significant price appreciation. At current levels, we believe the risk/reward profile in owning Verizon is more balanced.</td>
</tr>
<tr>
<td>2/04</td>
<td>$37</td>
<td>Buy</td>
<td>We believe SBC and BellSouth performance will be limited due to dilution and A WE performance overhang. Verizon will likely be a near-term beneficiary of the deal due to its solid execution and first class network. We are also encouraged by recent cost cutting, headcount reductions and the focus on portfolio re-balancing. As a result, Verizon is our top US large cap pick.</td>
</tr>
</tbody>
</table>
**TABLE 6**
Deutsche Bank’s rating changes on Verizon – 2002-2004

<table>
<thead>
<tr>
<th>Date</th>
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</tr>
</thead>
<tbody>
<tr>
<td>11/02</td>
<td>$39</td>
<td>Sell</td>
<td>…we remain concerned that the current market estimates for 2003-04 are unlikely to be attained, in our view. We believe that Verizon is likely to report declining earnings through 2003-04….We believe that the UNE-P pressure on Verizon is likely to escalate…we do not believe that Verizon’s data business will rebound strongly over the next 12-18 months….We anticipate a major reversal of pension surpluses and a further rise in post-retirement obligations…the above negatives are likely to offset the positives of growing long-distance and broadband access contribution….at the current price, the stock is trading at around a 12% premium to our valuation and more than a 25% premium to the implicit valuation of SBC….we would be strong buyers of the stock at prices closer to $30/share, but we also believe that any semblance of value disappears at prices much above $40 a share.</td>
</tr>
<tr>
<td>1/03</td>
<td>$36</td>
<td>Hold</td>
<td>We maintain our view that the rate of decline in Verizon’s core wireline business will accelerate as we progress through 2003. It is highly unlikely that Verizon will be able to maintain its wireline operating margins. The above negative however should be once again offset by strong performance from Verizon Wireless.</td>
</tr>
<tr>
<td>10/03</td>
<td>$32</td>
<td>Buy</td>
<td>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 vs. 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.</td>
</tr>
<tr>
<td>9/04</td>
<td>$40</td>
<td>Hold</td>
<td>We are downgrading our recommendation on Verizon from Buy to Hold. At current prices around $41, the stock has exceeded our DCF-based valuation of $40, and even after allowing for dividends, it is unlikely to yield the minimum 10%-15% return required to substantiate a Buy rating…We continue to favor VZ as our preferred play among the RBOCS, but believe that there is limited value left in the shares…while positive sentiment is likely to continue through the balance of 2004 and early 2005, long-term challenges are likely to accelerate, including cross-platform competition from wireless and cable, pressures from disruptive technologies, and rising capital commitments. Our $40 price target on VZ shares is based on a ten-year, DCF based sum-of-the-parts model.</td>
</tr>
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</table>
### TABLE 7
Morgan Stanley’s rating changes on BellSouth – 2002-2004

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>11/02</td>
<td>$26</td>
<td>Hold</td>
<td>The principal attraction of the Bells continues to be strong free cash generation. BellSouth’s balance sheet is rock solid, and we get the sense that much of next year’s surplus cash will be used for deleveraging with modest buybacks and dividend increases…our industry view reflects reasonable valuations and strong financial positions of the Bells offset by weak demand and competitive pressures.</td>
</tr>
<tr>
<td>4/03</td>
<td>$22</td>
<td>Buy</td>
<td>We are upgrading BellSouth to Overweight from Equal-Weight…we also downgraded…Verizon to Equal-Weight…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.</td>
</tr>
<tr>
<td>12/03</td>
<td>$27</td>
<td>Hold</td>
<td>downgrading following significant outperformance…the primary reason for our downgrade is valuation. Shares of BellSouth are up 16% in the fourth quarter and 22% since the end of 1Q03…we continue to find many of the attributes of BellSouth attractive, including its industry leading ROIC, solid balance sheet and free cash flow, strong management team and industry leading core local segment…we believe the valuation is less compelling at current levels…”</td>
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</tbody>
</table>

### TABLE 8
Deutsche Bank’s rating change on Bellsouth – 2002-2004

<table>
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<tbody>
<tr>
<td>11/02</td>
<td>$26</td>
<td>Hold</td>
<td>A quality operator but fairly valued…we believe that the market is factoring in a rather optimistic earnings rebound in 2003/04. We believe that earnings will decline in 2003…higher benefit expenses resulting from lower stock market returns will result in a negative $450 million ‘hit’ to EBITDA…Latin American currency collapse will be felt next year…reduce EBITDA by a further $100 million…</td>
</tr>
</tbody>
</table>
### TABLE 9
Deutsche Bank’s rating change on Qwest – 2002-2004

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>3/11/04</td>
<td>$4.63</td>
<td>Sell</td>
<td>Initiating with a sell rating…while we do see a gradual turnaround and little current evidence of debt problems – indicating a happy ending – we believe that the market has pushed the stock too far too fast, and begin coverage with a Sell rating.</td>
</tr>
<tr>
<td>3/25/04</td>
<td>$4</td>
<td>Hold</td>
<td>We are upgrading from Sell to Hold on the back of the recent derating that has brought the stock near our $3.90 target. We believe this adjustment can be attributed to two macro factors: 1) Market sell off, with Q suffering as a high beta stock, and 2) particularly weak telecom sector. We do not believe there has been any adverse change to fundamentals</td>
</tr>
</tbody>
</table>
Verizon's Stock Price
(Quarterly averages)
BellSouth's Stock Price
(Quarterly averages)