Is Dynamic Competition Greater in Technology-Intensive Industries?

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Abstract

A growing body of research in strategic management and related public policy fields concludes that the 1980s and 1990s saw greater dynamic competition in technology-intensive ("TI") industries, with increasing industry and business performance instability as principal consequences. We test for evidence of the consequences of dynamic competition using a sample of 2,309 US businesses from 1978-1997 operating in 31 industries with high average R&D expenditure-to-sales ratios. Contrary to the dynamic competition argument, we observe neither sustained change in the dynamism of TI industries, nor changes in the operating performance stability of businesses in TI industries. Overall industry dynamism and intra-industry operating performance instability during this period are not significantly greater in TI industries compared to non-TI industries. These results suggest that the conclusion of increasing dynamic competition in TI industries is premature. Competitive environments for businesses in TI-industries were apparently no more dynamic in the late 1990s than they were in the late 1970s. Research assuming generally greater dynamism in technology-based competition might benefit from closer (re-)examination of Schumpeterian perspectives on the consequences of entrepreneurial innovation for incumbent and insurgent firms, and the role of market characteristics and firm actions that may move industries in and out of periods of increased competitive dynamics.

1. INTRODUCTION

In this study, we examine evidence related to a fashionable contention among many scholars and practitioners that the 1980s and 1990s saw increased dynamic competition among businesses within technology-intensive ("TI") industries (*e.g.*, Bettis & Hitt, 1995; Nault & Vandenbosch, 1996; Ahlborn *et al*., 2001; Evans & Schmalensee, 2001; Posner, 2000, 2001). Within the management literature, there has been growing discussion suggesting an increased pace of innovation since the 1980s shortened technology and product lifecycles, undermined more quickly previously stable market positions based on superior technologies, and engendered within many industries a state of hypercompetition where long-term advantage was illusory and greater performance instability was likely that (*e.g*., D'Aveni, 1994, 1995; Lau & Woodman, 1995; Thomas, 1996; Hitt *et al*., 2001). While such arguments have generated a fair degree of interest in both academic and practitioner discussions,[1] broad empirical support has been scant and mixed. Thomas (1996) found broad support suggesting increased dynamism but Castrogiovanni (2002) and McNamara *et al.* (2003) found little, if any, change in overall industry munificence and dynamism or in the overall stability of intra-industry business performance.

One response to this mixed evidence on increased dynamism focuses on sample selection. The 1980s and 1990s actually might have seen increasing dynamic competition across several industries and businesses. Even so, effects on performance stability could have been difficult to uncover empirically, particularly if the consequences of heightened dynamic competition were not well-distributed across all industries, but instead, were substantially focused in a narrow sub-sample of industries and businesses more vulnerable to change from increase in dynamism.

Such a response is consistent with conclusions drawn by many researchers that dynamic competition increased in a sub-set of businesses operating in TI industries such as electronics or pharmaceuticals. In the strategic management literature (*e.g.*, Bettis & Hitt, 1995; Nault & Vandenbosch, 1996; Hamel, 2000) as well as in related literatures from economics (*e.g.,* Schmalansee, 2000, Evans &

[1] See McNamara *et al*. (2003) for a more complete discussion of the proponents of this view.

Schmalensee, 2001) and law and public policy (Ahlborn *et al*., 2001; Posner, 2000, 2001), scholars have argued that dynamic competition within TI industries increased markedly during the 1980s and 1990s. Bettis and Hitt (1995), for example, reasoned that the 1980s and early 1990s saw a technological transformation of the competitive landscape of TI industries: Increasing risk, uncertainty and rates of technological change were in the foreground; increasing reliance on knowledge-based assets and network relationships were in the background; and greater performance variability (though not necessarily poorer overall performance) were some of its most prominent landmarks. Similarly, Nault and Vandenbosch (1996) opined that firms in intensely and increasingly competitive industries, such as high technology industries, were and should be cannibalizing their own current advantages before rivals could step in and steal markets away from them. Christensen (1997: xxxvi) conjectured that Internet-related technologies diffusing in the 1990s constituted a new source of "disruption" to established industries and industry leaders.

Outside the management field, prominent industrial organization and antitrust economists (*e.g*., Schmalensee, 2000; Evans & Schmalensee, 2001) and scholars in law and public policy (*e.g*., Alhborn *et al*., 2001; Posner, 2000, 2001) have also advanced similar views about increasing dynamism in the 1980s and 1990s in TI industries both new and established but transformed. Ahlborn *et al.* (2001), for example, criticized existing antitrust regulations in Europe while Posner (2000) criticized current US antitrust regulations because of perceived bias against successful businesses in TI industries, which enjoyed increasing returns to scale, dominant market positions, and in the short-run, high profits. From Schmalensee's (2000) viewpoint, such performance results were part a "normal" phase of episodic "winner-take-all" (or "winner-take-most") rivalries; the winner in one round could be the loser in the next round of technological developments. Their arguments reflected growing faith in the built-in error correction mechanism of markets served by TI businesses. Wider swings in business profitability, market shares, even market entry and exit propensities, were argued to be increasingly common in TI industries.

Our study tests for evidence of dynamic competition and contributes to strategic management and related policy literatures with a broad empirical assessment of TI industry and intra- TI industry business performance patterns from 1978-1997. Analyses of 11,626 annual operating results posted by 2,309 businesses operating in 31 TI industries in the US over this 20-year period indicate little, if any, support for the proposition that dynamic competition has increased. TI industries and businesses during the 1980s and 1990s exhibited no pattern of sustained increase in performance instability nor did business performance in TI industries exhibit any greater instability than business performance in non-TI industries and businesses. At best, we conclude that there are slightly fluctuating cycles of increase and decrease in instability suggesting that dynamic competition in TI (and non-TI) industries in the late 1990s was not substantially different than it was 20 years earlier.

To make this point in detail and to discuss various implications for research and practice, we organize the remainder of our study into four additional sections. Section 2 immediately below summarizes historical perspectives on technology-based competition and strategy, leading up to recent dynamic competition perspectives in TI industries. We derive from our review the anticipated industry and intra-industry performance consequences of increased dynamic competition in TI industries, which lead us to four sets of paired hypotheses. Section 3 describes our methodology for testing these hypotheses. Section 4 reports results from our tests. Section 5 reviews our core findings, their implications for strategic management and related research and practice, and suggests future research.

2. BACKGROUND AND HYPOTHESES

TI Industries and Dynamic Competition

The dynamic competition view harkens back to Joseph Schumpeter (1934) and his vision of technology-based competition and economic development as a process of "creative destruction" rather than as a stable equilibrium condition. The search for new technologies and products as well as organizational forms for commercializing them was part of an entrepreneurial exercise designed to create temporary advantages relative to rivals, but then eventually eroding due to rival entry, imitation, and improvement. Often described as Austrian (*e.g.*, Jacobson, 1992), this perspective characteristically emphasizes the importance of entrepreneurial discovery and exploitation of temporary arbitrage opportunities in technology markets. Arguably, the technological transformation described in Bettis and Hitt (1995), the concept of strategic entrepreneurship developed in Hitt *et al.* (2001), and the hypercompetition concept espoused by D'Aveni (1994, 1995) and others (*e.g*., MacMillan, 1989) reflect this Austrian perspective applied to business strategy in the 1980s and 1990s.

The dynamic competition concept might be characterized as a "strong-form" formulation of the Austrian perspective. Also originated by Schumpeter (1950: 81-86), it might be simply described as technology-based rivalry *for markets* rather than price- and output-based competition *within markets*. Episodic rivalry between incumbent and insurgent firms with rival technologies permits one or only a few "winners" who then dominate the market, only to see their dominance imperiled with the next radical innovation redefining technologies, products, market boundaries, even organizational forms (Evans & Schmalensee, 2001). The performance implications of dynamic competition center on volatility: Profitability, sales, market share tend to exhibit broad swings over time as does the likelihood of maintaining a leadership position or even surviving within the industry (Schmalansee, 2000).

Dynamic Competition and Instability in TI Industries During the 1980s and 1990s

A recurring theme in recent research holds that such trends associated with dynamic competition have become more pronounced in TI industries during the 1980s and 1990s, thereby making positions of competitive advantage less durable. Brown and Eisenhardt (1998), Hamel (2000) and Stopford (2001), for example, assert that change in many technology industries became constant in the 1990s, thus, presenting challenges to business models that previously had produced steady profits. Baumol (1993; 2002) and Khalil (1997) describe current patterns of technology-based competition (after Lewis Carroll) as a "Red Queen" game, in which it is necessary to "run" (innovate) as rapidly as possible in order just to "stand still" in terms of performance vis-à-vis imitative rivals. Garud and Karaswarmy (1995: 93) proclaim that "[t]he Schumpeterian era during which gales of creative destruction brought about revolutionary changes over long periods of time…is past. In recent times, we have entered a neo-Schumpeterian era where technological change appears to be ceaseless. To survive in this new era, firms have to innovate continually..."

Evans and Schmalensee (2001) discuss antecedents of greater dynamism and consequent increases in the performance instability of businesses within TI industries. Of all the antecedents of increased dynamic competition, the most important may be the quickening pace and increasingly hard-fought nature of episodic battles for the market among businesses in TI industries. TI industry winners with temporary market power and seemingly dominant market positioning are increasingly vulnerable to dethronement by rivals in ever-quickening episodes of technology-based competition. They illustrate this point with the example of software giant Microsoft (Evans & Schmalensee, 2001: 13-14). Its "bet the company" strategy led to development of an operating system to replace MS-DOS, which in the early 1990s it viewed as obsolete and unlikely to fend off a challenge for the computer operating system market coming from IBM's OS/2 system. The success of Windows 3.1 against OS/2 was followed by episodic battles between Microsoft's successors to Windows 3.1, Windows 95 (and, presumably, 98, 2000, and XP), and IBM's OS/2 Warp 3.0.[2] The sustained popularity and market leadership of Microsoft's Windows operating systems in the 1990s purportedly reflects a string of insightful decisions, hard-fought battles for a changing market and, perhaps, a little luck, rather than a simple extension of an initially dominant market position. With each episode, market leadership could easily have been lost.[3]

As Nault and Vandenbosch (1996) assert, businesses in these situations are often forced to cannibalize their current sources of ephemeral advantage to pre-empt rivals in the next stage of escalating competitive dynamics. Eisenhardt (1989) dubbed decision-making in such situations (*e.g.*, micro-computer industry) as "high velocity" in part because profitable opportunities opened and closed in brief time-periods, but also in part because outcomes from fortunate decisions taken in one time-period could be imperiled easily in the next. Rindova and Kotha (2001) described similar circumstances in their case

[2] By extension, the episodic battles for operating system dominance are renewed with Microsoft's roll-out of Windows 98/NT, Windows 2000 and Windows XP on the one hand, and various rivals, some using networked operating systems (*e.g.*, Novell, Sun) and some using "open source" operating systems (*e.g.*, Red Hat).
[3] Episodic battles for the spreadsheet software market are purportedly similar to those for the operating system market (see, Evans & Schmalensee, 2001: 21). In the last two decades, Lotus 1-2-3 supplanted VisiCalc, and then Microsoft's Excel supplanted Lotus 1-2-3. Presumably, Excel's continued dominance of the spreadsheet software market in the 1990s masks a series of competitive thrusts from innovative rivals, adroitly parried by Microsoft.

history of Internet firms Yahoo! and Excite, both of which required "continuous morphing" to meet fast-following episodic battles for markets they served.

Fast-moving, episodic winner-take-all battles for the market (rather than static battles within the market based on pricing and output decisions) are purportedly not limited to information technology and related products. Again, Evans and Schmalensee (2001: 21-22) cite examples from pharmaceuticals (*e.g.*, Beecham's Tagamet anti-ulcer drug dominant in the 1970s giving way quickly to Glaxo-Welcome's Zantac anti-ulcer drug offering in the 1980s).

Breakdown in traditional industry definitions caused by the arrival of new technologies have also contributed to the increased frequency of these episodic battles, and to the increased number of businesses able to challenge current market leaders. For example, challenges to traditional cable and tele-type messaging came from fax- and then email-based systems. Chakravarthy (1997) and others (*e.g.*, McGarty, 2001; McKnight, *et al*., 2001) argue that the increasingly "digital" basis of many related products and services in telecommunications, computing, finance and media has blurred traditional industry distinctions, pooled businesses previously separated by distinctive technological and or regulatory regimes, and increased substantially the number of players who can vie in battles for markets providing voice, graphics and data transfer services.

Such TI industry examples constitute, perhaps, more extreme cases of technology-driven market re-definition and re-alignment that might also occur in non-TI industries. Even so, these examples suggest a broader tendency that permits seemingly dominant market leaders to persist only if they continue to respond, adapt and prevail anew across succeeding episodes of technology-based battles for a changing market. Again, the presumption is that many more market-leading businesses in TI industries are likely to fall by the wayside rather than endure increasingly frequent challenges from rivals.[4]

These views on technology-based competition reflect a broader management perspective assuming increased market turbulence, greater reliance on flexible and transient factors for organizational returns,

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[4] See McNamara *et al*. (2003) for conceptual analysis of the relationship between increase in the frequency of strategic investment decision-making, and the likelihood of increased performance instability among firms.

and greater overall performance instability in TI industries. Researchers arguing for the greater relevance of this broader management perspective often cite not only recent technology trends, but also trends linked to privatization and deregulation, trade liberalization and globalization, and interest in and veneration of markets and entrepreneurship. The confluence of these trends leads commentators like Hamel (2000: 4-5) to proclaim that the end of the twentieth century saw the end of incremental and additive change, and consequently, the diminution of predictability and durability in firm performance: "We now stand on the threshold of a new age –the age of revolution…it is going to be an age of upheaval, of tumult, of fortunes made and unmade at head-snapping speed…In the twenty-first century, change is discontinuous, abrupt, seditious."

Arguments about increased dynamic competition in TI industries or about increased competition across both TI and non-TI industries might find more advocates in and around the Academy if more evidence were available. In the strategy field, Makadok (1998) may have been the first to challenge advocates of generally increasing hypercompetition. He noted a conspicuous lack of supporting evidence from broader multi-year, multi-industry studies showing increased environmental dynamism and performance instability. What studies to date we do find of this sort convey, at best, mixed evidence of any general increase in dynamism and performance instability. Perhaps the only three multi-industry, multi-year studies assessing such changes came from Thomas (1996), Castrogiovanni (2002) and McNamara *et al.* (2003). Thomas (1996) examined the growth rates in the market value of corporations operating primarily in one of 200 US manufacturing industries from 1958-1991, and linked them to corporate expenditures on salary and general administrative expenses, a proxy for industry rivalry. He found evidence of dynamic competition in the form of an inverted-U shaped relationship between the level of industry rivalry on the one hand, and the growth of firm market value in later years of the sample studied on the other hand. He took this as evidence of a generalized "hypercompetitive shift" in US corporations from the 1950s to the early 1990s.

Castrogiovanni (2002) examined changes in organization task environments of manufacturing establishments operating in one of 88 US industries in the 1980s and 1990s. In contrast to Thomas (1996), he observed a generally decreasing trend in industry dynamism over time across this sample, and questioned the proposition of any fundamental shift indicating greater volatility. Findings published by McNamara *et al.* (2003) confirmed and extended results in Castrogiovanni (2002). They examined time trends in industry dynamism as well as business-unit performance instability in a sample of more than 100,000 annual business-unit returns reported for more than 9,000 business units operating in more than 700 four-digit non-banking industries over the period 1978-1997. They found no sustained trends indicating greater dynamism or performance instability. McNamara *et al.* (2003) concluded that claims by many strategy scholars of generally increasing dynamism and performance instability in the 1980s and 1990s were unfounded generally; yet, they held out the possibility that such claims might yet find support in a subset of industries and businesses more precisely defined by their vulnerability to trends inducing greater dynamism. Our literature review above suggests that businesses in TI industries constitute such a well-defined subset that is particularly vulnerable to trends inducing greater competitive dynamism and performance instability not found more broadly in Castrogiovanni (2002) and McNamara *et al.* (2003).

General Research Propositions

We can restate this final point in terms of two general research propositions. Related to the broader argument of greater dynamism and performance instability generally during the 1980s and 1990s (*e.g.*, D'Aveni, 1994, 1995; Thomas, 1996, Hamel, 2000), we first propose that dynamic competition within TI industries became more pronounced during this same period. Schumpeterian cycles of innovation followed by rival imitation became faster and more frequent (Garud & Karaswamy, 1995). Knowledge investments necessary to attain and maintain positions of market dominance could have become more important but also more risky due to heightened uncertainty as to their effectiveness in the market (Schmalensee, 2000) and due to their protection from rival imitation if proven effective (Bettis & Hitt, 1995). Organizational speed in decision-making (Eisenhardt, 1989) diversification of and flexibility in potential strategic direction (Roberts, 2001) and adaptability to different environments (Teece *et al*., 1997; Eisenhardt & Martin, 2000) could have become more valuable in markets with more frequent and wider swings in technology preferences among consumers (Rindova & Kotha, 2001) and in markets with more disruptive potential (Christensen, 1997). Accordingly, we propose that:

Proposition 1: Dynamic competition among businesses in TI industries increased in the 1980s and 1990s.

Our second general research proposition for empirical investigation distinguishes the extent of increase in dynamic competition between TI and non-TI industries. As Evans and Schmalensee (2001) argue and others (*e.g.,* Bettis & Hitt, 1995; Baumol, 2002) imply, businesses in TI industries may have distinctive characteristics accentuating more general tendencies toward increasing dynamism. Compared to businesses in non-TI industries, businesses in TI industries are more heavily dependent on R&D and related human and organizational knowledge investment (Evans & Schmalensee, 2001), and may require managers more frequently to take risky, often unsuccessful, sometimes even "bet-the-company" R&D investments (Lerner, 1998). Strong network and positive feedback effects are also thought to be more likely in TI versus non-TI industry settings (Schmalensee, 2000). Such effects may reduce competition to fights for the initial market (rather than within it through pricing and output decisions) with winner-take-all results. The frequency of such battles could be higher than in non-TI industries and could come from unlikely quarters with businesses outside "traditional" industry boundaries introducing an innovation providing functionally equivalent products or services (Chakravarthy, 1997). Together, these building forces compel TI businesses to make strategic decisions more frequently, with greater implications for survival and success than for non-TI businesses. Accordingly, we propose that:

Proposition 2: Dynamic competition among businesses in TI industries during the 1980s and 1990s was greater than among businesses in non-TI industries during the same period.

Hypotheses for Empirical Investigation

Industry Dynamism. These two general research propositions lead to several testable hypotheses concerning the logical consequences of increased dynamic competition. First, at the industry level, our general research propositions directly imply that TI industry dynamism should be increasing during the 1980s and 1990s. Similarly, they directly imply that TI industry dynamism in the 1980s and 1990s should be greater than non-industry dynamism during the same period. These hypotheses flow logically from predictions of change in the dynamism of industries more generally investigated in Castrogiovanni (2002) and McNamara *et al.* (2003). Accordingly, we predict here that:

Hypothesis 1a: TI industries will exhibit greater dynamism over time.

Hypothesis 1b: TI industries will exhibit greater dynamism than non-TI industries.

Durability of Abnormal Business Returns. At the intra-industry business unit level, our general research propositions imply at least three additional sets of predictions regarding consequences of increasing dynamic competition. The first of these predicted consequences links increasing dynamic competition to a decrease in the durability of abnormal business unit operating profitability within TI industries. As Roberts (2001) and McNamara *et al.* (2003) pointed out, a rich research stream substantiates the workings of a self-adjusting market mechanism for dissipating abnormally high (or low) business returns back to average levels (Mueller, 1986; Jacobsen, 1988). D'Aveni (1995: 46-47), for example, cites several factors in the 1980s and 1990s contributing to increased competitive pressures on more profitable market leaders: Lower barriers to entry; more radical re-definition of market boundaries; more frequent emergence of new technologies; shorter product life cycles; and more aggressive action-reaction patterns among rivals. As a consequence, he argued that only "temporary advantage and short periods of profit are achievable until competitors catch up with or outmaneuver the aggressor's last competitive move" D'Aveni (1995: 46).

Regarding TI industries during the 1980s and 1990s, a substantial corpus of strategy research has noted shorter cycles of innovation and competitive imitation, less effective legal and related protections of intellectual property, more frequent use of alliances and networked organizational forms to commercialize innovations, and deregulatory trends permitting potential rivals to cross traditional industry boundaries more easily and compete with incumbents (*e.g.,* D'Aveni, 1994, 1995; Bettis & Hitt, 1995; Chakravarthy, 1997). These developments purportedly contributed to lower entry and intra-industry mobility barriers, to greater rivalry, and to faster dissipation of any abnormally high or low returns. Schmalensee (2000) and Evans and Schmalensee (2001) have noted the greater potential if not greater actual rate of dissipation in high-profitability market positions in TI versus non-TI industries. Recall that they emphasize the winner-take-all nature of battles tending to leave one or two survivors able to exercise monopoly or near monopoly market power in the short-run. Yet, assaults by rivals using a next-generation technology are thought to have come with increasing speed and ferocity in the 1980s and 1990s. As the survivors react to this challenge, the interim impact on their operating returns may be much greater than in comparable cases in non-TI industries. Accordingly, we predict that:

Hypothesis 2a: Abnormal returns of businesses in TI industries will erode more quickly over time.

Hypothesis 2b: Abnormal returns of businesses in TI industries will erode more quickly than for businesses in non-TI industries.

Market Leadership. As, researchers in both strategy and economics have noted (*e.g.*, Ferrier, 1999; Schmalensee, 2000), a key metric of business success in TI industries is the ability to attain and maintain a leading market-share position. Network effects, positive feedback mechanisms, and increasing returns to scale from market leadership are especially important in TI industries, whether they be mature such as with telecommunications (Majumdar & Venkataraman, 1998) or altogether new such as with the Internet (Rindova & Kotha, 2001). On the other hand, factors increasing dynamic competition and, consequentially, decreasing the durability of abnormal returns in the 1980s and 1990s are also likely to affect the likelihood that businesses successfully battling others for the market in one episode will prevail again in the next episode of technology-based competition. Ferrier *et al.* (1999) find, for example, that market leaders are less likely to maintain their dominance against rivals making radical and unanswered (by leader) strategic thrusts. In TI industry environments of the 1980s and 1990s there are purportedly more potential rivals with a broader range of strategies and more opportunities to use them. Market leaders in TI industries may, therefore, be less able to consistently respond effectively over time and in comparison to their counterparts in non-TI industries. Accordingly, we predict that:

Hypothesis 3a: Market leading businesses in TI industries are more likely to be supplanted from one year to the next over time.

Hypothesis 3b: Market leading businesses in TI industries are more likely to be supplanted from one year to the next than market leading businesses in non-TI industries.

Business Survival. Numerous researchers have argued that organizations exhibit inertial tendencies, find organizational change very difficult, and, consequently, find their survivability called into question during periods of dramatic environmental change (*e.g*., Hannan & Freeman, 1977, 1984). Thus, organizational pressures for inertia are likely to have profound effects in purportedly faster-evolving TI industries of the 1980s and 1990s. There, increased dynamic competition includes as its logical consequences greater potential for discontinuities in technological development and the sudden obsolescence of an organization's existing technologies (Tushman & Anderson, 1986).

Alternatively, the very technological prowess of a TI industry incumbent or TI industry incumbents may create a technological "over-supply" for consumers. New entrants can exploit this over-supply condition with the introduction of cheaper but functionally equivalent technologies that "disrupt" incumbent positions (Christensen, 1997). Incumbent businesses not well adapted to the resulting turbulence could see the value of their resources depleted and become more likely to be selected out (Tushman & Anderson, 1986; Henderson & Clark, 1990). Schmalensee (2000), Evans and Schmalensee (2001) and others (*e.g*., Posner, 2000, 2001) propose that the increasing frequency and strength of such technological discontinuities and or disruptions in the 1980s and 1990s could help explain potential for higher business mortality (exit) rates in TI industries. For many researchers, winner-take-all battles for the market are natural results of dynamic competition in TI industries. This also means that exit by unsuccessful businesses is also a natural result that should increase in frequency if dynamic competition is itself increasing. Thus, we should find that business mortality in the form of industry exit should increase in TI industries during the 1980s and 1990s, and be greater overall in TI versus non-TI industries. Accordingly, we predict that:

Hypothesis 4a: Mortality (exit) rates within TI industries will increase over time.

Hypothesis 4b: Mortality (exit) rates within TI industries will be greater than within non-TI industries.

3. METHODS

Data Collection and Sampling

To find data to test these hypotheses, we turned to the Compustat Industry Segment database. Our choice followed previous researchers interested in understanding broader economy-wide trends in performance stability (*e.g*., McNamara *et al*., 2003) and the basis of firm performance (*e.g.,* McGahan & Porter, 1997). We started with the entire Compustat Segment database for the 1978-1997 period, a total of 234,164 annual observations of operating results reported by publicly-traded US corporations for their major lines of business, which we refer to as business units. This twenty-year panel allowed us to examine business segment financial data using a consistent set of financial reporting standards over an extended period of time, during which dynamic competition was purported to be increasing. Statement of Financial Accounting Standards 14 outlined the manner by which industries for individual businesses were identified for SEC reporting purposes. These standards were fully in force from 1978 to 1997. We ended our data collection in 1997 since a change in accounting standards taking full effect in 1998 substantially altered the schema used to identify and report firm activities in individual industries.

We followed McGahan and Porter's (1997) suggestions for screening these data and for arriving at our base sample for subsequent analyses[5]. Once screened on their criteria, our base sample comprised a total of 114,191 business-unit observations covering 1978-1997. Consistent with criteria for identifying TI industries described in Bettis and Hitt (1995) and Evans and Schmalansee (2001), we then calculated the relative R&D intensity of business units within all industries of the base sample to identify a sub-sample of businesses from TI industries. TI industries were defined as those with average R&D expenditure to sales ratios in 1997 at least one standard deviation above the mean business R&D expenditure to sales ratio for all industries in 1997. We chose to focus on the final year of the study period so that, in line with recent analyses of TI industries (*e.g*., Evans & Schmalansee, 2001), we could identify industries with TI attributes at of the end of (though not necessarily throughout) the study period. Thus, industries that may not have started our time-period of observation with TI attributes –perhaps pharmaceuticals or telecommunications— would be included with their purported transformation into TI

[5] Following their recommendations, we eliminated observations if: 1) they did not contain a primary SIC designation; 2) they were from residual industry categories or government-related classifications; 3) they operated in financial services industries since their returns were difficult to compare with those in other industries; 4) they were from small businesses with sales and or assets less than $10 million; 5) they had ROA values exceeding 100% since this suggests that the corporate parent either understated the assets of the business unit or consciously lumped profits into it for reporting purposes alone; or 6) they were described as "corporate" or "other" businesses since these did not appear to be active business units.

industries during the 1980s and 1990s. The mean and standard deviation for this measure of average business R&D intensity for 1997 was 1.6% and 3.5%, respectively. Based on this screen, we created a sub-sample comprising 31 four-digit SIC industries with average business R&D intensity values of at least 5.1%. A full list of the TI industries identified for study is presented in Table 1.[6]

(*Insert Table 1 Approximately Here*)

Consistent with our research hypotheses, we use multiple dependent variables related to industry and intra-industry business conditions, including most notably, performance stability. At the industry level, we included measures of overall industry dynamism derived from aggregation of intra-industry business sales values. At the intra-industry business level, we included measures of business operating returns (ROA), the likelihood of market share leadership loss by businesses, and the likelihood of industry exit (mortality) by businesses.

Industry Dynamism Analysis

To test Hypothesis 1a, we took a within subjects regression model approach. This amounted to a regression of industry dynamism on individual industry dummies and three of four possible time periods in our sample for comparison of overall dynamism scores. As a preliminary step, we followed previous research (*e.g.,* Dess & Beard, 1984; Sutcliffe, 1994) in calculating dynamism for each four-digit SIC industry operating in four different five-year panels of our data (1978-1982, 1983-1987, 1988-1992, and 1993-1997). To compute these scores, we first regressed industry sales on variables representing the years in a five-year panel. We then divided the standard error of each regression by the mean value of sales for that industry and used the resulting value as a dynamism score for each industry in each year of four five-year periods examined. In effect, the dynamism score is capturing volatility in the demand for industry products and services, an important antecedent of various TI industry trends noted by researchers

[6] To ensure that the industry sample we chose was not affected by using only a single year of data, we also identified a sample of TI industries using a three-year window (1995-1997). Using the same selection criteria, the three year screen identified 32 industries as technology intensive, 29 of which are the same as those identified using a single year of R&D intensity. Therefore, we concluded that the sample we identified was robust with respect to the length of the window used.

contending that dynamic competition was increasing in the 1980s and 1990s (*e.g.*, Bettis & Hitt, 1995; Evans & Schmalensee, 2001).

With these dependent variable measures for the within subjects regression, we turned next to the independent variables. They included dummies for each industry (31) less one in our analysis. Industry dummies controlled for systematic, industry-specific differences in dynamism; they permitted more precise analysis of common industry trends in dynamism over the period studied. We then added time-period dummies for three of the four time-panels. Specifically, we excluded the dummy for the final time period (1993-1997). By regressing the annual measure of dynamism on these time-period dummies, we obtained coefficient estimates for comparison with each other and against the omitted time period. Hypothesis 1a would be supported if we found that the parameter estimates for all of the time-periods dummied out in the dynamism regression were negative (relative to the omitted final time-period) and significant; the greatest negative estimate should be in the earliest time period, thus indicating a positive trend for dynamism over the period studied. To test Hypothesis 1b, we did a regression analysis where we first controlled for time-period effects. We then added a dummy variable to denote whether or not it was a TI or non-TI industry to compare the level of industry dynamism in the 31 TI industries to the level of dynamism in all other non-TI industries in our sample. Hypothesis 1b would be supported if the average dynamism level in the TI industries was found to be higher than in non-TI industries.

Autoregressive Analysis

To test Hypothesis 2a, we used regression analysis to model ROA for businesses in TI industries across all 20 years of our data based on a year-to-year autoregressive process similar to that used by Jacobsen (1988) and McNamara *et al.* (2003). With this model, we can assess the degree to which abnormally higher or lower business returns decay over time to the mean. Specifically, the dependent variable we used was the ROA of business *j* operating in year *t* (ROA_{jt}). It was regressed on a constant, a one-year lagged value of the dependent variable (ROA_{jt-1}), a year counter ranging from 1 (in 1979) to 19 (in 1997) ($YEAR_t$), a term interacting lagged ROA and the year counter ($ROA_{jt-1}*YEAR_t$), a measure of annual GDP growth ($GDPG_t$), a measure of annual inflation (INF_t), and an error term (ε_{jt}).

With this model, the coefficient estimate of the one-year lagged ROA (ROA_{jt-1}) generally falls between 0 and 1.00 with a value near 1.00 indicating that there is little if any decay in abnormal returns from the last to the current year. The coefficient estimate on the year counter ($YEAR_t$) indicates linear time trends in business returns. The key term in this model is the interaction term ($ROA_{jt-1}*YEAR_t$) the coefficient estimate for which indicates whether the rate of decay in abnormal returns exhibits any linear time trends over the study period. Consistent with Hypothesis 2a, we predicted that that this interaction term would exhibit a significant and negative coefficient estimate, indicating an increasing rate of decay in abnormal returns over 1979-1997.

To control for macroeconomic conditions that may also affect the degree to which abnormal returns persist, we included two control variables. Economic growth ($GDPG_t$) was measured using the rate of growth in the gross domestic product on an annual basis. We also controlled for the inflation rate (INF_t) using the percentage change in the consumer price index.

To test Hypothesis 2b, we conducted a slightly different autoregressive analysis. With this analysis, we used businesses from all industries in our sample and conducted an initial regression analysis that includes the same base variables as in our first autoregressive model. Then, we added a dummy variable for technology intensive industries ($TECH_i$). On its own, this term provided insight on the possibility of systematic differences in the operating returns of businesses in TI industries over the entire period studied. We then added an interaction term ($ROA_{jt-1}*TECH_i$). This interaction term indicated whether the rate of decay in abnormal returns differed between businesses from TI versus non-TI industries in our sample. If significant and negative, indicating a higher decay rate for firms in technology industries, the coefficient on this interaction term would indicate support for Hypothesis 2b.

Loss of Market Leadership Analysis

We used logistic regression to test Hypotheses 3a and 3b. We began by first identifying the business in each industry with the largest share of industry sales in a given year ($LEADER_{it}$), and used only these observations in our analyses. We then constructed a dummy variable, our dependent variable, to identify whether or not that firm was still the market share leader in the following year ($LEADER_{it+1}$). For our test of Hypothesis 3a, we limited our analysis to these 31 TI-industry market share leaders. We conducted an initial regression analysis that also included a control for industry concentration, using a Herfindahl-Hirschman index score (HHI_{it}). Industry concentration may influence the ability of a single business to exercise market power and or for multiple businesses to collude to maintain market stability (Viscusi *et al*., 1995). We then added a year counter ($YEAR_t$) to indicate whether or not there is a time trend in the likelihood that a market share leader will be dethroned. In line with Hypothesis 3a, we expect to find the coefficient estimate for the *YEAR* variable to be positive and significant, indicating that the likelihood lost market share leadership by businesses in TI industries had increased over the period studied.

To test Hypothesis 3b, we included businesses with leading shares of annual industry sales from all industries in our sample. Using logistic regression, we tested whether the likelihood of lost market share leadership by these businesses was different for businesses in TI or non-TI industry. We again began by regressing a dummy variable for loss of market share leadership in the subsequent year ($LEADER_{it+1}$) on current year industry concentration (HHI_{it}), and on a dummy variable for TI industries ($TECH_i$). The TI industries dummy permitted a test of differences in the likelihood of lost market share leadership for businesses in TI versus non-TI industries. Hypothesis 3b would be supported if the coefficient estimate for $TECH_i$ is positive and significant, indicating that market share leading businesses in TI industries are more likely to lose their positions than counterparts in non-TI industries.

Mortality (Hazard Rate) Analysis

To test Hypothesis 4a, we resorted to a proportional hazard rate model (Lin & Wei, 1989) explaining the likelihood that a business would disappear (exit) from TI industry *i* in the following year *t*. The model operationalizes business mortality as a dummy taking the value of 1 if the business does not survive in the following year. Our independent variables included a year counter (*$YEAR_t$*), and various controls to account for macroeconomic and industry-specific conditions that might also affect business mortality. We included economic growth (*$GDPG_t$*) to control for economic conditions possibly affecting the likelihood of business failure. We also included the annual dollar volume of US mergers and acquisitions (*$VM\&A_t$*) as activity in this field may also change the likelihood of industry exit. Finally, we controlled for industry density (*$INDDENS_{it}$*) using a count value of businesses in the appropriate four-digit SIC. We also included the quadratic form of this term (*$INDDENS_{it}^2$*) to capture possible non-linear, inverted U-shaped density effects. These control variables were standardized with a mean value of 0 and a standard deviation of 1 to limit the effect of multicollinearity on the results, and to allow for estimates that were of a magnitude easily represented in the results table. Consistent with Hypothesis 4a, we predicted that the coefficient estimate for the year counter (*$YEAR_t$*) term, would be significant and positive, indicating an increasing likelihood of mortality (exit) over the 1978-1997 period. Over time, increasing dynamic competition would increase the likelihood of business mortality in TI industries.

To test Hypothesis 4b, we included businesses from all industries in our sample and used the proportional hazards model to test for systemic differences in the mortality rate of businesses in TI versus and non-TI industries. We first regressed the dependent variable for business mortality on the control variables (*$GDPG_t$, $VM\&A_t$, $INDDENS_{it}$, $INDDENS_{it}^2$*) used in the first mortality analysis. We then added a dummy variable for TI industries (*$TECH_i$*) to test whether there were differences in the likelihood of business mortality for TI versus non-TI industries. Consistent with Hypothesis 4b, we predicted that the estimate for *$TECH_i$* would be significant and positive, indicating a higher mortality rate in TI industries.

4. RESULTS

Industry Dynamism Results

We begin discussion of our results with those related to industry-level hypotheses. Recall that we developed hypotheses predicting increase in dynamism over time (1978-1997) in TI industries (Hypothesis 1a) as well as greater dynamism in TI compared to non-TI industries over the entire period of observation (Hypothesis 1b). Results from our within subjects analysis of industry dynamism listed in Table 2 support neither of these predictions. As a preliminary analysis, we first estimated an equation for each dependent variable using industry dummy variables only. We then added dummies for three of our four five-year data windows (omitting the final window running from 1993-1997). Hypothesis 1a predicted that the time-period dummies should all be negative with the largest magnitude in the earliest time period. As Column 2 of Table 2 indicates, the signs on the time-period dummies were neither consistent with the predicted pattern, nor significantly different from zero. Addition of the time-period dummies did not significantly improve the explanatory power of the industry dynamism regression ($F = 0.14$; $p > 0.10$). Thus, we observed neither significant increase nor decrease in the dynamism of TI industries from 1978 to 1997. Levels of dynamism in TI industries showed no change from the late 1970s to the late 1990s.

To test Hypothesis 1b, we compared the level of dynamism in our TI industry sub-sample to non-TI industries in the broader sample. Again, we found no evidence of significant difference in the overall dynamism exhibited by TI versus non-TI industries ($F = 0.99$, $p = .32$). Thus, we find no support for Hypothesis 1b. In sum, our industry-level analyses provide no evidence consistent with either an increase in dynamic competition in TI industries during the 1980s and 1990s, or significantly greater dynamism in TI versus non-TI industries over the same period.

(*Insert Table 2 Approximately Here*)

Autoregressive Model Results

We next turn to results from analysis of intra-industry business-level indicators of increased dynamic competition within TI industries during the 1980s and 1990s. Hypothesis 2a predicted a decrease in the durability of abnormal business returns in TI industries over this time period. We tested this prediction with results from two autoregressive analyses reported in Table 3. Similar to the industry-level analysis results, they provided little indication of any significant increase in business performance instability over the period of study. Consistent with Jacobsen (1988), we found that the base autoregressive coefficient was significant, positive and less than one ($ROA_{it-1} = 0.7078$). Business performance exhibited significant time trends and abnormal business returns tended to regress to the mean over time. Recall that Hypothesis 2a's support depended on there being a significant increase in the decay rate of abnormal business returns over the period studied. This implied a significant and negative coefficient estimate for the interaction term included in the expanded autoregressive model in Column 2 of Table 3 ($ROA_{it-1}*Year_t < 0$). As results reported there indicate, the coefficient estimate on this interaction term was not significantly different from zero ($t = -0.35$; $p = 0.73$), thus indicating no support for Hypothesis 2a. We found no evidence of decreasing durability in the abnormal returns of businesses in TI industries in the 1980s and 1990s.[7]

To test Hypothesis 2b, we looked for differences in the decay rate of abnormal returns for businesses in TI versus non-TI industries over 1978-1997. Results in Column 4 of Table 3 indicated that there was, in fact, a statistically significant difference in the decay rate of abnormal business returns in TI versus non-TI industries ($t = 7.08$, $p < 0.01$); however the positive sign on the interaction term indicates that, in contrast with Hypothesis 2b, the decay rate for businesses in the TI industries is *lower* than for businesses in non-TI industries. Admittedly, this effect has a small degree of explanatory value on the overall regression (Incremental $R^2 = 0.0003$), and thus, should be interpreted with care. Still, this result is clearly inconsistent with the view that businesses in TI industries face more difficulty in sustaining performance differences due to greater competitive dynamism. Businesses in non-TI industries during the 1980s and 1990s apparently faced just as much (if not more) competitive pressure as businesses in TI

[7] As a follow-up to this analysis, we conducted an analysis where we included dummy variables for the TI industries to control for industry specific mean performance differences. The inclusion of these variables did not alter the findings associated with the durability of abnormal returns. We also analyzed each of the 31 four-digit SICs separately to see if they exhibited any significantly different time trends in the durability of abnormal returns compared to the larger sample of TI industries analyzed above. Interestingly, we found few industry-specific differences in linear decay rate. Of the 31 industries, 26 exhibited no linear trend. Two industries, 3823 (Industrial Instruments for Measurement, Display, and Control of Process Variables) and 3825 (Instruments for Measuring and Testing of Electricity and Electrical Signals) ($p < 0.05$ and $p < 0.10$, respectively) exhibited a significant increase in the decay of abnormal returns over the period studied, thus, indicating that it did experience a sustained increase in performance instability over the 20-year period we observed. On the other hand, four other industries exhibited significantly less decay in abnormal returns over time: 3571 (Electronic Computers) ($p < 0.01$); 3826 (Laboratory Analytical Instruments) ($p < 0.05$); 3845 (Electromedical and Electrotherapeutic Apparatus) ($p < 0.05$); and 4822 (Radio and Telegraph Services) ($p < 0.01$). Business returns in this sub-set of TI industries exhibited progressively less instability, a finding surely inconsistent with claims by many scholars that IT, telecom and or biotech sectors were becoming increasingly dynamic (*e.g.*, Evans & Schmalensee, 2001).

industries.[8]

(Insert Table 3 Approximately Here)

Loss of Market Share Leadership Analysis Results

Results from analysis of the likelihood of losing of market share leadership are reported in Table 4. With Hypothesis 3a, we predicted that the likelihood of business losing the leading share of overall industry sales in a TI industry would increase over the period studied. Results in Column 2 did not support this prediction. The parameter estimate for the year counter ($YEAR_t$) variable was not significant ($\chi^2 = 0.17$; p = 0.68), indicating no significant change in the likelihood of losing market share leadership from one year to the next over the 1978-1997 time period. TI industry leaders in the late 1990s seemed as secure (or insecure) in their position as they were in the late 1970s.

(*Insert Table 4 Approximately Here*)

Results in Column 4 of Table 4 also provided little support for proponents of greater overall dynamic competition among businesses in TI than non-TI industries. Hypothesis 3b predicted that businesses with the greatest share of sales in TI industries in a given year would be more likely to lose that position in the next year than their counterparts in non-TI industries. The test of that prediction was reflected in the parameter estimate for TI industries ($TECH_i$) in Column 4 of Table 4. That parameter estimate exhibited a *negative* rather than the predicted positive sign, though in any case, the coefficient was not significant at commonly acceptable statistical levels ($\chi^2 = 0.99$; p = 0.32). Again, results indicate no difference in the likelihood of market share leadership loss for businesses in TI versus non-TI industries. Yet another consequence of purported increase in dynamic competition in the 1980s and 1990s –increasing likelihood of dethronement from market share leadership in TI industries— has failed to find empirical support.

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[8] We also conducted autoregressive analyses using an alternative dependent variable: Return on sales (“ROS”). ROS results are completely consistent with findings reported here using ROA, and are available from the authors upon request.

Mortality (Hazard Rate) Analysis Results

Table 5 reports results from the mortality (exit) analyses. As with our earlier tests, these analyses provided little evidence supporting Hypothesis 4a's prediction of increasing business mortality (exit) in TI industries from 1978 to 1997. We expected to find the parameter estimate for the year variable in our hazard rate model to be positive and significant, thus, indicating an increase in the intra-TI industry business mortality (exit) rate over time. Instead, the key parameter estimate in Column 2 of Table 5 ($YEAR_t$) was *negative,* though not significant at commonly accepted statistical levels ($\chi^2 = 2.21$; p = 0.14). Again, our results suggested no sustained positive linear trend in the likelihood of mortality (exit) of businesses in TI industries during the 1980s and 1990s.

As with our earlier tests comparing business performance measures in TI and non-TI industries, we tested with Hypothesis 4b the prediction that businesses in TI industries would exhibit greater mortality (exit) rates compared to businesses in non-TI industries over the 1978-1997 period. Results in Column 4 of Table 5 suggested no supporting evidence for this prediction. Mortality (exit) rates for businesses in TI industries were not significantly different from rates for the broader sample of businesses from non-TI industries. The parameter estimate for the TI industry indicator variable in Column 4 of Table 5 ($TECH_i$) was not significant (χ^2=0.62, p=.43). With no support for Hypothesis 4b, we again conclude that a logical consequence of purportedly greater dynamic competition in TI industries lacks empirical support. Indeed, *all* of the predicted industry and intra-industry business consequences of greater dynamic competition failed to find support.

(*Insert Table 5 Approximately Here*)

5. DISCUSSION AND CONCLUSION

Summary of Central Findings

The recurring message in these results is that evidence of the consequences of increased dynamic competition in TI industries --increased industry dynamism, decreased durability of abnormal business returns, increased likelihood of share-leadership-loss, increased likelihood of mortality—is conspicuously absent. It is absent within TI industries and businesses assessed in isolation over time. It is absent between TI industries and businesses and their non-TI counterparts assessed in comparison. If evidence of the logical consequences of increasing dynamic competition in TI industries is so consistently lacking, what can we surmise about conclusions drawn in recent research that dynamic competition has nevertheless increased?

Reconciling Previous Research Conclusions with Present Empirical Evidence

We have three immediate answers to this question. First, the existing evidence in support of increased dynamic competition in TI industries is primarily anecdotal in nature. Researchers have marshaled case study (*e.g*., Rindova & Kotha, 2001), descriptive statistical evidence (*e.g*., Schmalensee, 2000; Evans & Schmalensee, 2001) and other anecdotes (*e.g.,* D'Aveni, 1994, 1995) to support the argument of increasing dynamic competition in the 1980s and 1990s. While important, such results would surely carry greater scholarly weight if supported by more rigorous quantitative evidence, which we found conspicuously lacking above. Instead, we suspect that proponents of increasing dynamic competition (over)rely on salient, anecdotal examples noted for their vividness and recency (Tversky & Kahneman, 1973) rather than for their representativeness of actual trends. They more easily recall recent examples of major market successes and failures, including upsets of industry titans, than more mundane events of continued industry and intra-industry stability. But the more mundane may nonetheless represent reality. In any case, it seems inadvisable to us to maintain arguments about increasing dynamic competition in TI industries given the lack of broad empirical support we note. Such an advisory seems particularly appropriate for certain TI industries linked to IT software (*e.g*., Microsoft) or telecommunications currently under close scrutiny by strategy as well as antitrust policy analysts. Claims of recent and substantial change in industry dynamism and or intra-industry performance stability merit greater skepticism and more spirited debate among scholars in light of our findings.

A second response to the question of inconsistency between arguments of increasing dynamism and missing evidence has less to do with analytical methods and more to do with industry sample selection.

Perhaps, our study would have uncovered broad trends indicating increasing dynamism if only we had sampled TI industries differently. As stated previously, our own sample of TI industries followed closely published descriptions and or sampling approaches by proponents of the increasing dynamic competition view (*e.g*., Bettis & Hitt, 1995; Schmalensee, 2000; Evans & Schmalensee, 2001). By requiring that TI industries exhibit an R&D expenditure-to-sales-ratio greater than one standard deviation above the average for the entire sample in 1997 we may have eliminated industries that some may argue have experienced dynamic competition. Others may argue that our selection criterion is not stringent enough. To test this possibility, we raised the standard for inclusion as a TI industry from one to two standard deviations above the average ratio of R&D expenditures-to-sales and found similar results.

Yet a third response to the question of inconsistency between arguments of increasing dynamism and missing evidence has less to do with research timing, sampling or analytical methods, and more to do with researcher hindsight. Perhaps academic researchers and practitioners analyzing this argument suffer from hindsight bias (Fischhoff, 1975) prompting them to view the recent past with less clarity and inevitability than they view events further back in business history. They may perceive the 1980s and 1990s as less logical and stable than more distant history, and more easily attribute to the recent past increasing dynamism in TI industries. Mintzberg (1994: 7) made a similar point about researcher hindsight and managerial egoistic bias when he chided strategy colleagues almost decade ago that "[w]e glorify ourselves by describing our own times as turbulent… While 'now' has always been turbulent, 'before' had somehow always magically stabilized, the very same 'before' that used to be 'turbulent.'" No doubt, hindsight bias, sampling, methods, and perhaps, other factors, might explain the apparent inconsistency we see in arguments versus evidence of increasing dynamic competition in TI industries.

Implications for Management Research and Practice

There are many implications to draw from this study for management research and practice. One central implication for research is that researchers in strategic management and related fields should take more care in assuming that dynamic competition is becoming more pronounced, either in TI industries specifically or across the economy more generally. Those assumptions may be based on evidence gleaned from very limited samples, drawn from inappropriate time periods, examined with *prima facie* analytics, and interpreted with hindsight bias or other bias related to currently fashionable characterizations of TI industries. Our results rebut a presumption among many scholars of greater dynamism and performance instability for businesses in TI industries over time. The burden shifts back to them to show what is really "new" about competition in "new economy" industries such as software, telecoms and pharmaceuticals. Just as critics question the need for a "new economy" exception to antitrust policy (*e.g*., Jacobson, 2001) we might also question the need for "new economy" strategic management perspectives dealing with some purported state of steadily increasing dynamism. The current retinue of perspectives may be more than capable of guiding current strategy research in TI industries exhibiting periodic ups and downs in volatility.

Limitations and Future Research

Going forward, we see many ways to refine and extend this study. One refinement relates to the way we define TI and non-TI industries and businesses. We think our definitions and resulting sampling approaches were fair and surprisingly robust to reasonable changes. Nonetheless, future research might test the robustness of our findings further with samples of businesses and industries based on quite different criteria for defining "technology intensive" or "R&D intensive" or "high technology." Our approach relied on R&D expenditure to sales ratios, which has advantages of data availability and comparability across a wide range of businesses and industries. Perhaps other measures based on more direct measures of technology and knowledge endowments (*e.g*., patent counts, scientist counts, average employee educational levels) may result in different businesses and industries included for analysis. Future research may explore such definitional alternatives as data availability and comparability increase.

For now, we conclude that there is little evidence that dynamic competition increased in TI industries from the late 1970s to the late 1990s. However, another plausible interpretation of results reported in this study notes a confluence of changes rendering competition within TI industries more dynamic *and* compensating changes in business strategy by executives. A dynamic capabilities perspective on strategy (Teece *et al*., 1997; Eisenhardt & Martin, 2000) suggests that, as dynamism increased in the 1980s and 1990s, adroit managers across TI industries also learned to make investments in technologies and related assets with more flexible dimensions, the overall effect of which led to the null effects we observed.

While plausible, we find this alternative interpretation of our results rather far-reaching and, when examined carefully, unlikely. This alternative interpretation assumes that businesses in TI industries uniformly exhibit a rather substantial capability to respond to and mitigate threats to their competitive positions quickly. In the process, it soft-pedals, we think, the significance of organizational commitments businesses often make that inhibit their ability to change course (Ghemewat, 1991), and their differential rates of friction in making change speedily due to time-impactedness (Dierickx & Cool, 1989). Such organizational characteristics leave us skeptical of this alternate interpretation, though admittedly, our empirical tests discussed above do not permit us to reject it outright.

Perhaps, however, a less ambitious form of the dynamic capabilities argument may merit closer study in response to our findings about TI industries. The concept of dynamic competition led Schumpeter to different conclusions regarding the ability of incumbent businesses in TI industries to sustain their competitive positions in the face of innovative rivals. The Schumpeter of the *Theory of Economic Development* (Schumpeter, 1934) concluded that dynamic competition would pose increasing difficulty to incumbents seeking to sustain their industry leadership and profitability in the face of entrepreneurial businesses and radical innovations. Later, though, the Schumpeter of *Capitalism, Socialism and Democracy* (Schumpeter, 1950) reached a different conclusion. Dynamic competition still threatened industry leaders, particularly where rival firms were armed with radical innovations. Over time, however, economies of scale and scope necessary to develop and successfully commercialize innovations would increasingly favor leaders, their more routinized and incremental approach to innovation, and would temper the dislocational potential of dynamic competition. Indeed, these incumbent advantages related to scale and scope would lead to ever fewer viable industry rivals, and eventually, to industry monopoly.

Teece *et al*. (1997) and others (*e.g*., Mitchell, 1991; Tripsas, 1997; Rothaermel, 2001) may reflect aspects of this later Schumpeterian view applied to the business strategy domain when they highlight the importance of "complementary" or "specialized" or "co-specialized" assets with competitive value to industry leaders across a range of related innovation contexts. Such assets may buffer incumbent leaders from the full force of competitive dynamism generated by a new entrant's innovation. Within TI industries, such advantages to incumbents (disadvantages to newcomers) may have proved more durable in the 1980s and 1990s than many scholarly proponents of increasing dynamic competition have admitted to date. Rather than claim that all TI businesses developed compensating dynamic capabilities leading to the trendless findings reported above, we speculate that these less complex tendencies related to industry incumbency and leadership might explain the absence of change in TI market dynamism, in the 1970s, 1980s, 1990s, and probably, today. Perhaps proponents of increasing dynamic competition might benefit from re-examination of their arguments through this more "traditional" Schumpeterian lens.

Similarity between past and present should not stifle further research into the causes and consequences of dynamic competition in TI industries. Our study tested for evidence of longer-term (20-year) linear trends in dynamic competition across TI industries generally; it was not focused on shorter-term peaks and troughs in dynamism that might be specific to a TI industry subset or an individual TI industry. Though less grandiose, this research direction could yield important insight on conditions that move specific industries in and out of periods of temporarily heightened volatility as well as strategic actions firms may take to exploit such volatility. Footnoted analyses of several individual TI industries included in our sample suggested that different industries might experience rather different levels of dynamic competition over time. Future research would benefit from a greater understanding of the endogenous and exogenous forces that lead to such variation. Other future research could explore how effective businesses differ in strategy and structural responses calculated to mitigate if not exploit these changes. With such follow-on work, researchers might develop a contingency-based understanding of likely responses to phases of rising and falling dynamism by industry incumbents, new entrants and potential entrants influencing the structure, conduct and performance of TI industries over time.

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TABLE 1

TI Industries Used in Analyses

SIC Code	Description
2800	Chemicals and Allied Products
2820	Plastics, Materials, and Synthetic Resins
2833	Medicinal Chemical Botanical Products
2834	Pharmaceutical Preparations
2835	In Vitro and In Vivo Diagnostic Substances
2836	Biological Products
3555	Printing Trades Machinery and Equipment
3570	Computers and Office Equipment
3571	Electronic Computers
3572	Computer Storage Devices
3575	Computer Terminals
3577	Computer Peripheral Equipment
3578	Calculating and Adding Machines
3661	Telephone and Telegraph Apparatus
3663	Radio and Television Broadcasting and Communications Equipment
3674	Semiconductors and Related Devices
3695	Magnetic and Optical Recording Media
3822	Automatic Controls for Regulating Commercial and Residential Climate
3823	Industrial Instruments for Measurement, Display, and Control of Process Variables
3825	Instruments for Measuring and Testing of Electricity and Electrical Signals
3826	Laboratory Analytical Instruments
3827	Optical Instruments and Lenses
3841	Surgical and Medical Instruments and Apparatus
3842	Orthopedic, Prosthetic, and Surgical Appliances
3844	X-ray Apparatus and Related Irradiation Apparatus
3845	Electromedical and Electrotherapeutic Apparatus
3861	Photographic Equipment and Supplies
4822	Radio Telegraph Services
7372	Prepackaged Software
7373	Computer Integrated Systems Design
8731	Commercial, Physical, and Biological Research

TABLE 2

Within Subjects Model Results: Impact of Time (Comparison of Four Windows) and Membership in a TI Industry on Industry Dynamism[a,b]

Independent Variables	Examination for a Change in Dynamism Over Time in TI Industries: Controls Only	Including Time Periods	Examination for Differences in Dynamism in TI & Non-TI Industries: Base Model	Model with the TI Industry Indicator
Constant	0.0493†	0.0471	0.0756**	0.0760**
	(0.0279)	(0.0293)	(0.0030)	(0.0031)
Time Period 1 (*1978-1982*)		0.0014	0.0100*	0.0099*
		(0.0016)	(0.0044)	(0.0044)
Time Period 2 (*1983-1987*)		-0.0005	0.0023	0.0023
		(0.0129)	(0.0044)	(0.0044)
Time Period 3 (*1988-1992*)		0.0071	-0.0021	-0.0021
		(0.0129)	(0.0043)	(0.0043)
TI Industry ($TECH_i$)				-0.0080
				(0.0081)
F	1.93*	1.70*	2.84*	2.37†
R^2	0.4303	0.4338	0.0031	0.0035
Incremental F		0.14		0.99
Incremental R^2		0.0035		0.0007
N	104	104	2736	2736

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
[a] Industry dummy variables excluded from the table.
[b] Standard errors in parentheses.

TABLE 3

Autoregressive Model Results: Impact of Time (Year) and Membership in a TI Industry on Lagged Business-Unit ROA's Relationship to Current Period ROA[a]

Independent Variables	Examination for a Change in the Decay Rate Over Time for Businesses in TI Industries: Base Model	Examination for a Change in the Decay Rate Over Time for Businesses in TI Industries: Model With the Year Interaction Term	Examination for Differences Between Businesses in TI vs. Non-TI Industries: Base Model	Examination for Differences Between Businesses in TI vs. Non-TI Industries: Model with the TI Industry Interaction Term
Intercept	0.0102	0.0098	0.0187**	0.0194**
	(0.0065)	(0.0066)	(0.0017)	(0.0017)
Prior Performance (ROA_{jt-1})	0.7078**	0.7144**	0.6737**	0.6663**
	(0.0071)	(0.0204)	(0.0023)	(0.0025)
Year Counter ($YEAR_t$)	-0.0002	-0.0001	-0.0004**	-0.0004**
	(0.0003)	(0.0003)	(0.0001)	(0.0001)
GDP Growth Rate ($GDPG_t$)	-0.0005	-0.0005	0.0029**	0.0029**
	(0.0006)	(0.0006)	(0.0002)	(0.0002)
Inflation Rate (INF_t)	0.0025**	0.0025**	0.0016**	0.0017**
	(0.0007)	(0.0007)	(0.0002)	(0.0002)
TI Industry ($TECH_i$)			-0.0096**	-0.0140**
			(0.0010)	(0.0012)
Year Interaction ($ROA_{jt-1}*YEAR$)		-0.0005		
		(0.0014)		
TI Industry Interaction ($ROA_{jt-1}*TECH_i$)				0.0432**
				(0.0061)
F	2644.5**	2115.4**	17591.1**	14675.6**
R^2	0.4891	0.4891	0.4944	0.4947
Incremental F		0.01		50.11**
Incremental R^2		0.0000		0.0003
N	11,055	11,055	89,937	89,937

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

[a] Standard error terms appear in parentheses.

TABLE 4

Logistic Regression Model Results: Examining the Impact of Time (Year) and Membership in a TI Industry On the Likelihood of Losing Market Share Leadership[a]

	Examination for a Change in the Likelihood of Losing Market Share Leadership In TI Industries		Examination for Differences Between Businesses in TI vs. Non-TI Industries	
Independent Variables	Base Model	Model With the Year Interaction Term	Base Model	Model with the TI Industry Interaction Term
Intercept	1.0894**	0.9957**	0.9506**	0.9437**
	(0.1609)	(0.2795)	(0.0381)	(0.0393)
Industry Concentration (HHI_{it})	-0.3995	-0.4154	-0.6789**	-0.6870**
	(0.5148)	(0.5159)	(0.0686)	(0.0695)
Year Counter ($YEAR_t$)		-0.0083		
		(0.0204)		
TI Industry ($TECH_i$)				-0.0782
				(0.1079)
χ^2	0.60	0.77	97.80**	98.28**
Incremental χ^2		0.17		0.48
N	513	513	13,717	13,717

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
[a] Standard errors in parentheses.

TABLE 5

Hazard Rate Model Results: Impact of Time (Year) and Membership in a TI Industry on Likelihood of Business Mortality (Exit from Industry)[a]

	Examination for Change in the Mortality Rate Over Time For Firms in TI Industries		Examination for Differences Between Firms in TI vs. Non-TI Industries	
Variables	Base Model	Model with Year Variable	Base Model	Model with TI Industry Term
GDP Growth Rate ($GDPG_t$)	-0.0004	-0.0030	-0.0012	-0.0012
	(0.0115)	(0.0118)	(0.0037)	(0.0037)
M&A Value ($VM\&A_t$)	0.0255†	0.0395*	0.0205**	0.0207**
	(0.0141)	(0.0169)	(0.0044)	(0.0044)
Industry Density ($INDDENS_{it}$)	-0.0297	-0.0189	-0.0299**	-0.0292**
	(0.0188)	(0.0204)	(0.0055)	(0.0056)
Industry Density^2 ($INDDENS_{it}^2$)	0.0075	0.0054	0.0074**	0.0072**
	(0.0053)	(0.0055)	(0.0021)	(0.0021)
Year Counter ($YEAR_t$)		-0.0035		
		(0.0023)		
TI Industry ($TECH_i$)				-0.0075
				(0.0095)
χ^2	6.39	8.67	53.56**	54.15**
Incremental χ^2		2.28		0.59
N	13,151	13,151	107,979	107,979

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
[a] Standard errors in parentheses.