Are Technology−Intensive Industries More Dynamically Competitive? No and Yes

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Abstract

A growing body of research in management and related public policy fields concludes that the 1980s and 1990s saw greater dynamic competition throughout technology−intensive (“TI”) industries, with wide−spread, steady increase in TI industry and business performance instability as principal consequences. We test for evidence of these consequences in a large sample of US businesses operating from 1978−1997 in 31 industries with high average RDexpenditure−to−sales ratios. In the full sample, we find no evidence of sustained increase in TI industry and business performance instability, nor any evidence of significant cross−sectional differences in performance instability between TI and non−TI industry businesses over these 20 years. For a small segment of very high−performing businesses from TI industries, however, we do uncover evidence of both significantly declining performance stability as well as evidence of significant cross−sectional differences in performance stability compared to similarly high−performing businesses from non−TI industries over 20 years. We conclude that assumptions of wide−spread, long−term increase in dynamic competition lack robust evidentiary support. It is premature to embrace and apply broadly new theoretical perspectives, management practices and public policies to TI industry competitive dynamics that may be little changed since the late 1970s. Yet, we find evidence of increasing dynamic competition within the strict boundary conditions of very high−performing TI industry businesses. Careful application of new perspectives, practices and policies within these boundary conditions may contribute significantly and substantially to explanations of business behavior and performance in TI industries.

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Abstract

A growing body of research in management and related public policy fields concludes that the 1980s and 1990s saw greater dynamic competition throughout technology-intensive ("TI") industries, with wide-spread, steady increase in TI industry and business performance instability as principal consequences. We test for evidence of these consequences in a large sample of US businesses operating from 1978-1997 in 31 industries with high average R&D expenditure-to-sales ratios. In the full sample, we find no evidence of sustained increase in TI industry and business performance instability, nor any evidence of significant cross-sectional differences in performance instability between TI and non-TI industry businesses over these 20 years. For a small segment of very high-performing businesses from TI industries, however, we do uncover evidence of both significantly declining performance stability as well as evidence of significant cross-sectional differences in performance stability compared to similarly high-performing businesses from non-TI industries over 20 years. We conclude that assumptions of wide-spread, long-term increase in dynamic competition lack robust evidentiary support. It is premature to embrace and apply broadly new theoretical perspectives, management practices and public policies to TI industry competitive dynamics that may be little changed since the late 1970s. Yet, we find evidence of increasing dynamic competition within the strict boundary conditions of very high-performing TI industry businesses. Careful application of new perspectives, practices and policies within these boundary conditions may contribute significantly and substantially to explanations of business behavior and performance in TI industries.

Keywords: dynamic competition, technology-intensive industries

The last decade saw growing discussion among academics in management and related fields regarding what many perceived as quickening innovation pace, shortening technology and product lifecycles, increasing volatility in sales and profits, and shifting patterns of business rivalry, particularly in industries described as "high-technology" or "new economy" or as we describe them below, "technology-intensive" ("TI") industries. Several scholars argue that these changes began in the US during the mid-1970s and worked through the 1980s and 1990s to transform competition in TI industries from predominately static to dynamic with traditional sources of competitive advantage rendered increasingly less durable (*e.g*., D'Aveni, 1994; Bettis & Hitt, 1995; Nault & Vandenbosch, 1996; Thomas, 1996; Schmalensee, 2000; Evans & Schmalensee, 2002; Hitt, Ireland, Camp & Sexton, 2001).

Prescriptive implications of increasing dynamic competition are far-reaching for management research. Theoretical perspectives reaching back to Schumpeter (1934, 1939, 1950) have acknowledged the potential for greater swings in year-to-year profitability, sales, even survival in TI industries where dynamic competition, that is, innovation-based competition for markets, is more pronounced. Increasing dynamic competition in TI industries implies a new vogue for Schumpeterian perspectives emphasizing environmental volatility, potential for performance instability and the importance of ephemeral factors in any explanation of business performance differences. For management researchers holding for this "fundamental shift" in the nature of competition (*e.g*., Thomas, 1996; Wiggins & Ruefli, 2005), sustained competitive advantage is increasingly rare. When observed, it is better explained as a concatenation of several ephemeral advantages, rather than as a few "big bets" with long-term consequences. Increasing dynamic competition in TI industries demands greater attention to perspectives emphasizing "strategic entrepreneurship" (Hitt *et al*., 2001) and "dynamic capabilities" (Teece, Pisano & Shuen, 1997; Brown & Eisenhardt, 1998; Eisenhardt & Martin, 2000) rather than difficult-to-reverse commitments (Ghemewat, 1991) to business resources, industry structures and corporate relationships that might be quickly rendered obsolete in a new and fast-changing technological landscape (Bettis & Hitt, 1995).

As, perhaps, Makadok (1998) first pointed out, the popularity of this view rests on rather thin empirical evidence, mostly in the form of descriptive analyses (Schmalensee, 2000; Evans & Schmalensee, 2002), case studies (Rindova & Kotha, 2001) and single industry statistical studies (Nault & Vandenbosch, 1996). To date, only four published broad sample, multi-industry studies have investigated these assumed trends across several years. They yield a mixed bag of evidence consistent (Thomas, 1996; Wiggins & Ruefli, 2005) and inconsistent (Castrogiavanni, 2002; McNamara, Vaaler & Devers, 2003) with the assumption of increasing dynamic competition in TI industries. These four studies all sample from a range of TI *and* non-TI industries even though the phenomenon of increasing dynamic competition may be most pronounced in TI industries. Other analytical methods vary considerably across the four studies and make it difficult to accord their findings appropriate weight. Results based on more precise TI industry sampling and more robust analytical methods would greatly improve our understanding of evidence related to debate over increasing dynamic competition and its various research, practice and policy implications.

We respond with the first long-term study of performance stability trends across a broad range of TI industries and businesses. Specifically, we examine the operating behavior and returns of 2,309 businesses operating in 31 TI industries from 1978-1997. With this sample, we apply a battery of tests for evidence of the consequences consistent with greater dynamic competition in TI industries since the late 1970s, that is, tests for: 1) reduced durability in abnormal business returns; 2) less durable positions of market leadership; 3) greater mortality rates; and 4) increasing industry dynamism. We apply these tests to probe for longitudinal trends within the sample of businesses in TI industries from 1978-1997, and for cross-sectional trends between this sample and a broader sample of businesses operating in non-TI industries from 1978-1997.

Test results yield a mix of general and segment-specific trends important to scholars, practitioners and policy-makers. On the one hand, results from longitudinal study of all businesses in TI industries yield no general trend of increasing dynamic competition from 1978-1997. At the industry-level, we find no evidence of increasing dynamism. At the business-level, we find no patterns suggesting a general decrease in the ability to maintain year-to-year operating performance differences, market leadership and or survival.

Similarly, cross-sectional tests comparing all businesses in TI to all businesses in non-TI industries across the same 20-year period uncover few if any significant performance differences.

On the other hand, we do uncover evidence that a small segment of very high-performing businesses in TI-industries exhibit statistically significant and practically substantial declines in their ability to sustain lofty performance advantages over our 20-year period of observation. These very high-performance businesses in TI industries also exhibit decreasing ability to maintain superior performance compared to similar businesses from non-TI industries. These contrasting results tell us that claims of increasing dynamic competition in TI industries lack broad general support. Yet, such claims should not be entirely dismissed. Theoretical perspectives, practical business strategies, and prudential public policies based on the assumption of increasing dynamic competition in TI industries may yet apply to a select group of businesses in very high-performing TI-industry segments. If the question posed by this research is whether dynamic competition has steadily increased in TI industries, then our answer is generally "no," but perhaps selectively, "yes."

To make these points in greater detail, we organize the remainder of our study into four additional sections. Section 2 immediately below defines the fundamental concept of dynamic competition, and describes current management and related researcher claims regarding its assumed increase in the 1980s and 1990s. In Section 3, we derive four sets of hypotheses related to the logical consequences of increasing dynamic competition in TI industries. Section 4 describes our methodology for testing these four sets of hypotheses. Section 5 reports results from our tests. Section 6 interprets our general findings undercutting and selective findings supporting claims of increasing dynamic competition in TI industries. We discuss their implications for management research, practice and related public policy issues, and suggest future avenues of research.

BACKGROUND

The Dynamic Competition Concept in Schumpeter and in Contemporary Research

Central to this study is concept of dynamic competition, which harkens back to Joseph Schumpeter (1934, 1939, 1950) and his vision of technology-based competition and economic development as a process of "creative destruction" rather than as a stable equilibrium condition. Schumpeter (1950: 81-86) describes dynamic competition as innovation-based rivalry *for markets* rather than price- and output-based competition *within markets*. Episodic rivalry between incumbent and insurgent businesses 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 (Schmalensee, 2000; Evans & Schmalensee, 2002).[1]

With such attributes, it is not surprising that dynamic competition is described by contemporary management researchers in terms of fast-changing technologies, markets and organizational environments as well as shifting patterns of investment and performance. For example, Thomas (1996: 221) holds that "*dynamic* (*or Schumpeterian*) *competition* changes technology at various points of the value chain, challenging firms to compete in completely new ways." As dynamic competition increases, "the strategic focus of firms shifts from careful exploitation of given, highly durable strategic assets to the steady creation of many new, rapidly depreciable assets."

With faster rates of technological change and the strategic shift to ephemeral sources of advantage, it is not surprising that increasing dynamic competition is associated with greater environmental volatility and performance instability. Schmalensee (2000) describes the US software industry of the 1980s and 1990s in such terms. Software firms are increasingly vulnerable to broad swings in profitability, sales and market share. In such markets, it is increasingly difficult to maintain market leadership, fend off rival innovators, or just keep up with the "generally brisk" pace of innovation and survive (Schmalensee, 2000: 193).

Other contemporaries echo these points about the causes and consequences of increasing dynamic competition in TI industries. Bettis and Hitt (1995), Brown and Eisenhardt (1998), Stopford (2001), Hitt *et al.* (2001) and others have reasoned that the 1980s and early 1990s saw a technological transformation of the competitive landscape of US TI industries, and link it to a combination of: US TI industry deregulation

[1] Examples of dynamic competition fitting this description in recent times come from many TI industry contexts. The personal computer industry, for example, requires firms to make substantial investments in human capital and know-how and produces episodic battles for establishment of favorable technology standards leading to the serial dominance of one or a few "winners." In this industry, market leadership changed hands six times over a twenty-five year period (1977-2002): from Radio Shack (TRS-80) to Atari, Commodore, Apple, IBM, Compaq, and most recently, Dell. The pre-packaged software industry provides another illustration. In spreadsheet products during 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 (*e.g.*, Novell's Quattro), adroitly parried by Microsoft.

and globalization, particularly in telecommunications, computing and Internet-related industries; intellectual property regime modernization; growth in venture capital markets; development of a technologically-adept entrepreneurial class; and new transactional modes (*e.g*., cross-licensing) and organizational modes (*e.g*., alliances, networks). Increasing rates of technological change and uncertainty were in the landscape background, with firms competing more on knowledge-based assets and network relationships, and coping with greater performance variability in the landscape foreground. Business responses to this "new" context include frequently "morphing" organizational structure to fit fast-changing markets (Rindova & Kotha, 2001) and "cannibalizing" currently technology assets to produce the next generation of temporary advantage (D'Aveni, 1994; Nault & Vandenbosch, 1996). By the mid-1990s, such perceived environmental trends and business responses led Garud and Karaswarmy (1995: 93) to proclaim that the "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..."

Outside the management field, scholars in economics, law and public policy have advanced similar views about increasing dynamic competition in the 1980s and 1990s. Industrial organization economists like Baumol (1993; 2002) and Khalil (1997) describe emerging patterns of technology-based competition (after Lewis Carroll's *Through the Looking Glass*) as generating a "Red Queen" effect, 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. Public policy commentary by Ahlborn, Evans and Podilla (2001) criticizes existing antitrust regulations in Europe while policy commentary by Jorde and Teece (1989) and legal analyses offered by Posner (2001) criticize current US antitrust regulations for perceived bias against successful businesses in TI industries --Microsoft with its Windows operating system and Explorer web browser, for example. To these critics, such businesses enjoy increasing returns to scale, dominant market positions and high profits as a "normal" result of episodic "winner-take-all" (or "winner-take-most") rivalries. Increasingly frequent and radical technological shifts will make it difficult for such businesses to hold onto leadership through simple extension of an initially dominant market position, thus obviating the need for close government antitrust oversight. Their arguments reflect growing faith in what Roberts (2001) describes as a Schumpeterian built-in error correction mechanism of markets created by TI businesses and consumers.

Previous Broad Sample Studies Related to Increasing Dynamic Competition in TI Industries

Interestingly, the evidentiary basis for the conclusion of increasing dynamic competition derives largely from anecdotes, descriptive analyses, case studies and limited statistical studies of one or two industries over a short time-span. They derive from anecdotes about the frequency of innovation in the US software industry during the 1990s (Schmalensee, 2000), and descriptive analyses documenting the "high" turnover in the top-ten largest TI firms by sales from 1990-2000 (Evans & Schmalensee, 2002). It derives from case studies of continuous product and organizational change in successful Internet portal firms (Rindova & Kotha, 2001), and from focused industry studies of US printer and chip makers in the 1980s and 1990s pre-empting rival attempts to supplant their technology leadership by "eating their own lunch," that is, rapidly replacing popular TI products with more sophisticated versions financed from current product profits (Nault & Vandenbosch, 1996). While important, such evidence still raises questions in scholars and others regarding the depth and breadth of any time trend in business performance stability. As Makadok (1998) may have first pointed out, those making the case for developing new theory and practice to deal with trends promoting increasing performance instability would benefit from complementary studies documenting these trends in a broad, multi-industry, multi-year sample of firms.

To date, only four published studies fit that description generally, though none focus on performance trends across TI industries specifically. The study by Thomas (1996) was first, and came as part of a larger volume of research on theoretical perspectives and empirical evidence related to "hypercompetition" (D'Aveni, 1994; *Organization Science*, 1996). Thomas examined growth rates in the market value of corporations operating primarily in one of 200 US manufacturing industries from 1958-1991. He linked firm market value to corporate expenditures on salary and general administrative expenses, which he took as a proxy for industry rivalry levels. He observed an inverted-U shaped relationship between levels of industry rivalry on the one hand, and growth of firm market value in later years of his sample (1970s-1991) on the other hand. He took this relationship as evidence of a generalized "hypercompetitive shift" in recent US corporate performance.

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 performance 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 intra-industry business performance instability in a sample of more than 110,000 annual business-unit returns reported for nearly 20,000 businesses operating in over 900 four-digit Standard Industrial Classification ("SIC") non-banking industries from 1978-1997. They found no sustained trends indicating greater industry dynamism, decreasing industry munificence, less sustainable operating business performance differences, or business mortality rates. 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.

Wiggins and Ruefli (2005: 894) accepted previous findings by McNamara *et al.* (2003) regarding the lack of time trends in broader industry dynamism and munificence, and regarding intra-industry business mortality rates, but uncovered other time trends in performance indicative to them of increasing instability. They examined performance stability trends in 6,772 US corporations and their affiliated businesses operating in 40 3- to 4-digit SIC industries from the 1970s to 1997. Using an iterative Kolgomorov-Smirnov technique, they partitioned samples into superior, modal and inferior performing strata, and found in multivariate analyses that corporations in the superior stratum for a minimum of 10 consecutive years (7.78% of their observations based on ROA performance measure and 3.77% of the sample using a Tobin's Q performance measure) were significantly less likely to remain there later in their time period of study.

Interestingly for our study, they also found this trend in certain corporations/business judged to be operating in seven "high tech" industries they sampled. With the superior stratum, they also conducted univariate analyses indicating that businesses leaving this stratum were significantly less likely to return in later years. They took these results as broad evidence of significantly increasing corporate/business performance instability consistent with Thomas (1996) and his conclusion of a hypercompetitive shift in the US economy.

These four studies yield evidence indicating support for (Thomas, 1996; Wiggins & Ruefli, 2005) and skepticism about (Castrogiavanni, 2002; McNamara *et al*., 2003) claims of increasing performance instability since the late 1970s. Closer scrutiny to sampling and other analytical methods used might indicate appropriate weight to give each study. For example, results from Thomas (1996) and Castrogiavanni (2002) might be given less weight since their samples were limited to manufacturing industries, which currently comprise a small and decreasing percentage of overall economic activity in the US. These two studies and McNamara *et al.* (2003) might also be given less weight because they fail to segregate out TI industries and businesses to probe for performance stability time trends specifically related to debate over increasing dynamic competition. Here, Wiggins and Ruefli (2005) stand out as they did examine time trends in seven TI industries and found results largely consistent with their broader set of results indicating greater performance instability over time. Yet, as we show below, these seven industries represent only a fraction of the US TI industry sector. Their sub-sample results merit re-examination with a full range of TI industries before giving Wiggins and Ruefli (2005) greatest weight.

Other analytical methods used in Wiggins and Ruefli (2005) merit closer scrutiny and caution by researchers trying to weigh findings appropriately. Wiggins and Ruefli (2005: 907) emphasize that any evaluation of time-trends in Schumpeterian competition should include *only* clearly superior performing firms (*e.g.*, at least 10 years of superior performance) rather than evaluate performance time trends for all competitors who might deviate from average performance positively or negatively over time. In this context, they argue for greater weight accorded to their findings compared to findings in McNamara *et al*. (2003) who found no time-trends in the ability of businesses to sustain abnormally higher (superior) or abnormally lower (inferior) performance levels.

The Wiggins and Ruefli (2005) position on limited (to superior performer) sampling seems to contradict Schumpeter's own view that innovation-based competition has performance implications not just for high-performers, but also for other firms responding to challenges of innovation-based competition. Schumpeter (1939: Vol I, 134) describes four prospective performance paths of these "old" incumbents facing competitive challenge:

> For some of the "old" firms new opportunities for expansion open up: the new methods or commodities create New Economic Space. But for others the emergence of the new methods means economic death; for still others, contraction and drifting into the background. Finally, there are firms and industries which are forced to undergo a difficult and painful process of modernization, rationalization and reconstruction…Aggregative analysis, here, as elsewhere, not only does not tell the whole tale but necessarily obliterates the main (and the only interesting) point of the tale.

The "point of the tale" is that innovation-based competition for markets generates performance implications for established firms and businesses at all performance levels, from the persistently profitable to the mediocre, the under-performing but re-structuring, and even to the possibly moribund. Attention to the failure or renewal of incumbent firms facing competitive challenge also occupies Schumpeter's attention in his *Theory of Economic Development* ("[D]istress is a form of the process by which means of production are withdrawn from old businesses…" (1934: 232)) and in *Capitalism, Socialism and Democracy* ("Our argument extends beyond the cases of new concerns, methods and industries. Old concerns and established industries, whether or not directly attacked, still live in the perennial gale." (1950: 90)). Any examination of time-trends in such Schumpeterian competition should be similarly broad in analytical scope.

In this context, we find it difficult to accord to any one of these four studies greater evidentiary weight in the debate about increasing dynamic competition. We still know relatively little about long-term time trends in the performance stability of businesses in TI industries. If increasing performance instability is the logical consequence of increasing dynamic competition since the late 1970s, then we should observe it in the performance patterns of a well-defined set of TI industry businesses over the same period.

HYPOTHESES

Consistent with our last point, we start with a statement of the two broad research propositions concerning TI industries in the 1980s and 1990s: 1) TI industries generally as well as individual businesses within TI industries have experienced increasing dynamic competition; and 2) TI industries generally as well as individual businesses within TI industries have experienced greater dynamic competition than other non-TI industries and businesses. We examine support for these longitudinal and cross-sectional propositions through a battery of tests, each of which probes for evidence of performance consequences associated with greater dynamic competition in a broad sample of TI industries from 1978-1997. These performance consequences follow from our discussion above and include tests for time trends in: 1) the durability of abnormal returns; 2) the loss of market leadership; 3) mortality; and 4) broader industry-wide volatility. So that our tests have broader and deeper implications, we apply them to a sample of 2,309 businesses operating in 31 TI industries in the US from 1978-1997. We apply them to these TI industries and businesses alone (longitudinally), and in comparison with an even larger sample of businesses operating in non-TI industries for assessment over the same time period (cross-sectionally).

Durability of Abnormal Business Returns and Greater Dynamic Competition in TI Industries

For businesses in TI industries, our general research propositions imply at least three sets of predictions regarding the consequences of increasing dynamic competition. The first of these predicted consequences links increasing dynamic competition to decreasing durability of abnormal business-unit returns within TI industries. Makadok (1998) and Roberts (2001) point out a rich research stream describing the self-adjusting market mechanism leading to the decay of 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 technological change; shorter product life cycles; and more aggressive interactions among rivals. As a consequence, he argues 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 also 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 (Bettis & Hitt, 1995; Chakravarthy, 1997). These developments are hypothesized to have contributed to lower entry and intra-industry mobility barriers, to greater rivalry, and to faster dissipation of abnormal returns. Schmalensee (2000) and Evans and Schmalensee (2002) have noted a greater potential decay rate in high-profitability market positions for businesses 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, they further argue that assaults by previously disadvantaged rivals using next-generation technologies arrived with increasing frequency and ferocity in the 1980s and 1990s. Dynamic competition classically starts with one or a few insurgent businesses introducing new products or services with potential for wholly displacing incumbent offerings and businesses from the market. Gans, Hsu and Stern (2002) describe an increasingly popular alternative basis for starting episodes of innovation-based competition for markets. Innovating firms first legally appropriate and then selectively license their technologies to several surrogate insurgent businesses, which in turn, start a faster-developing threat to incumbents with even greater potential decay rates (Gans *et al*., 2002). As the previously disadvantaged businesses use new forms of competitive assault to challenge currently advantaged incumbents, the impact on operating returns may be much greater than in comparable cases with businesses from non-TI industries, thus:

Hypothesis 1a: Abnormal returns of businesses in TI industries have decayed more quickly over time.

Hypothesis 1b: Abnormal returns of businesses in TI industries have decayed more quickly than for businesses in non-TI industries.

Business Market Leadership and Greater Dynamic Competition in TI Industries

As researchers in both strategy and economics have noted (Ferrier, Smith and Grimm, 1999; Schmalensee, 2000), a key metric of business success in TI industries is the ability to attain and maintain a leading market-share position. Positive network effects, feedback mechanisms, and increasing returns to scale from market leadership are especially important in TI industries. Yet, 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 strategic thrusts. Increasingly dynamic TI industries imply that market leaders face more frequent and deeper thrusts, that they may be less able to respond effectively, and that they may find it more difficult to maintain market leadership over time and in comparison to their counterparts in non-TI industries. Thus, we predict:

Hypothesis 2a: Market leading businesses in TI industries have been more likely to be supplanted from one year to the next over time.

Hypothesis 2b: Market leading businesses in TI industries have been more likely to be supplanted from one year to the next than market leading businesses in non-TI industries.

Business Mortality and Greater Dynamic Competition in TI Industries

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 (Hannan & Freeman, 1977, 1984). Thus, organizational pressures for inertia are likely to have profound effects in faster-evolving TI industries of the 1980s and 1990s. 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 (2002) and others (*e.g.*, Posner, 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. 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. Similarly, we should find that business mortality in the form of industry exit during the 1980s and 1990s should be greater overall in TI versus non-TI industries, thus:

Hypothesis 3a: Mortality (exit) rates within TI industries have increased over time.

Hypothesis 3b: Mortality (exit) rates within TI industries have been greater than within non-TI industries.

Industry Dynamism and Greater Dynamic Competition in TI Industries

With our final set of hypotheses, we raise the level of analysis to the industry level. Our general research propositions directly imply that TI industry dynamism should have increased during the 1980s and 1990s. As new technologies appear, gain acceptance and mature more quickly and with greater frequency, Schumpeterian creative destruction could become more wide-spread and pronounced across TI industries, a trend explicitly predicted by Garud and Karaswarmy (1995: 93) and contemplated by other scholars examining broader trends in the TI industry sector of the 1980s and 1990s (Bettis and Hitt, 1995; Chakravarthy, 1997; McKnight, Vaaler and Katz, 2001). In line with these views, we expect to find that industry-wide dynamism has increased from 1978-1997 and was greater than in non-TI industry dynamism over the same period, thus:

Hypothesis 4a: TI industries have exhibited greater dynamism over time.

Hypothesis 4b: TI industries have exhibited greater dynamism than non-TI industries.

METHODS

Data Collection and Sampling

To find data to test these hypotheses, we turn to the Compustat Industry Segment ("Compustat") database. Our choice follows previous researchers interested in understanding broader economy-wide trends in the performance stability of industries and businesses (*e.g.*, McNamara *et al*., 2003; Wiggins & Ruefli, 2005) as well as the relative importance of factor-types driving such performance (Roquebert *et al*., 1996; McGahan & Porter, 1997; 1999; 2002; 2003). We start with the entire Compustat database from

1978-1997, a total of 234,164 annual observations of operating results reported by publicly-traded US corporations for their major 4-digit SIC industry segments (at least 10% of sales, income or assets), which we also refer to as "business segments" or simply as "businesses." This twenty-year panel allows 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 may be increasing. Statement of Financial Accounting Standards 14 outlines the manner by which industries for individual businesses are identified for US Securities & Exchange Commission regulatory reporting purposes. These standards are fully in force from 1978 to 1997. We end our data collection in 1997, since a change in accounting standards taking effect in 1998 substantially altered the schema used to identify and report business activities in individual industries.

Compustat continues to be a central source of valuable data for strategy research largely because it provides the only easily-accessible, broad cross-sectional (economy-wide), and substantial time series (+20 years) of publicly audited (FASB/SEC) information on public US firm sales, assets, selected expenditures and operating returns by industry.[2] The 10% required reporting threshold in Compustat no doubt permits some aggregation of smaller business operations in different industries and some change in aggregation over time, though the extent of such practices appears to be limited to the point that Davis and Duhaime (1992) conclude that Compustat data is quite effective for purposes of intra-firm business market share measurement within industries defined at 4-digit SICs.[3]

We follow McGahan and Porter's (1997) suggestions for screening these data and for arriving at our base sample for subsequent analyses.[4] Once screened on their criteria, our base sample comprises a total of

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[2] See Davis and Duhaime (1992), Ravenscraft and Wagner (1992), and Villalonga (2003) for detailed comparisons of Compustat with other alternatives datasets commonly used in broad sample, multi-industry, multi-year studies of operating performance.

[3] With respect to changes in industry segment reporting by firms over time, this view would appear to be confirmed by Denis, Denis and Sarin (1997: 151-152), who investigate changes in business segment reporting by 933 larger corporations in Compustat from 1985-1989. Denis *et al.* observe 430 segment changes over the period they studied, which reflects only 6.1% of the total observations in their sample (7,052 segment-year observations). Of these, they are able to identify the underlying structural change (*e.g.*, divestiture, discontinued operations, spin-offs, business reorganizations, joint venture formation, acquisition, new business formation) leading to 75% of the reported changes, based on a review of publicly available information. We draw two implications from these results: 1) that the frequency in year-to-year industry segment changes for firms in Compustat is not high; and 2) that year-to-year industry segment changes are most likely related to real industry segment entries or exits rather than mere accounting changes.

[4] Following their recommendations, we eliminate observations if: 1) they do not contain a primary SIC designation; 2) they are from residual industry categories or government-related classifications; 3) they operate in financial services industries since their

114,191 operating performance observations from 1978-1997 posted by 19,214 different businesses operating in 982 different non-banking 4-digit industries and affiliated with 10,298 different corporations. On average, we have approximately 5700 annual business operating performance observations in each of the 20 years covered. The breadth of coverage in this base sample is very similar to the McNamara *et al.* (2003) study, and compares favorably to much more narrowly sampled returns from only 200 manufacturing industries in the Thomas (1996) study, 80 manufacturing industries in Castrogiavanni (2002) study, and 40 industries in the Wiggins and Ruefli (2005) study. We also highlight our principal focus on the business-within-industry unit rather than corporate unit of analysis. This focus is more likely to result in comparison of performance results for organizations competing in homogenous market settings.

Consistent with criteria for identifying TI industries described in Bettis and Hitt (1995) and Evans and Schmalensee (2002), we then calculate the relative R&D intensity of corporations within all industries of the base sample to identify a sub-sample of businesses from TI industries.[5] TI industries are 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.[6] We focus on the final year of the study period to make this important distinction so that, in line with recent analyses of TI industries (*e.g*., Evans & Schmalensee, 2002), we can identify industries with TI attributes at of the end of (though not necessarily throughout) the study period. Thus, industries that may not have met TI attributes in 1978 will have an opportunity to be included in the TI sample if they transformed into a TI industry during the 1980s and 1990s.[7] The mean and standard deviation for this measure of average business R&D intensity for 1997 is 1.6% and 3.5%, respectively. Based on this screen, we create a sub-sample comprising 11,626 observations of annual operating results from 1978-1997 for 2309 different businesses operating in 31

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returns are difficult to compare with those in other industries; 4) they are from small businesses with sales and or assets less than $10 million since small businesses are prone to extremely wide variance in operating returns; 5) they have ROA values exceeding 100% since this suggests that the corporate parent either understates the assets of the business or consciously lumps profits into it for reporting purposes alone; or 6) they are described as "corporate" or "other" businesses since these do not appear to be active businesses.

[5] We use data from the Compustat corporate level database for this test since R&D expenditures are not widely reported in segments.

[6] We also conduct an analysis using a two standard deviation cutoff and find results consistent with those reported here.

[7] To ensure that the industry sample we choose is not skewed by using only a single year of data, we also identify a sample of TI industries using a three-year window (1995-1997). Using the same selection criteria, the three year screen identifies 32 industries

different 4-digit industries affiliated with 1898 different corporations with average business R&D intensity values in 1997 of at least 5.1%.[8] Again, the breadth of TI industry coverage here compares favorably to Wiggins and Ruefli (2005), who examine time trends in corporate and business returns in only seven TI industries.

Consistent with our research hypotheses, we use multiple dependent variables related to industry and business performance conditions. At the business level, we include measures of business operating returns (ROA), the likelihood of falling from higher to lower business ROA levels, the likelihood of market share leadership loss by businesses, and the likelihood of industry exit (mortality) by businesses. At the industry level, we include measures of overall industry dynamism derived from aggregation of intra-industry business sales. These performance-based measures become the basis for our examination of time trends in performance stability.

Abnormal Business Returns Models

To test Hypothesis 1a, we first employ 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 Mueller (1986), Jacobsen (1988) and McNamara *et al.* (2003). With this model, we assess the degree to which abnormally higher or lower business returns decay over time to the population mean. Our dependent variable is the ROA of business *j* operating in year *t* (ROA_{jt}). It is 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 ($ROA_{jt-1}*YEAR_t$), and a set of control

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as TI, 29 of which are the same as those identified using the 1997 R&D intensity measure. We conclude that the sample we identify is robust with respect to the length of the window used.

[8] The 31 industries include: 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, and 8731 - Commercial, Physical, and Biological Research

variables.

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 returns from the previous to the current year. The coefficient estimate on the year counter ($YEAR_t$) indicates linear time trends in 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 lagged returns exhibits any linear time trends over the study period. Consistent with Hypothesis 1a, we predict that this interaction term will exhibit a significant and negative coefficient estimate, indicating an increasing rate of decay in abnormal business returns over 1979-1997. To control for macroeconomic and industry conditions that may also affect the degree to which abnormal returns persist, we include three control variables. Economic growth ($GDPG_t$) is the annual rate of growth in the US gross domestic product. We control for inflation (INF_t) using the annual percentage change in the US consumer price index. We also include a third control for industry concentration, using a Herfindahl-Hirschman index score (HHI_{it}). Industry concentration may influence the ability of a single business to curb rivalry and collude to maintain market performance stability (Viscusi, Vernon and Harrington, 1995). The simplicity of our autoregressive model differs with more complex specifications designed to assess the persistence *and* partition the components of any abnormal returns (*e.g.*, McGahan & Porter, 1999; 2003). Our interest here is limited to the persistence issue alone, with special emphasis on differences in that persistence over time.

To test Hypothesis 1b, we specify a slightly different autoregressive model designed to assess cross-sectional differences between businesses in TI versus non-TI industries from 1978-1997. With this model, we use businesses from all industries in our sample and implement a regression including the same base variables as in our first autoregressive model. Then, we add a dummy variable for businesses operating in TI industries ($TECH_i$). On its own, this term provides insight on the possibility of systematic differences in the operating returns of businesses in TI industries over the entire period studied. We then add an interaction term ($ROA_{jt-1}*TECH_i$) capturing any differences in the rate of decay in abnormal returns between businesses from TI versus non-TI industries from 1978-1997. If significant and negative, indicating a higher decay rate for firms in TI industries, the coefficient on this interaction term will provide support for Hypothesis 1b.

The autoregressive model makes no distinction between changes in the persistence of abnormally higher or lower returns. Again, this follows from Schumpeter's own insights about the performance impact of dynamic competition no matter the favorable or unfavorable market position of a TI business. On its face, this model seems most appropriate to examination of claims that the 1980s and 1990s saw greater performance instability for formerly more persistent high-, low- and mid-range performing businesses. Complementing this broader examination, we add a more targeted analysis focusing only on performance durability of high-performing businesses. A second logistic regression ("logit") model assesses changes over time in the durability of returns for progressively higher-performing businesses from TI industries.

We begin this complementary analysis by defining high-performing businesses broadly, that is, as businesses with operating returns (ROA) above their industry average in a given year. We use only these observations in our first analysis. We construct a dichotomous dependent variable to identify whether or not that business is still performing above the industry average in the following year. We then estimate a logit model with this dependent variable. For independent variables, we again include controls for economic growth ($GDPG_t$) and inflation (INF_t) and industry concentration (HHI_{it}). A year counter ($YEAR_t$) captures any time trend in the likelihood that a business performing above the industry average continues to do so in the next year. When our sub-sample is limited to above-average performers from TI industries alone, Hypothesis 1a will be supported if the coefficient estimate for the *YEAR* variable is negative and significant, indicating that the likelihood of sustaining above-average performance has decreased over time. If we replace the year counter with a dummy for TI industries ($TECH_i$), we can use the entire sub-sample of businesses from TI and non-TI industries in a logit model permitting a test of Hypothesis 1b. Support will be indicated if the coefficient on TI industry dummy is negative and significant.

We repeat this first analysis, but with progressively more exclusive definitions of high-performing businesses: those with operating returns more than one standard deviation above their industry average;

then those with operating returns more than two standard deviations above their industry average; and finally those with operating returns more than three standard deviations above their industry average. With each new and more exclusive definition of high-performing businesses, we re-estimate logit models to test for support of Hypothesis 1a and Hypothesis 1b.

We see multiple benefits in assessing performance durability using this method and sample. First, it permits closer comparison of results from analysis of time trends in high-performing businesses alone. Second, it allows us to examine high performers for a wide range of TI industries rather than a smaller, potentially unrepresentative subset. Third, our approach does not limit us to a single definition of superior performing businesses. It permits durability assessments using multiple, progressively more exclusive definitions to assess the robustness of initial results and compare performance durability trends generally and in increasingly select segments of high performers.

Loss of Market Leadership Models

We also use logit models to test Hypotheses 2a and 2b. We begin here by identifying the business in each industry with the largest share of industry sales in a given year, and use only these observations in our model implementations. We then construct a dummy variable, our dependent variable, to identify whether or not that firm is still the market share leader in the following year. To test of Hypothesis 2a, we limit our analysis to the TI-industry market share leaders. We estimate an initial logit model including a control for industry concentration, the Herfindahl-Hirschman index score (HHI_{it}). Industry concentration may also influence the ability of a single business to exercise market power and for multiple businesses to collude and maintain market stability (Viscusi *et al*., 1995). We then add a year counter ($YEAR_t$) to indicate whether there is a time trend in the likelihood that a market share leader will be dethroned. In line with Hypothesis 2a, we expect to find the coefficient estimate for the year counter ($YEAR_t$) variable to be positive and significant, indicating that the likelihood of losing market share leadership by businesses in TI industries increased in the 1980s and 1990s.

To test Hypothesis 2b, we include businesses with leading shares of annual industry sales from all industries in our sample. Using logistic regression, we test whether the likelihood of lost market share leadership by these businesses is different for businesses from TI versus non-TI industries in the 1980s and 1990s. Current year industry concentration (HHI_{it}), and a dummy variable for TI industries ($TECH_i$) comprise our independent variables. Hypothesis 2b will be supported if the coefficient estimate for the TI industry dummy ($TECH_i$) is positive and significant, indicating that market share leading businesses in TI industries are more likely to be dethroned in the following year than leaders in non-TI industries.

Business Mortality (Exit) Models

To test Hypothesis 3a, we resort to a proportional hazard rate model (Lin & Wei, 1989) explaining the likelihood that a business will disappear (exit) from one year to the next. 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 include a year counter ($YEAR_t$), and various controls to account for macroeconomic and industry-specific conditions that might also affect business mortality. We include economic growth ($GDPG_t$) to control for economic conditions possibly affecting the likelihood of business failure. We also include the annual dollar volume of US mergers and acquisitions ($VM\&A_t$) since activity in this field may also change the likelihood of industry exit. Finally, we control for industry density ($INDDENS_{it}$) using a count value of businesses in the appropriate four-digit SIC. We also include the quadratic form of this term ($INDDENS_{it}^2$) to capture possible non-linear, inverted U-shaped density effects on mortality. These control variables are 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 are of a magnitude easily represented in the results table. Consistent with Hypothesis 3a, we predict that the coefficient estimate for the year counter ($YEAR_t$) term will be significant and positive, indicating an increasing likelihood of mortality (exit) from 1978-1997 as a consequence of increasing dynamic competition.

To test Hypothesis 3b, we include businesses from all industries in our sample and use the proportional hazards model to test for systemic differences in the mortality rate of businesses in TI versus and non-TI industries. We first regress 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 add 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 3b, we predict that the estimate for $TECH_i$ will be significant and positive, indicating a higher mortality rate in TI industries over our 20-year period of observation.

Industry Dynamism Models

To test Hypothesis 4a, we take a within subjects regression model approach. This amounts 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 follow previous research (*e.g.,* Dess & Beard, 1984) in calculating dynamism for each 4-digit industry operating in four different 5-year panels of our data (1978-1982, 1983-1987, 1988-1992, and 1993-1997). To compute these scores, we first regress industry sales on variables representing the years in a five-year panel. We then divide the standard error of each regression by the mean value of sales for that industry and use the resulting value as a dynamism score for each industry in each year of four five-year periods examined.[9] In effect, the dynamism score is capturing volatility in the demand for industry products and services, an important outcome of various TI industry trends noted by researchers contending that dynamic competition increased in the 1980s and 1990s (*e.g.*, Bettis & Hitt, 1995; McKnight *et al*., 2001; Evans & Schmalensee, 2002).

With these dependent variable measures for the within subjects regression, we turn next to the independent variables. They include dummies for each industry (31) less one in our analysis. Industry dummies control for systematic, industry-specific differences in dynamism. They permit more precise analysis of common industry trends in dynamism over the period studied. We then add time-period dummies for three of the four time-panels (*1978-1982*, *1983-1987* and *1988-1992*). We exclude the dummy for the final time period (*1993-1997*). By regressing the annual measure of dynamism on these time-period dummies, we obtain coefficient estimates for comparison with each other and against the omitted time period. Hypothesis 4a will be supported if we find that the parameter estimates for all of the time-period indicator variables in the dynamism regression are negative (relative to the omitted final time-

[9] We also conduct an additional analysis measuring dynamism based on a composite measure of the standard error of sales, total assets, and capital expenditures over the same five-year periods. Results from this analysis are consistent with those reported here.

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 4b, we estimate a regression model where we first control for time-period effects. We then add a dummy variable ($TECH_i$) to denote a TI industry to compare the level dynamism in the 31 TI industries to the level of dynamism in all other non-TI industries in our sample. Hypothesis 4b will be supported if the TI industry dummy ($TECH_i$) is positive and significant, indicating that average dynamism levels in the TI industries were higher than in non-TI industries over the 20 years we observe.

RESULTS

Abnormal Returns Model Results

Hypothesis 1a, predicts a decrease in the durability of abnormal business returns in TI industries over the study period. We test this prediction with results from the first two autoregressive analyses reported in Table 1. These results provide little indication of any significant increase in business performance instability over the period of study. Consistent with Jacobsen (1988), we find that the base autoregressive coefficient is significant, positive and less than one (ROA_{it-1} = 0.7068). Business performance exhibits significant time trends and abnormal business returns tend to regress to the mean over time. Recall that Hypothesis 1a's support depends on there being a significant increase in the decay rate of abnormal business returns over the period studied. This implies a significant and negative coefficient estimate for the interaction term included in the expanded autoregressive model in Column 2 of Table 1 ($ROA_{it-1}*YEAR_t < 0$). Yet, the coefficient estimate on this interaction term is not significantly different from zero (t = -0.22; p = 0.83), thus indicating no support for Hypothesis 1a. We find no evidence of decreasing durability in the abnormal returns of businesses in TI industries in the 1980s and 1990s.

To test Hypothesis 1b, we look for differences in the decay rate of abnormal returns for businesses in TI versus non-TI industries over 1978-1997. As with our first analysis, we find a base decay rate in the expected range, 0.67. We also observe a negative time trend in ROA, consistent with the findings of Barber and Lyon (1996). As for our hypothesized relationship, results in Column 4 of Table 1 indicate that there is, in fact, a statistically significant difference in the decay rate of abnormal business returns in TI versus non-TI industries ($t = 7.34$, $p < 0.01$); however the positive sign on the interaction term indicates that, in contrast to the hypothesis, 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 ($\Delta R^2 = 0.0003$), 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. Generally, businesses in non-TI industries during the 1980s and 1990s apparently faced just as much (if not more) competitive pressure as businesses in TI industries.

(Insert Table 1 Approximately Here)

Recall that we also wanted to examine Hypotheses 1a and 1b focusing solely on higher performing firms. Results from these logit models are presented in Tables 2 and 3. We would find support for Hypothesis 1a with a negative coefficient on the year counter ($YEAR_t$) of the logit models in Table 2. As we move from 1978-1997, increasing dynamic competition in TI industries will make it is less likely that high-performing businesses in TI industries will be able to sustain their performance level. With these analyses, we find an interesting but inconsistent pattern of results. When we define high performers most broadly –any business performing above their respective TI industry average– we see in Column 1 of Table 2 that the year counter is significant ($p < 0.01$) and *positive* rather than negative as predicted. Above-average performing businesses in TI industries may be *more* likely to sustain their current performance level over time. When we tighten our definition of high performance in Column 2 to include only businesses with returns more than one standard deviation above the industry average, the year counter loses significance. When we tighten further to include only businesses performing more than two standard deviations above the industry average in Column 3, the sign on the year counter becomes significant and negative ($p < 0.05$) in line with the increasing dynamic competition argument. And when we tighten the definition of high performance yet again in Column 4 to include only businesses performing at more than three standard deviations above the industry average –only 50 observations left from our starting group of 6,415 above-average performing business-year data points– the negative sign on the year counter remains but loses significance.

This pattern of results does not lend itself to easy interpretation. On the one hand, these logit results yield evidence that above-average performing TI businesses were more rather than less likely to sustain their success as the 1980s and 1990s unfolded, a result contrary to Hypothesis 1a. On the other hand, we do find some evidence that very high-performing TI businesses did not follow that trend. This very small segment of businesses performing more than two standard deviations above industry average performance, the top 2% of TI businesses in our sample, were less likely to sustain their very high level of performance as they moved through the 1980s and 1990s. This finding is consistent with Hypothesis 1a and the argument that top performers find it more difficult to retain dominance in their industry as dynamic competition increased over this period.

If we do a log transformation of the parameter estimates, this finding translates to a dramatic decline in the likelihood that their very high performance is sustainable. Using the results from this analysis, we expect that this small segment of very high-performing TI businesses (two standard deviations above the industry average) would, in the early period of observation (1978) have a 73.5% likelihood of sustaining such lofty performance in the following year (1979). 10 years later, that likelihood declines to 47.1%. By the end of period of observation (1996-1997), that likelihood declines to 31.4%. Recall, that an even more select group of TI businesses (three standard deviations above the industry average) exhibit the same sign but not significance of this slightly larger group of high performers. Readers might conclude from this that support for the dynamic competition argument applies to higher but not merely high nor highest performing TI businesses. We think that the very small size (50 TI businesses) of the highest-performing sub-segment of TI businesses should limit any such conclusion of more complex patterns in our results.

(Insert Tables 2 and 3 Approximately Here)

An interesting and parallel pattern of results also emerges when testing Hypothesis 1b's prediction of cross-sectional differences in TI versus non-TI industry business performance using only a sub-sample of high-performing businesses (see Table 3). Column 1 of Table 3 defines high-performing businesses most broadly as any business with operating returns above their industry mean. With this definition, we see that the indicator term for a TI industry business (*$TECH_i$*) is positive and significant ($p < 0.01$), contrary to Hypothesis 1b. In other words, from 1978-1997, businesses in TI industries were slightly more likely to sustain above-average performance in the subsequent year compared to businesses performing above the mean in non-TI industries. As we tighten up the definition of high-performing businesses from above-average (Column 1) to one (Column 2), two (Column 3) and three (Column 4) standard deviations above the industry mean, the sign on the TI industry business indicator switches from positive to negative and becomes increasingly significant ($p < 0.10$ and $p < 0.01$ for businesses two and three standard deviations above industry average performance, respectively). These results suggest that very high-performing TI businesses were somewhat less able to sustain their lofty level of performance compared to similarly performing businesses in non-TI industries over the 20 years we observed.[10]

Consider the practical implications of these findings, first by starting with a hypothetical business operating in an industry with average concentration and operating in a year with average economy-wide growth and inflation. If that business is currently performing at least two standard deviations above industry average, it has a 60.3% likelihood of sustaining that performance level in a TI industry. In a non-TI industry, that same very high-performing business has a 66.5% likelihood of sustaining such performance. These differences are more pronounced for businesses performing more than three standard deviations above the industry average. A TI business now has a 55.1% likelihood of sustaining its extraordinary performance level, but a non-TI business has a 74.4% likelihood. Broadly speaking, cross-sectional differences in performance stability among high-performing TI and non-TI businesses do not support the proposition of increasing dynamic competition. Again, however, a small segment of very high-performing businesses - those with performance at least two standard deviations about industry average - exhibit differences consistent with the proposition. At the very top, there may be significant cross-sectional differences in performance stability between TI and non-TI businesses from 1978-1997.

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[10] To assess the robustness of our results, we also re-estimate logit models based on the likelihood of remaining in the high-performing businesses stratum in the following year after membership in this stratum two, three, four and five years earlier. Results from these re-estimations are consistent with those reported above and are available from the authors.

Loss of Market Share Leadership Model Results

Results from analysis of the likelihood of losing of market share leadership are reported in Table 4. With Hypothesis 2a, we predict that the likelihood of business losing the leading share of overall industry sales in a TI industry will increase over the period studied. Results in Column 2 do not support this prediction. The parameter estimate for the year counter ($YEAR_t$) variable is 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 from 1978-1997. TI industry leaders in the late 1990s seem as secure (or as insecure) in their position as they were in the late 1970s.

(*Insert Table 4 Approximately Here*)

Results in Column 4 of Table 2 also provide little support for assumptions of greater overall dynamic competition among businesses in TI than non-TI industries. Hypothesis 2b predicts that businesses with the greatest share of sales in TI industries in a given year will be more likely to lose that position in the next year than their counterparts in non-TI industries. But the parameter estimate for TI industries ($TECH_i$) exhibits a *negative* rather than the predicted positive sign, though in any case, the coefficient is not significant ($\chi^2 = 0.99$; p = 0.32). Again, results indicate no difference in the likelihood of market share leadership loss for businesses in TI versus non-TI industries over 20 years of observation.

Mortality (Exit) Model Results

Table 3 reports results from the mortality (exit) analyses. As with our earlier tests, these analyses provide little evidence supporting Hypothesis 3a's prediction of increasing business mortality (exit) in TI industries from 1978-1997. We expect 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 ($YEAR_t$) exhibits a *negative* rather than the predicted positive sign, though in any case, the coefficient is not significant ($\chi^2 = 2.21$; p = 0.14). Again, our results suggest no sustained positive linear trend in the likelihood of business mortality in (exit from) TI industries.

As with our earlier tests comparing business performance measures in TI and non-TI industries, we test Hypothesis 3b's prediction that businesses in TI industries will exhibit greater mortality (exit) rates compared to businesses in non-TI industries across the 1978-1997 period. Results in Column 4 of Table 3 suggest no supporting evidence for this prediction. Mortality (exit) rates for businesses in TI industries are 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 3 ($TECH_i$) is not significant (χ^2=0.62, p=.43). Thus, we find no support for Hypothesis 3b.

(*Insert Table 5 Approximately Here*)

Industry Dynamism Model Results

We now turn our attention to the results associated with the industry-level hypotheses. Recall that we developed hypotheses predicting an increase in dynamism over time across TI industries (Hypothesis 4a) as well as greater dynamism in TI compared to non-TI industries over the period of observation (Hypothesis 4b). Results from our within subjects analysis of industry dynamism listed in Table 6 support neither of these predictions. As a preliminary analysis, we first estimate an equation for each dependent variable using industry dummy variables only. We then add dummies for three of our four five-year data windows (omitting the final window, *1993-1997*). Hypothesis 4a predicts that the time-period dummies should all be negative with the largest magnitude in the earliest time period. As Column 2 of Table 6 indicates, the signs on the time-period dummies are neither consistent with the predicted pattern nor significantly different from zero. Indeed, addition of the time-period dummies does not significantly improve the explanatory power of the regression ($F = 0.14$; $p > 0.10$). Thus, we observe neither significant increase nor decrease in the dynamism of TI industries from 1978-1997.

To test Hypothesis 4b, we compare the level of dynamism in TI and non-TI industries over the entire 20-year period. Again, we find no evidence of significant difference in the overall dynamism of TI versus non-TI industries. The TI industry dummy ($TECH_i$) exhibits a *negative* rather than the predicted positive sign, but in any case is not significantly different from zero at commonly acceptable levels. Indeed, all of the terms in this cross-sectional model yield little if any collective explanation of variation in industry dynamism ($R^2 = 0.0052$). Thus, we find no support for Hypothesis 4b. 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 6 Approximately Here*)

DISCUSSION AND CONCLUSION

Summary of Central Findings and Implications

Our results tell more than one story. On the one hand, our broad sample results tell a story inconsistent with claims of increasing dynamic competition in recent academic, managerial and policy debates. There is little if any broad evidence of the logical consequences of increased dynamic competition in TI industries. There is no general decrease in abnormal business returns durability, no general increase in dethronement of market leaders, no general increase in mortality, and no general increase in industry dynamism. We found this when we examined TI industries and businesses alone over time (longitudinally) as well as in our comparisons of TI industries and businesses to their non-TI counterparts (cross-sectionally). We see little basis for claims of a generally increasing dynamic competition in TI industries in the 1980s and 1990s. We would look with caution and some constructive skepticism on any calls to discard well-tested theories, managerial practices and public policies to respond to "new realities" in TI industries. Broadly speaking, competitive dynamics in TI industries of the late 1990s (and likely today) may not be substantially different from competitive dynamics in TI industries of the late 1970s.

On the other hand, our broad sample results miss important sub-sample differences, which tell another story about changes in the technological landscape of very high-performing businesses. We do see evidence of shifting patterns for very high-performing TI businesses since the late 1970s. The evidence points to a long-term trend of increasing performance instability for these select TI businesses. The evidence also points to consistently greater performance instability for these select TI businesses compared to counterparts in non-TI industries. The evidence points to increasing dynamic competition in TI industries since the late 1970s, but only for a select group of very-high performers. We observed reduced sustainability of very high performance in a sub-sample of only 218 TI industry businesses, that is, only 0.2% of our base sample. Within these boundary conditions, we see substantial value in debating the continued primacy of certain established theories, managerial practices and public policies to explain competitive dynamics, sources of competitive advantage, and the prudential regulation of select TI industry segments. Exceptionally performing TI businesses may be moving in a substantially changed competitive landscape requiring new theoretical, practical and regulatory guides. Ironically, those new guides may derive substantially from Schumpeterian notions of dynamic competition developed in the first half of the previous century (Schumpeter, 1934, 1939, 1950).

Understanding these two stories about dynamic competition in TI industries should help debate between advocates and skeptics move forward more productively. In line with arguments made by several scholars in management, economics, and law (*e.g.,* Bettis & Hitt, 1995; Schmalensee, 2000; Posner, 2001), TI industries appear to offer especially challenging economic conditions for "winning firms." We documented the decreasing durability of very high operating returns by businesses in TI industries, and the significant, and perhaps growing gap in performance durability for these select businesses in TI versus non-TI industries.

At the same time, our results are in line with skeptics (*e.g*, Castrogiovanni, 2002; McNamara *et al*., 2003), who find evidence of broad-based time trends in performance stability wanting. Our battery of tests probed for broad-based evidence of the logical consequences of increasing dynamic competition longitudinally and cross-sectionally, at business- and industry-levels, across the entire TI industry sector and within individual TI industries, for TI businesses enjoying market share leadership and for TI businesses facing exit. We documented no broad-based supporting evidence, and indeed, some broad-based evidence indicating increased rather than decreased performance stability in TI industries since the 1970s.

Thus, there is something both for advocates who may focus on time trends in performance stability for relatively few high-performing TI businesses, and for skeptics who may take a less-focused, panoramic view of time-trends in performance stability across all TI businesses. Future debate will benefit from being more explicit about these differing points of view and the contradictory conclusions about dynamic competition they may engender. It is 10 years since special issues in the *Strategic Management Journal*

(*Strategic Management Journal*, 1995) and *Organization Science* (*Organization Science*, 1996) brought a wave of new empirical research on technology strategy issues for a competitive landscape that many thought had changed considerably since the late 1970s. Our results help to put that previous wave of research in broader context, refine the implications for scholars and others, and to set boundary conditions for future debate.

Finding increased performance instability in a small segment of very high-performing TI businesses, but no such trends in the broad sample of TI businesses raises an interesting question about consistency with prior research findings. Recall that McNamara *et al*., 2003 found no evidence of greater performance instability for businesses and industries generally over the 1978-1997. Did they fail to find performance instability time trends in a broad sample of TI and non-TI industries for lack of focus on very high performers? We can answer this question by re-estimating the "high performance" logit models reported in Table 2 with our base sample, which includes 114,191 operating performance observations from 1978-1997 posted by 19,214 different businesses operating in 982 different non-banking 4-digit industries (31 TI and 951 non-TI industries), and affiliated with 10,298 different corporations. This base sample is virtually identical to the base sample McNamara *et al.* (2003) used. The resulting logit model again examines time trends in the year-to-year likelihood of sustaining some level of high performance from 1978-1997, but the time trend is now economy-wide rather than limited to the TI industry sector. Again, we expect a negative time trend for the very high-performing (two and three standard deviations above industry average) businesses in this base sample.

Interestingly, we find no economy-wide evidence that very high-performing businesses are any less likely to sustain their year-to-year performance as we move from the late 1970s to the late 1990s (parameter estimate = -0.004, $p = 0.67$ for businesses performing at two standard deviations above the industry average; parameter estimate = 0.0002, $p = 0.98$ for businesses performing at three standard deviations above the industry average). These findings suggest that forces leading to greater instability among very high-performing TI businesses in the 1980s and 1990s did not extend to the broader business population. There is something special about select TI industry segments since the late 1970s. A few very high-performing TI industry businesses experienced changes significantly and substantially affecting their performance stability during the 1980s and 1990s while businesses in the rest of the TI industry sector and in the broader economy did not.

Limitations and Future Research

Going forward, we see many avenues for this research to follow. We briefly note two. First, we see value in understanding better how the causal chain works from dynamic competition drivers to performance outcomes. Our study examined evidence of the logical consequences of increased dynamic competition in the 1980s and 1990s. We found supporting evidence for very high-performing TI businesses, but not for the larger population. We did not empirically model links in the causal chain leading to increased performance instability in one segment but not in others. In TI industries, those links could be regulatory in nature –think, for example, how specific deregulatory milestones in US telecommunications during the 1980s and 1990s might explain long-term decline of very high-performing incumbents with relatively little effect on the performance stability of other incumbents and new entrants. Future research could theorize about these apparently selective causal links, model them empirically, and test for evidentiary support, so that we might have a better picture of the changing competitive landscape for select, very high-performing businesses in TI industries.

Additional empirical research on the antecedents and consequences of greater dynamic competition also promises benefits to practicing managers interested in understanding whether the TI industry landscape has changed at all, and if so, what guides to use in navigating that changed landscape. Those same theoretical and practical implications are also relevant to public policy-makers and regulators concerned with antitrust issues (*e.g*., Schmalensee, 2000; Posner, 2001; Evans and Schmalensee, 2002). They, too, would benefit from a more nuanced view of TI industry trends informed by careful empirical study rather than broad-brush assertions of ubiquitous change.

A second avenue for extending our research concerns a key boundary condition we set to investigate time trends in dynamic competition. We defined the population of TI industries based on R&D expenditures as a percentage of sales. This approach has advantages of data availability and comparability across a wide range of businesses and industries. It yields a sample of TI industries and businesses corresponding very closely to industries and businesses identified similarly in other scholarly research (*e.g.*, Evans and Schmalensee, 2002). Future research might refine our definitions and test the robustness of our findings with samples of businesses and industries based on quite different criteria for defining "technology intensive" or "R&D intensive" or "high technology." 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, possibly resulting in a better understanding of the industry conditions that lead to greater dynamic competition. These and other avenues provide direction for productive research and debate about the antecedents and consequences of increasing dynamic competition, and the boundary conditions of related theories, practices and public policies.

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TABLE 1

Autoregressive Model Results: Longitudinal Analysis of Persistence in TI Industry Business Returns From 1978-1997; Cross-Sectional Analysis of Differences in Persistence in TI Versus Non-TI Industry Business Returns From 1978-1997[a]

	Examination for a Change in the Decay Rate Over Time for Businesses 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
Control Variables:				
Intercept	0.0153*	0.0150*	0.0171**	0.0178**
	(0.0067)	(0.0069)	(0.0018)	(0.0018)
Prior Performance (ROA_{jt-1})	0.7068**	0.7109**	0.6724**	0.6647**
	(0.0071)	(0.0204)	(0.0023)	(0.0026)
Year Counter ($YEAR_t$)	-0.0002	-0.0002	-0.0004**	-0.0004**
	(0.0003)	(0.0003)	(0.0001)	(0.0001)
GDP Growth Rate ($GDPG_t$)	-0.0006	-0.0006	0.0029**	0.0029**
	(0.0006)	(0.0006)	(0.0002)	(0.0002)
Inflation Rate (INF_t)	0.0025**	0.0025**	0.0017**	0.0017**
	(0.0007)	(0.0007)	(0.0002)	(0.0002)
Industry Concentration (HHI_t)	-0.0285**	-0.0284**	0.0070**	0.0073**
	(0.0103)	(0.0103)	(0.0015)	(0.0015)
TI Industry ($TECH_i$)			-0.0091**	-0.0136**
			(0.0010)	(0.0012)
Hypothesized Variables:				
Year Interaction ($ROA_{jt-1}*YEAR$)		-0.0003		
		(0.0014)		
TI Industry Interaction ($ROA_{jt-1}*TECH_i$)				0.0448**
				(0.0061)
F	2118.8**	1765.5**	14639.5**	12563.2**
R^2	0.4895	0.4895	0.4941	0.4944
Incremental F		0.01		53.81**
Incremental R^2		0.0000		0.0003
N	11,055	11,055	89,938	89,938

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

[a] Standard error terms appear in parentheses.

TABLE 2

Logit Model Results: Longitudinal Analysis of Ability to Sustain Superior TI Industry Business Returns From 1978-1997[a]

Independent Variables	Ability to Sustain Above-average Performance	Ability to Sustain Performance One Std. Deviation Above Industry Average	Ability to Sustain Performance Two Std. Deviations Above Industry Average	Ability to Sustain Performance Three Std. Deviations Above Industry Average
Control Variables:				
Intercept	0.7607**	0.6708*	0.0584	0.3833
	(0.1960)	(0.3360)	(0.8346)	(1.6201)
GDP Growth Rate ($GDPG_t$)	0.0188	0.0093	0.0653	-0.1623
	(0.0197)	(0.0340)	(0.0855)	(0.1708)
Inflation Rate (INF_t)	0.0456*	-0.0012	0.0751	-0.0010
	(0.0196)	(0.0329)	(0.0788)	(0.1496)
Industry Concentration (HHI_t)	-0.7881**	-0.8911*	0.2253	1.2089
	(0.2634)	(0.4100)	(0.6280)	(0.7443)
Hypothesized Variable:				
Year Counter ($YEAR_t$)	0.0452**	-0.0145	-0.0744*	-0.0191
	(0.0083)	(0.0147)	(0.0379)	(0.0774)
X^2	45.11**	5.87	16.41**	3.75
Incremental X^2 (Adding $YEAR_t$)	29.03**	0.98	3.90*	0.06
Pseudo R^2	0.0070	0.0037	0.0700	0.0698
Incremental Pseudo R^2 (Adding $YEAR_t$)	0.0045	0.0007	0.0157	0.0011
N	6415	1331	218	50

† p<0.10, * p<0.05, ** p<0.01
[a] Standard error terms appear in parentheses.

TABLE 3

Logit Model Results: Cross-Sectional Analysis of Differences in Ability to Sustain Superior TI Versus Non-TI Industry Business Returns From 1978-1997[a]

Independent Variables	Above-average Performing Firms	Firms Performing At Least One Std. Deviation Above Industry Average	Firms Performing At Least Two Std. Deviations Above Industry Average	Firms Performing At Least Three Std. Deviations Above Industry Average
Control Variables:				
Intercept	1.3372**	0.2660**	-0.3877	0.2831†
	(0.0336)	(0.0536)	(0.1070)	(0.1670)
GDP Growth Rate ($GDPG_t$)	0.0052	0.0152	0.0154	0.0303
	(0.0064)	(0.0101)	(0.0192)	(0.0249)
Inflation Rate (INF_t)	-0.0152**	0.0009	0.0302**	0.0106
	(0.0038)	(0.0061)	(0.0116)	(0.0156)
Industry Concentration (HHI_t)	0.2100**	0.6710**	1.4142**	1.3897**
	(0.0481)	(0.0574)	(0.0803)	(0.1310)
Hypothesized Variable:				
TI Industry ($TECH_i$)	0.1082**	-0.0514	-0.2684†	-0.8635**
	(0.0341)	(0.0596)	(0.1450)	(0.3123)
X^2	48.79**	152.88**	364.84**	138.72**
Incremental X^2 (Adding $TECH_i$)	10.20**	0.75	3.45†	7.87**
Pseudo R^2	0.0010	0.0110	0.0820	0.0506
Incremental Pseudo R^2 (Adding $TECH_i$)	0.0002	0.0000	0.0007	0.0028
N	49,421	13,738	4085	2604

† p<0.10, * p<0.05, ** p<0.01

[a] Standard error terms appear in parentheses.

TABLE 4

Logit Model Results: Longitudinal Analysis of Likelihood of Losing TI Industry Share Leadership From 1978-1997; Cross-Sectional Analysis of Differences in Likelihood of Losing in TI Versus Non-TI Industry Share Leadership From 1978-1997[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
Control Variables:				
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)
Hypothesized Variables:				
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: Longitudinal Analysis of Mortality (Industry Exit) Likelihood for TI Industry Businesses From 1978-1997; Cross-Sectional Analysis of Differences in Mortality (Industry Exit) Likelihood for TI Versus Non-TI Industry Businesses From 1978-1997[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	
Independent Variables	Base Model	Model with Year Variable	Base Model	Model with TI Industry Term
Control Variables:				
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)
Hypothesized Variables:				
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.

TABLE 6

Within Subjects Model Results: Longitudinal Analysis of TI Industry Dynamism From 1978-1997; Cross-Sectional Analysis of Differences in TI Versus Non-TI Industry Dynamism From 1978-1997[a,b]

	Examination for a Change in Dynamism Over Time in TI Industries		Examination for Differences in Dynamism in TI & Non-TI Industries	
Independent Variables	Controls Only	Including Time Periods	Base Model	Model with the TI Industry Indicator
Intercept	0.1469	0.1332	0.0958**	0.0964**
	(0.1059)	(0.1106)	(0.0035)	(0.0036)
Time Period 1 (*1978-1982*)		-0.0281	0.0134**	0.0132*
		(0.0604)	(0.0044)	(0.0052)
Time Period 2 (*1983-1987*)		0.0028	-0.0013	-0.0014
		(0.0485)	(0.0051)	(0.0051)
Time Period 3 (*1988-1992*)		0.0383	-0.0018	-0.0018
		(0.0485)	(0.0043)	(0.0051)
TI Industry ($TECH_i$)				-0.0152
				(0.0095)
F	0.82	0.77	3.87**	3.55**
R^2	0.2430	0.2573	0.0042	0.0052
Incremental F		0.49		2.59*
Incremental R^2		0.0143		0.0010
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.