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ABSTRACT

The concept of disruptive innovation has gained currency among managers even while core concepts remain misunderstood. Likewise, foundational research on disruption has produced extensive citations and provoked vibrant debates, but empirical research in management has not kept pace. Such inconsistencies warrant deeper reflection and provide the impetus for evaluating research on disruptive innovation in management and strategy. We trace disruptive innovation theory's intellectual history, noting both how core principles have crystallized through a process of anomaly-seeking research and how it has evolved from a technology change framework to a more expansive, causal theory of innovation and competitive response. The assessment reveals that while the phenomenon of disruption has not changed, our understanding has as the theory developed and was refined. Finally, to reinvigorate academic interest in disruptive innovation, we propose several new topic areas—performance trajectories, response strategies and hybrids, platform businesses, and innovation metrics—to guide subsequent empirical work.

Keywords: Competitive strategy, disruptive innovation, innovation metrics, platform businesses, technology hybrids

INTRODUCTION

The theory of disruptive innovation [i] presents some intriguing inconsistencies for management scholars. The initial concept has gained widespread currency among managers, and "disruption" has become part of the business lexicon. Yet, despite its popularity-in-use, the core concepts remain widely misunderstood (Christensen, 2006; Raynor, 2011). As an applied field, management purports to develop prescriptive advice for practitioners (Gulati, 2007; Hambrick, 1994; Tushman and O'Reilly, 2007), so the theory seems reasonably well-positioned on any assessment of relevance. But even with extensive citations to the foundational work across diverse academic fields such as innovation, technology strategy, organization theory, marketing, economics, and healthcare (Di Stefano, Gambardella, Verona, 2012), as well as vibrant debates (Christensen, 2006; Danneels, 2004; Gans, 2016; Henderson, 2006; King and Tucci, 2002; Slater and Narver, 1998; Sood and Tellis, 2005; Sood and Tellis, 2011; Utterback and Acee, 2005), empirical *management* research on disruptive innovation has simply not kept pace (Figure 1).

Seeking to address these contradictions and invite renewed interest in the topic (see Ansari, Garud, and Kumaraswamy, 2016 for a recent exemplar), we undertake two tasks aimed at a single objective. First, we develop a current conceptualization of disruptive innovation by integrating studies scattered across academic journals, practitioner outlets, and books. We aim for a coherent perspective on the theory as it has evolved from a descriptive framework on responses to technology change to a normative theory of innovation and competitive response. Second and more importantly, in an effort to reinvigorate research on disruptive innovation, we propose several novel topic areas—performance trajectories, response strategies and hybrids, platform businesses, and innovation metrics. Together with our review, these topics are meant to create a unified theoretical base to stimulate and guide future empirical research.

INSERT FIGURE 1 ABOUT HERE

THEORETICAL DEVELOPMENT

Origins of a Descriptive Framework: The Disk Drive Industry

Like other management theories, disruptive innovation began with an observation that prompted a broader research question. Across industries ranging from computers to retail to steel, leading firms failed to stay atop their respective markets. More strikingly, these seemingly well-managed firms were widely lauded by analysts and the business press—yet they missed something important that precipitated their decline. And while explanations based on technological complexity, managerial cognition, and organizational inertia prevailed (Henderson, 1993; Henderson and Clark, 1990; Tushman and Anderson, 1986), the observation led to a very different framework and research program seeking to explain the struggles of leading firms when confronted by certain types of market and technological change.

To investigate the drivers of failure, Christensen (1997) first examined the hard disk drive industry. Results of his multi-method study indicated that when a new innovation emerged that improved performance on dimensions that customers historically valued (i.e., the capacity and recording density of disk drives), incumbents tended to lead commercialization and maintain their market position. However, when an innovation emerged that did not improve performance along this performance trajectory but introduced a unique constellation of new product attributes (e.g., small, lightweight, rugged), entrants led development while incumbents languished or failed. A similar pattern was observed across multiple technological generations and product lifecycles (Christensen, Suarez, and Utterback, 1998; Rosenbloom and Christensen, 1994).

From the disk drive industry study, Christensen (1997) inducted a descriptive framework for disruptive innovation that consisted of three principal components. First, in many industries, the pace of technological progress outstrips growth in markets' demand for higher-performing technologies. As a result, incumbents can *over-serve* the market by producing more advanced, feature-rich products than customers need, leaving a gap at lower tiers of the market between the performance demanded by customers versus that provided by firms, and providing an opening for entrants at the bottom of the market (See Figure 2). Second, for firms, there is a strategically important distinction between different types of innovations—in technology or business model—that emerge in an industry. The majority are categorized as *sustaining innovations*, which improve products and services along dimensions of performance that mainstream customers care about and that major markets have historically valued. They enable incumbents to sell more products to their best existing customers at higher margins and higher profitability. The other less frequently occurring type of innovations are *disruptive innovations*.[ii] When introduced, disruptive innovations are initially *inferior* on accepted performance dimensions relative to incumbent products, but offer a novel mix of attributes that appeal to fringe customer groups such as those near the bottom of the market (See also Markman and Waldron, 2014). For example, they may be smaller, cheaper, more accessible, or more convenient. Third, existing customers and established profit models constrain established firms' investments in new innovations, so investments appearing unattractive to incumbents may actually be attractive for entrants who have few (if any) customers and face fewer competing investment opportunities. Consequently, incumbents are typically not motivated to develop their own disruptive innovations that promise lower margins, target smaller markets, and introduce inferior products and services that their existing customers cannot use.

INSERT FIGURE 2 ABOUT HERE

Early Anomalies, Extensions, and Improvements

With the basic model as a guidepost, researchers conducted several deductive explorations to ascertain whether the associations observed in disk drives occurred in other industries. Two early case studies in excavating equipment and steel production were particularly noteworthy (Christensen, 1997 p. 69-87; p. 101-108). Subsequent researchers have studied retailing, computers, printing, motorcycles, cars, semiconductors, cardiovascular surgery, management education, financial services, management consulting, cameras, communications and fiber optics, computer-aided design software, newspapers, and digital video recorders (Ansari, Garud, and Kumaraswamy, 2016; Christensen, 1997; Christensen, 2006; Christensen and Tedlow, 2000; Gilbert, 2005; Gilbert, 2006; Kaplan, 2008; Tripsas and Gavetti, 2000). Altogether, these investigations have largely supported the basic tenets of disruption, but also provided a few notable elaborations to the theory.

Some of these elaborations came from resolving unexpected observations, or anomalies, that arose from empirical research. For instance, while Christensen and Bower (1996) initially observed that established firms did not allocate resources to disruptive innovations that were not desired by their existing customers, other research showed that resources sometimes flowed freely. Whether incumbents exhibited core rigidities (Leonard-Barton, 1992) depended on whether executives framed the new technological innovation as a threat or an opportunity. Threat framing led to greater resource allocation to disruptive innovations while opportunity framing did not (Gilbert, 2005; Tripsas and Gavetti, 2000). However, even when firms allocated resources to

disruptive innovations, other inertial forces prevented them from adopting the new technology. Researchers confronted a second anomaly when a select few incumbent leaders—in contrast to theoretical predications—successfully dealt with disruptive innovations that emerged in their industries. For example, Gilbert's (2005) multi-case study of newspaper organizations' responses to digital media showed that one newspaper maintained its market leadership positon in the transition from print to digital. Unlike competitors, this newspaper "launched a structurally differentiated venture from the outset" (p. 752). Studies of semiconductors, computers, and a re-examination of disk drives arrived at a similar insight: when faced with disruptive innovations, leading incumbents can maintain their position by setting up an autonomous business unit, separate from the parent company, that has the freedom to enact its own business model and pursue the disruptive opportunity (Gilbert, 2006; see also Gulati and Garino, 2000; O'Reilly and Tushman, 2008; and Westerman, McFarlan, and Iansiti, 2006 for more nuanced treatments).

Researchers also encountered other surprising observations that were difficult to reconcile with the existing categorization scheme. Disruptive innovations were assumed to take root in the lowest tiers of established markets, but instances surfaced in which entrants seemed to be competing in entirely new markets. Such anomalies prompted further reflection and led to more precise definitions that encompassed different types of disruptions (Govindarajan and Kopalle, 2006; Markides, 2006). For example, *low-end disruptions* typify the initial disruptive innovation model where disruptive upstarts enter at the bottom of the market and take hold within an existing value network before moving up-market and attacking incumbents (Christensen and Raynor, 2003). Examples of low-end disruptions include the steel industry (minimills) and retailing (discount retailers) (Christensen and Raynor, 2003; Christensen and Tedlow, 2000). By contrast, *new market disruptions* take hold in a completely new value network. Because initial customers

have not used the prior generation of products and services, the primary competition for these disruptive entrants comes from customers who would otherwise go without the product or service. New market disruptions compete against "non-consumption" so incumbents tend to ignore them instead. Examples include the PC, Sony's transistor pocket radio, and Godrej's chotuKool—a small portable refrigerator (Anthony, Johnson, Sinfield, Altman, 2008; Charitou and Markides, 2003; Christensen and Raynor, 2003). Overall, this re-characterization has led to a clearer conceptualization that more fully captures two different circumstances of disruptive innovation.

Proposing Causal Mechanisms for Disruption

The emergent theory of disruptive innovation was initially a statement of correlation. Empirical findings showed that incumbents outperformed entrants in the context of sustaining innovations, but underperformed in the context of disruptive innovations. But there was no intellectually satisfying understanding of why this happened—there was no causal mechanism to link the observed association between circumstances and market leadership outcomes.

However, three sources coalesced to enable researchers to propose the desired causal pathway. First, interviews with disk drives managers pointed to an insidious resource allocation process deep within organizations that favored sustaining innovations. New product initiatives that promised high margins, targeting large markets with identifiable customers received priority over disruptive innovations meant for smaller markets with less well-defined customers—even when senior managers explicitly pushed to target new disruptive markets (Burgelman, 1991; Burgelman, 1994; Burgelman, 1996). Second and closely linked to the first, resource dependence theory suggests that organizations are dependent on resources in their external environment with some of the most critical resources residing with customers (Pfeffer and Salancik, 1978). This led

Christensen and Bower (1996) to posit that a "firm's scope for strategic change is strongly bounded by the interests of external entities (customers in this study) who provide the resources the firm needs to survive" (p. 212). In other words, incumbents value sustaining over disruptive innovations because they prioritize their existing customers; they may not be concerned with nascent disruptive threats that exist within largely separate resource networks. These two sources explained incumbents' response to disruptive innovations but not why disruptive entrants eventually moved up-market to challenge incumbents who in turn ceded the market rather than fighting back. So third, Adner and colleagues used mathematical models of asymmetric preferences to show that as product performance improves, there is greater overlap between different market segments (Adner, 2002). Entrants pursuing low price, high volume strategies are motivated to invade, while incumbents are motivated to retreat to uncontested, higher tiers of the existing market (Adner and Zemsky, 2006). In short, the same mechanism—the pursuit of profitability—explains the asymmetry in motivation in which both types of firms moved up, but not down market.

Notable Exceptions to the General Pattern

As the theory continued to develop, researchers uncovered additional anomalies to the theory, or cases for which the theory's predictions did not obtain. One of the most intriguing was identifying industries that had thus far resisted the forces of disruption. A particularly salient example is the hotel industry, which had been described as "disruption proof" (Raynor, 2011, p.90). Despite the entrance of low-end competitors such as Motel 6, these discount chains never moved up market to challenge high-end hotels like the Four Seasons (Raynor, 2011). More generally, there was no "up-market march" toward higher, more profitable tiers of the market like there was in the disk drive, steel, and retail industries.

How do we explain this? Researchers recently proposed two important qualifications to disruption theory to more fully account for these anomalies. First, for disruption to occur, industries must be structured such that producing higher-performing products and services results in higher profitability for firms so they have an economic motivation to move up-market. Throughout the evolution of the hotel industry, profitability has been relatively consistent across all tiers of the market, making disruption less likely to occur. Second, certain industries are characterized by the presence of an "extendable core"—a business model or underlying technology that allows firms to produce simple products or services initially, but over time, the core can be extended up-market to do more and more sophisticated things at a lower cost than incumbents (Wessel and Christensen, 2012). Whether a given industry experiences disruption and the corresponding up-market migration of new entrants depends on the presence or absence of a core. Thus, the hotel industry was immune to disruption because there was no enabling technology or business model intended for lower, less attractive parts of the market to improve over time. There was no way to break the tradeoffs that define the frontier of the incumbents' business models (Raynor, 2011, p.93). Perhaps the rapid rise of temporary lodging startups suggests that a digitally-enabled extendable core has recently emerged, allowing entrants to successfully challenge the market leadership of established hotel chains. We return to this point in a subsequent section.

New Methodological Approaches and Attempts at a Normative Theory

Recently, researchers have sought to further advance disruption theory from descriptive to normative with the aim of developing useful prescriptions that guide managers on what they ought to do in given circumstances (Bazerman, 2005). Raynor (2011) reports on several field experiments that were conducted to test the predictive accuracy of some of the theory's core

insights. One set of studies compiled data on 48 ventures launched as part of Intel's internal corporate venturing program. Blind to actual outcomes, researchers developed hypotheses predicting the new ventures' successes or failures. Specifically, if the innovation was sustaining and Intel was an incumbent (entrant) in the target market, the venture would succeed (fail). If the innovation was disruptive and an autonomous (integrated) business unit was formed to pursue it, the venture would succeed (fail). Using business plans to classify the ventures and survival to proxy performance, the theory correctly predicted the outcomes of 45 of the 48 businesses (94 percent accuracy rate) (Raynor, 2011). A second set of studies explored the benefits of disruptive innovation using a training intervention to examine the impact of learning the theory on aspiring managers' ability to correctly predict outcomes of innovating ventures (see Burt and Ronchi, 2007 for a similar research design). Across experiments in three different study populations, the interventions had a positive and statistically significant impact on subjects' predictive accuracy. Together with the discovery of a causal mechanism, these experiments provide intriguing evidence for a normative theory of disruptive innovation (see Table I. for selected empirical studies on disruptive innovation).

INSERT TABLE I. ABOUT HERE

FUTURE DIRECTIONS FOR RESEARCH ON DISRUPTIVE INNOVATION

Thus far, we have evaluated diverse perspectives on disruptive innovation and traced the evolution of key concepts over time. A fundamental premise of our assessment is that while the phenomenon of disruption has probably not changed, researchers' understanding of it has evolved over time as the theory has been extended and refined through a process of anomaly-seeking research. The accumulated effort has produced a rich and useful theory, but many opportunities

for future research remain. Inspired by the historical evolution of the ideas thus far and drawing on recent developments in adjacent literatures as well as the broader technology and business landscape, we identify four topic areas for future research. These areas, we believe, hold great promise not only for improving disruptive innovation theory but also for stimulating research that prepares companies for managing effectively in the age of disruption. They are: (1) performance trajectories, (2) response strategies and hybrids, (3) platform businesses, and (4) innovation metrics. We present these four topics with the hope that they will generate academic discussion and catalyze further theoretical and empirical research into disruptive innovation.

1. Refining Performance Trajectories: Exploring Variation in the Disruption Process

Disruption theory posits the existence of two different performance trajectories that are present in most markets. Acknowledging changing market demands over time, one trajectory captures the rate of improvement customers can utilize or absorb. The other trajectory captures the improvement that innovating companies provide as they strive to develop better products and services to sell to these customers. In many markets, the performance improvement provided by innovators *exceeds* the rate of improvement customers can absorb, which is sometimes referred to as "overshooting" the market (Christensen, 1997). This means that a product or service that was initially not good enough for what customers need becomes, at a later time, *more* than customers can actually use. At this point—the intersection of the two performance trajectories—disruption occurs.

Despite traditional conceptualizations of similarly-sloped performance trajectories, some scholars have suggested that the rate of improvement varies quite significantly by industry (Christensen, Raynor, and McDonald, 2015). For example, in the disk drive industry—the fruit flies of the business world—technology improved quickly, creating a relatively steep performance

trajectory. Disruption played out over a short period of time with new entrants displacing incumbents every few years. In other industries such as steel or discount retailing in which the performance trajectory exhibits a more gradual slope, the process of disruption unfolded over several decades (Christensen and Raynor, 2003). And in still other industries, the trajectory appears relatively flat; disruption does not occur at all (See Figure 3). This alternative conceptualization suggests that while the concept is broadly applicable, disruption does not happen everywhere, nor does it play out at the same pace across industries. Whether it can occur depends upon whether technology advancement drives improvement upward, above and beyond that which most customers can use. Collectively, such observations about the variance in the speed of disruption *across different industries* and the variance in speed *within the same industry over time* is useful for clarifying the mechanism of disruption and establishing boundary conditions for its application.

Other scholars have observed factors that emerge suddenly to shift existing trajectories of performance improvement in new directions (Christensen and Sundahl, 2016). Innovators may introduce novel technologies or business models that bend or kink the trajectory upward—steepening an existing slope or creating entirely new performance improvement to replace one that has historically been flat. Thus, industries like hotels, which once appeared inoculated from disruptive forces (Raynor, 2011), have the potential to transform quickly. This occurs when new entrants introduce new technologies or business models that enable them to move upmarket without adding commensurate costs. A contemporary example is Airbnb. The temporary lodging startup began by appealing to a fringe segment—customers who could not afford a hotel or could not book one in a crowded market. Presumably, these early customers were content to stay in a spare room or even sleep on a stranger's couch because it was better than nothing at all. Although

a vastly inferior alternative to hotels initially, Airbnb appears to be leveraging its unique network-based business model and elegant review/rating system to move upmarket quickly—appealing to ever more sophisticated customers (even business travelers) with nicer amenities comparable to some high-end hotels.

INSERT FIGURE 3 ABOUT HERE

This more nuanced perspective on performance trajectories suggests several promising avenues for future research. First, through careful empirical study, researchers could continue to develop and expand the theory's boundary conditions to better understand the circumstances in which disruption is most versus least likely to occur and how quickly. This would likely involve identifying underexplored factors that make certain industries particularly vulnerable to disruption while rendering others "disruption proof." Second, given that disruption presupposes a unique constellation of product attributes and a corresponding up-market migration by entrants, to what extent is disruption possible in markets with few differentiation opportunities (e.g., commodity or raw materials markets) or in those known for having rigid status hierarchies and low turnover at the top (e.g., venture capital and higher education)? Third, researchers have offered merely tentative conceptualizations of technologies and business models thought to spur dramatic changes within performance trajectories in existing markets (Raynor, 2011; Wessel and Christensen, 2012). Subsequent empirical work has the potential to go much further, concretely specifying the nature and influence of these "extendable cores."

2. Responding to Disruptive Innovation: Identifying Strategies and Exploring Hybrids

Documenting Alternative Response Strategies

Within the literature on disruption innovation, much empirical work has focused on documenting how the process of disruption unfolds in different industries (Christensen, 1997; Gilbert, 2003; Rosenbloom and Christensen, 1994). New entrant upstarts successfully threaten, and, in some cases, eventually overtake leading incumbents despite the latter group's plethora of seemingly unassailable advantages—resources, brand, and market power. Theoretical work has articulated the organizational and managerial mechanisms that contribute to disruption—citing a natural-yet-ultimately-pathological devotion to an existing customer base and the sensible-but-detrimental abandonment of certain market segments as culprits (Christensen and Raynor, 2003; Christensen, Kaufman, and Shih, 2008). While productive, the focus on tracing the phenomenon and proposing mechanisms that give rise to it may lead some to characterize disruptive innovation theory as strong on problem framing (when and why disruption occurs) and weaker on proposing solutions (what incumbents can, or should, do about it). Indeed, in perhaps the earliest and most-celebrated narrative of disruption theory in-use, then-CEO Andy Grove, actively sought but did not receive explicit guidance about what Intel should do about a potential disruption (low-cost computers) then emerging in the market (MacFarquhar, 2012; Mack and Summers, 1999).

How do firms respond to disruption? Which strategies are effective? Early theoretical formulations are decidedly pessimistic, suggesting that incumbents typically ignore or retreat from disruptive encroachments. However, upon observing a small number of established firms that maintained market leadership when facing disruption, researchers proposed what has arguably become the canonical effective response: as a disruptive innovation emerges in an adjacent market, the incumbent creates a separate organizational unit (e.g., a 'skunkworks' or spin-off) tasked with developing or commercializing the new innovation (Christensen, 1997). Encumbered neither by

an existing customer base's insatiable demand for better performing products nor by the margins and market size thresholds against which corporate development departments have grown accustomed to evaluating new business opportunities, the unburdened unit essentially becomes an upstart—a startup that freely pursues the disruptive opportunity in the context of a new value network. Autonomous units also circumvent traditional stage-gate processes in organizations whose metrics screen out disruptive innovations that do not meet rigid hurdles for new product ideas. Though its primacy has been challenged (O'Reilly and Tushman, 2008), this response strategy has enjoyed broad empirical support with notable contingencies about how senior managers frame disruption internally (Gilbert, 2005; Gilbert, 2006).

Yet incumbents can and do respond in numerous other ways. Scholars have identified several additional strategies for dealing with disruption. First, situating their work in the economics of transitions, technology strategists have shown that incumbents may aggressively invest in existing capabilities to *extend current performance* improvement trajectories to slow or delay the onset of disruption (Utterback, 1994), or boldly retreat by *proactively repositioning* (rather than reactively ceding the market) to profitable new niches (Adner and Snow, 2010). Second, drawing from organizational identity and strategic leadership, organizational theorists have argued that incumbents use *organizational ambidexterity* (enacting dual-structures, processes, sub-cultures, and a cognitively flexible team) to carefully manage conflicts expected to arise from pursuing different types of innovations simultaneously (O'Reilly and Tushman, 2016), or they can *redefine the organization's identity*, convincing customers to value their products not on functional dimensions (where disruptive upstarts have already eclipsed their performance) but on characteristics like nostalgia and authenticity that favor firms with a long history (Raffaelli, 2016). Third, entrepreneurship and innovation scholars have shown that incumbents may seek to capture

gains from disruptive innovations by partnering with or licensing startups' technology once it advances beyond a certain threshold (Marx, Gans, and Hsu, 2014) or by acquiring them altogether (Christensen, Alton, Rising, Waldeck, 2011; Sandström, Magnusson, and Jornmark, 2009).

Fourth, recent evidence at the intersection of marketing and strategy suggests that high brand status can help incumbents "re-emerge" after experiencing a decline due to disruption (Raffaelli, 2016). However, the role that brands play more generally in incumbent responses to disruption is an under-explored area. To what extent might brand prowess inoculate incumbents against disruptive competitors? Anecdotal evidence suggests that brands are also exposed to the same processes that drive disruption in other dimensions of the business. For example, in the breakfast cereal market, incumbents like General Mills and Unilever appear to have nudged their brands further and further upmarket in search of higher margins, ceding physical supermarket shelf space to generics like Tesco (Christensen, 2006). Whether brand status alone can or cannot provide a suitable defense against disruption warrants deeper reflection.

Collectively, this work has substantially enriched existing perspectives by illustrating an array of potential incumbent responses beyond the canonical. Now that several solutions to the problem of disruption have been proposed, scholars can profitably build on this promising work by conducting careful empirical analyses to evaluate and compare these strategies' effectiveness. A well-crafted, circumstance-contingent theory of incumbent response would, we suspect, not only be a major contribution to disruptive innovation theory, but would guide managers seeking to prioritize among several strategies to protect against competitors on a disruptive path.

Technology Hybrids: A Path Through Disruption?

Recently, scholars have reintroduced the notion of *hybrid offerings*, arguing that they may be employed as a device for managing certain types of market and technology transitions like those implied by disruption. As the name connotes, hybrid offerings combine elements from a newly emerging innovation (either in technology or business model) with existing elements to create something novel (e.g., a new product)—establishing an interim step between competing generations (Furr and Snow, 2015b). Prominent contemporary examples include hybrid cars (combining electric propulsion systems with conventional internal combustion engine) and online newspapers (merging digital technologies and business models with traditional print media). Prior research offers a skeptical interpretation of hybrid offerings. For instance, several studies of technology change in a variety of industries have characterized incumbents' awkward and unsuccessful attempts to introduce hybrid products as a misguided effort to navigate technology transitions (Foster, 1986; Tripsas, 1997). In his early case study of the mechanical excavator industry, for example, Christensen (1997) observed that Bucyrus Erie (and several similar incumbents) responded to the advent of hydraulics excavating technology by developing a hybrid product that combined conventional cable and hydraulics elements. Targeting its existing customers, Bucyrus Erie's product was plagued by limited capacity and reach and never reached commercial viability. Along with the entire population of cable shovel makers, the company was eventually supplanted by hydraulics upstarts (p. 69-80). Far from an effective strategic response then, hybrid offerings in this perspective are conceptualized as the embodiment of mismanaged technology change. Moreover, this perspective mirrors other notoriously inelegant responses to disruption like Blockbuster's hybrid brick-and-mortar online rental offering to combat Netflix.

For studies that have investigated hybrid products more explicitly, results have challenged the prevailing, gloomy depiction. Rather than the embodiment of mismanaged change, hybrids,

they argue, can be a potentially useful tool to learn about an uncertain future and to bridge market transitions (see Ansari and Garud, 2009 for discussion of hybrid 2.5G mobile networks). Studying the carburetor to electronic fuel injection system transition in the U.S. auto industry, for example, Furr and Snow (2015a) showed that intergenerational hybrids *helped* incumbents maintain product leadership relative to competitors in the new technology. They concluded that, under certain circumstances, hybrid offerings constitute an effective response strategy—recombinations serve as a useful "stepping stone" that allows firms to improve their existing technology while learning and adapting to an uncertain new technology (p. 1047). How do we reconcile these two opposing views on hybrids? More specifically, when might we expect hybrid offerings to enable a path through disruption versus create a stumbling block for incumbents?

Revisiting key concepts from disruption theory may help resolve these tensions while paving the way toward several open questions. Consider a classic disruptive innovation case study, which is quickly becoming a classic case of technology hybrids, too. When steam power emerged, steam-powered ships underperformed conventional sailing ship technology on nearly every dimension (operating costs, speed, and reliability) so transoceanic shippers—the customers of sailing ship manufacturers—could not use it (Christensen, 1997 p. 85). Incorporating the new technology, these incumbents introduced hybrid ocean transports (sailing ships that integrated steam power), to improve navigation near port. Meanwhile, the initially inferior steam technology *did* appeal but only to a different market and application—inland waterways such as rivers and lakes, where moving in the absence of wind was highly valued (Christensen, 1997 p. 86). Left to their own devices, steamship builders honed the new technology over many years before eventually supplanting sailing technology in transoceanic shipping.[iii] Not a single maker of sailing ships survived the industry's transition to steam power (Foster, 1986).

Together with mechanical excavators, the steamship case offers important insights about hybrids in the context of disruptive change, and highlights promising new avenues of research. First, although incumbents like Bucyrus Erie have the option of developing hybrid products to target new customers/applications, they may tend to deploy them as sustaining innovations in performance-enhancing applications for existing customers. Future research might explore when and how incumbents successfully overcome these tendencies. Second, upstarts like steam-sail inland waterway transporters may develop technology hybrids as a market entry strategy, backing up inferior disruptive technologies with more reliable conventional technology. Future research may consider the conditions under which a hybrid-entry strategy is more effective than a purely disruptive entry strategy. Third, while acknowledging that hybrid offerings may combine elements from different business models (Battilana and Lee, 2014), existing innovation research has largely focused on technology hybrids. Given the increasingly prominent role of business models in disruption theory, future research might explore what role *business model hybrids* play in helping incumbents (upstarts) respond to (harness) disruptive forces.

3. Platform Businesses: Considerations for Disruptive Innovation

Platform Businesses, Modularity, and Disruption

In recent years, a burgeoning literature has developed related to platform businesses[iv] (Eisenmann, Parker, and Van Alstyne, 2006; Hagiu and Wright, 2015; Rochet and Tirole, 2003) and their ecosystems of complementors (Boudreau, 2012; Wareham, Fox, and Giner, 2014; Zhu and Iansiti, 2012). Research focused on these business structures and the innovations they generate has evolved largely independently of disruptive innovation theory. We posit that just as the theory

may inform the study of platform and ecosystem businesses, disruptive innovation scholars can incorporate platform concepts.[v]

Disruptive innovation theory has explored where in the value chain profits will reside in the future as industries evolve and change (Christensen, Raynor, Verlinden, 2001). A key insight is that when products are not yet good enough to satisfy customers' performance requirements, firms rely on highly internally interdependent and integrated product architectures to maximize product performance (Christensen and Raynor, 2003). As a new industry emerges, for example, performance-driven competition may be especially fierce so firms cannot afford to adopt modular architectures (Baldwin, 2008; Baldwin and Clark, 2000; Brusoni, Marengo, Prencipe, and Valente, 2007) because the standard interfaces associated with modularity tend to, at least initially, compromise performance (Christensen and Raynor, 2003). As performance eventually satisfies and then surpasses existing customers' needs (they can no longer absorb new features as shown in Figure 2), the basis of competition shifts to other product dimensions such as convenience, customization, price, and flexibility (Christensen, Raynor, and Verlinden, 2001). As industries shift to less integrated offerings; modular architectures take root as they enable simpler and more efficient interfaces between, and modifications to, products. During this phase, a disruptive entrant incorporating a modularity strategy can prove highly effective.

Platform businesses are built around modular architectures (both from a technological and business model perspective) since the primary basis of competition they enable involves independent entities interacting with one another and often building upon the others' products (Parker, Van Alstyne, and Choudary, 2016). Recent advances in technology, particularly the exponentially decreasing costs of information technology (Altman, Nagle, and Tushman, 2015; Hilbert and Lopez, 2011; Koh and Magee, 2006), have enabled significant growth in platform and

network-based business strategies (Gnyawali and Madhavan, 2001; Benkler, 2006). At their core, these businesses have the ability (and necessity) to engage with and leverage third-parties in new ways (Boudreau, 2010; Zhu and Iansiti, 2012). Their modular structure enables platform businesses not only to innovate more efficiently on their own, but also to engage more effectively with communities of external innovators developing complementary products and services. This is especially the case for software-centric products and on-line cloud-based offerings, which offer well documented and publicized interfaces and tools. Consider an example from the smartphone industry. Apple operates a platform business by enabling and facilitating application developers and accessory providers to create products that work with and enhance Apple's own smartphone offerings. An ecosystem of complementors forms around a platform, providing products and services that improve the functionality and value of the platform operator's core product (Adner and Kapoor, 2010; Adner, Oxley, and Silverman, 2013; Iansiti and Levien, 2004). In the language of disruptive innovation, the phones became "good enough" so there was a shift in competition to modular systems.

Disruption through Incumbent Transitions to Platform Businesses

Some platform businesses are founded as network-based. Examples are matchmaker businesses (Evans and Schmalensee, 2016) eBay and Airbnb, which employ a business architecture that facilitates interaction between multiple users. eBay enables buyer interaction with sellers; Airbnb enables host interaction with guests. These businesses chose not to compete through sustaining innovations with incumbents in markets providing highly integrated performance-based offerings, which in the case of eBay would have been consignment shops, and for Airbnb would have been hotels. Rather, these businesses used platform strategies incorporating

a modular architecture to facilitate third-party interactions and pursued a disruptive innovation approach. They chose to compete with services that provided "good enough" offerings, yet dramatic increases in convenience and lower costs following the classic disruption pattern as entrepreneurial ventures.

Not all platform businesses are new entrants however. Incumbent businesses may follow a disruptive strategy as they evolve from previously non-platform, traditional product and service businesses to embrace platform strategies. For example, Ticketmaster transitioned its integrated retail ticket business to operate a marketplace allowing individual fans to resell tickets. This is a modular business architecture allowing individuals to become sellers (setting prices and sales timing) on Ticketmaster's site. While the resale offering includes a higher risk of fraud (lower performance on traditional dimensions), customers accept it because of increased convenience afforded them. Ticketmaster adopted this platform strategy in response to a disruptive encroachment into its core market after StubHub and other platform businesses entered and quickly became a "good enough" offering via fan-to-fan ticket resale. As incumbents transition to platform businesses, firms that initially provide highly integrated, high performance offerings may shift to modular platform businesses as they overshoot the needs of the market. In Figure 2, these incumbent firms shift from operating on the left incumbent trajectory to following a disruptive innovation trajectory by embracing platform strategies.

A potentially productive area of research links questions related to incumbent businesses transitioning to platforms with disruptive innovation theory. The disruptive innovation diagram may provide insights about when in an industry's lifecycle it might be most effective for an incumbent firm to transition to a modular architecture and adopt a platform approach. When differentiation is performance-based, a platform business model might be sub-optimal. When

industry offerings overshoot customer needs, and the basis of competition shifts to convenience, customization, or flexibility, a platform alternative may prove viable. In wireless phones, for example, when call quality, product size, and weight were salient features in the buying process, a system offering modularity and choice of applications was not compelling enough to affect market share. Once phones became good enough, and the differentiation between hardware became less distinct, platform businesses that effectively enabled complementors became competitive. We propose that platform businesses with modular architectures are more likely to succeed as disruptors when the basis of competition has moved beyond performance to dimensions such as convenience, customization, flexibility, and so on.

Disruption through Complementor Ecosystems and Network Effects

When the basis of competition in a market moves beyond performance and disruptive innovations emerge, the ability of firms to manage external complementors (Boudreau and Jeppesen, 2015; Kapoor and Furr, 2015; Yoffie and Kwak, 2006) may play an increasingly important role. During early industry stages when products and services are highly integrated, a prevailing underlying assumption in management literature is that core processes are managed through hierarchical control and a Chandlerian approach to organizing (Chandler, 1977; Tushman and Anderson, 1986). Innovation is considered a core process (Leonard-Barton, 1992; Henderson and Cockburn, 1994) for which firms gather and assimilate external information (Cohen and Levinthal, 1990), and may ally for critical resources (Gulati, 1995; Gulati, 1998; Tatarynowicz, Sytch, and Gulati, 2015). In traditional management literature, including in most disruption research, innovation is considered to occur as a process conducted internally or with strong

contractually governed outsourcing and supply chain partnerships (Jacobides and Billinger, 2006; MacDuffie and Helper, 1997).

As firms adopt disruptive platform strategies, a firm's ability to leverage complementors may increase its likelihood of success. Firms manage complementors through developer programs (e.g., Apple's developer program and App Store), innovation ecosystems (Adner and Kapoor, 2010), and engaging with individuals through activities like crowdsourcing (Howe, 2008) and innovation contests (Boudreau, Lacetera, and Lakhani, 2011). Platforms may enable new market disruption since complementor interactions introduce new competitive dimensions. For example, Facebook enabled Zynga to create a new market disruption of casual gaming appealing to customer groups who otherwise would not have consumed video games because they were too complicated; Airbnb enabled college students to become hotel proprietors despite their lack of capital and expertise. This link between the management of complementor ecosystems and disruptive innovation has yet to be fully explored and offers promising avenues for future research.

It is also often the case that the competitive success of a platform strategy hinges on a firm's ability to create and harness network effects (Afuah, 2013; Katz and Shapiro, 1985; Parker and Van Alstyne, 2005). This is true for firms founded as platforms such as Airbnb (the more hosts willing to rent their homes, the more attractive the platform is for guests and vice versa), and for incumbent firms transitioning to platform businesses. Ticketmaster's fan-to-fan offering becomes more valuable as more fans post tickets for sale and more buyers seek to purchase tickets. We suggest it may be useful to leverage the disruptive innovation diagram to inform our understanding of when network effects may become most valuable for platform transitions. As offerings begin to overshoot the needs of customers, adding a platform business that grows and succeeds through

network effects may enable a new basis of competition such as greater product availability and lower cost.

Competition in markets with network effects differs from that in traditional product markets along a variety of dimensions. Some may enable disruptors to more effectively unseat an incumbent, such as pricing strategies. For example, firms are often willing to subsidize products (or offer them for free) on one side of a platform market to gain adoption (Parker and Van Alstyne, 2005). For incumbent firms in that market, this incursion by a platform business offering a free good may cause significant challenges. To build network effects, a firm may adopt strategies that rely on revenue sharing or royalties rather than sales revenues, which also may affect the basis of competition in an industry and prove to be highly disruptive. Coopetition (Brandenburger and Nalebuff, 1996) may play a role as competitors join each other's ecosystems. Empirical research exploring network effects with disruptive innovation could improve our understanding of network effects and help us extend disruptive innovation theory.

Recently, a few scholars have started to link disruptive innovation theory with network and platform business strategies (Hajhashem and Khorasani, 2015; Hynes and Elwell, 2016). Sandström, Berglund, and Magnusson (2014) introduce a theoretical argument exploring some of the original underlying assumptions of disruption innovation theory and how they relate to dynamics in more networked and interconnected systems. Ansari, Garud, and Kumaraswamy (2016) explore disruptive innovation in the context of multisided platform ecosystems with their longitudinal study of TiVo, one of the original digital video recorder firms, which introduces disruptive innovation theorizing considering ecosystem and coopetition (Brandenburger and Nalebuff, 1996; Ritala and Hurmelinna-Laukkanen, 2013) dynamics. Still, there is scant work studying the distinct considerations of platforms with disruptive innovation.

4. Financial Metrics as Enablers of Disruption

In early work, disruptive innovation was framed as a technology problem for incumbents. Indeed, the subtitle of *The Innovator's Dilemma's* first edition was: "When new technologies cause great firms to fail." While scholars observed that disruptive innovations seemed to "promise lower profit margins per unit sold and could not be used by [an incumbent's] best customers" (Christensen, 1997), there was little systematic investigation as to why. Subsequent empirical research and anecdotal evidence (as quoted in Christensen, 2006 see Andy Grove's account of DEC's inability to prioritize PCs due to comparatively lower margins and price despite engineers' technical prowess in PC design) prompted a reformulation centered *not* on incumbents' inability to adapt to newly emerging technologies, but rather on the challenges innovations posed for the incumbents' business model. Relabeling the phenomenon "disruptive innovation," Christensen (2006) asserted that the business model in which technology gets deployed paralyzes incumbent leaders; "In other words, [disruption] was not a technology problem; it was a business model problem" (p. 43).

Consistent with these revisions, we closely examine the business model, especially the firm's profit formula, as an underappreciated driver of disruption. A sustaining product, service, or technology innovation that helps a firm make more money in the way it is already structured to make money—and, importantly, in a way that drives up the acceptable *metrics* that stakeholders rely on to measure success—attracts capital to the business. This has two potential effects. First, it drives firms systematically up-market since well-run companies may find it difficult to prioritize down-market investments in lower value projects. Most executive compensation plans include measures of profit, often expressed as ratios, such as earnings per share, or return on assets (Murphy, 2012). High margin sales are a tantalizing means of increasing these ratios since their

effect on the numerator (profit) comes with a small denominator (capital). Second, firms may overlook opportunities that do not fit with the way they currently make money. Rewarded for returns that occur during their tenure, executives may prioritize projects whose returns are realized more quickly (Dechow and Sloan, 1991). Counterintuitively, as they pursue profitability, incumbents may become more susceptible to disruption by startup entrants who do not yet have an established business model (or profit formula) and rely on different metrics to gauge success.

Consider a firm seeking to drive up gross margin percentage (a common financial metric used by analysts to evaluate firms in many industries). It may sensibly drop low-end products from its product line—reorienting toward higher-margin offerings. If instead it focused on improving, say, net dollars per ton or per unit sold (a less-common financial metric), it might take different actions. Had integrated steel mills measured success by net profit per ton of steel—in whole numbers rather than a ratio—they may have tried to maintain their position in rebar (where greater volume spreads out more of the overhead costs) rather than ceding it to minimills (Christensen and Raynor, 2003).

Managers that employ financial metrics and tools popular today may unconsciously create a bias against certain types of innovations—sowing the seeds of disruption (Christensen, Kaufman, and Shih, 2008). First, managers may not consider some of the implications of marginal cost thinking and the sunk cost fallacy. Following the tenets of financial accounting on this topic may lead incumbents to leverage old technology because marginal costs are low and new technologies often require large up-front costs that temporarily use up cash or dilute equity (here again, the integrated steel mills provide a salient illustration since they have struggled to adopt continuous casting technology introduced by minimills decades ago). Second, managers that rely on common valuation metrics such as discounted cash flow analysis may underestimate the true benefits of

investing in certain types of innovations. Nudged by metrics, they prioritize incremental upgrades with near-term payoffs over innovations that require longer time horizons. Finally, managers that rely heavily on ratio-based financial metrics may be tempted to "manage by the metrics" (a variation on "managing by the numbers"). To increase the metric, for example, managers may opt for the more straightforward path of reducing the denominator (by shedding assets from the balance sheet) over trying to increase the numerator (investing in innovation). In an extreme illustration, a senior Boeing engineer criticized upper management for "managing by the metrics" in their decision to outsource nearly all production of the 787 aircraft so as to increase return on net assets (RONA) (Hart-Smith, 2001). His perspective was later vindicated by Boeing's CEO (Gates, 2011).

These emerging insights on the implications of metrics for disruptive innovation have laid the groundwork for several promising avenues of future empirical research. First, researchers could develop an innovation metrics framework that defines the scope and limits of various metrics in evaluating innovation projects. To overcome the natural tendency to prioritize sustaining innovations, organizations may adopt structures that incubate disruptive innovations, namely by encouraging small-scale design and tests of new, low-margin products targeted at current non-consumers. Second, given that a firm's innovation strategy depends on the projects it invests in, we posit that an integrated approach that combines strategy and finance might remove some of the impediments to innovation that arise from considering these concepts separately. Research could inform the best mix of financial instruments and investors, each with specific time-horizons and risk-limits, to enable innovation. Third, researchers could develop new tools and measures to evaluate success—metrics that do not automatically bias incumbents toward sustaining innovations that pay off in the near term. Entrepreneurship theories may be a unique source of

insight since the startups that are the objective of study get evaluated differently. In developing new metrics, researchers stand to contribute to disruptive innovation theory and to managers charged with setting the innovation agenda for their companies.

CONCLUSION

In this paper, we have sought both to develop a current conceptualization of disruptive innovation and to suggest opportunities for future research on the subject. Our motivation stemmed from the stark contrast between the concept's widespread use in practice (including vibrant debates) and empirical academic research, which seems not to have kept pace. By first charting the theory's evolution from a descriptive framework of technology change to a normative theory of innovation and competitive response, we documented recent updates and improvements to the theory's core tenets. Then, we proposed four promising avenues of research: performance trajectories, response strategies and hybrids, platform businesses, and innovation metrics. With this newly unified theoretical base and the seeds of a research program, we hope to reinvigorate empirical management research on disruption. Our ultimate aspiration is that through continued refinement and application, the theory will be a force for guiding managers and management thinkers alike. Rather than a definitive conclusion on disruption innovation, we hope our paper serves as the opening of a new chapter.

NOTES

[i] Christensen, Raynor, and McDonald (2015) offered a summary: "Disruption describes a process whereby a company with fewer resources is able to successfully challenge established incumbent businesses. Specifically, as incumbents focus on improving their products and services for their most demanding (and usually most profitable) customers, they exceed the needs of some segments and ignore the needs of others. Entrants that prove disruptive begin by successfully targeting those overlooked segments, gaining a foothold by delivering more-suitable functionality—frequently at a lower price. Incumbents, chasing higher profitability in more-demanding segments, tend not to respond vigorously. Entrants then move upmarket, delivering the performance that incumbents' mainstream customers require, while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants' offerings in volume, disruption has occurred."

[ii] As used in practice (and sometimes in scholarly work), a disruptive innovation by our definition does not refer to *any* circumstance in which incumbents stumble and a market re-ordering occurs (Raynor, 2011). As a modifying label for innovation, "disruptive" exists independent of the outcome.

[iii] Some scholars have argued that the original steam ship builders may have also began with a hybrid product—a steamship outfitted with sails (Foster, 1986). However, unlike incumbent sailing ship manufacturers, these upstarts deployed it as a *disruptive innovation,* targeting a fringe customer group and new application in the inland waterway market rather than the mainstream transoceanic shipping market.

[iv] While there are multiple definitions of platforms, we use the terms "platforms" and "platform businesses" to refer to business structures that act as "two-sided markets," "two-sided platforms," or "multisided platforms." We use more general terms to simplify, but the reader should recognize that when we say "platforms" or "platform businesses," we are referring to multisided platform (MSP) and platform-based businesses. For a more detailed treatment of these structures, see Rochet and Tirole (2003) and Hagiu and Wright (2015).

[v] While disruption innovation literature has not yet thoroughly studied platform businesses, it has considered "facilitated network businesses," a form of platform businesses (Christensen, Grossman, and Hwang, 2009).

Figure 1: Number of articles citing disruption over time

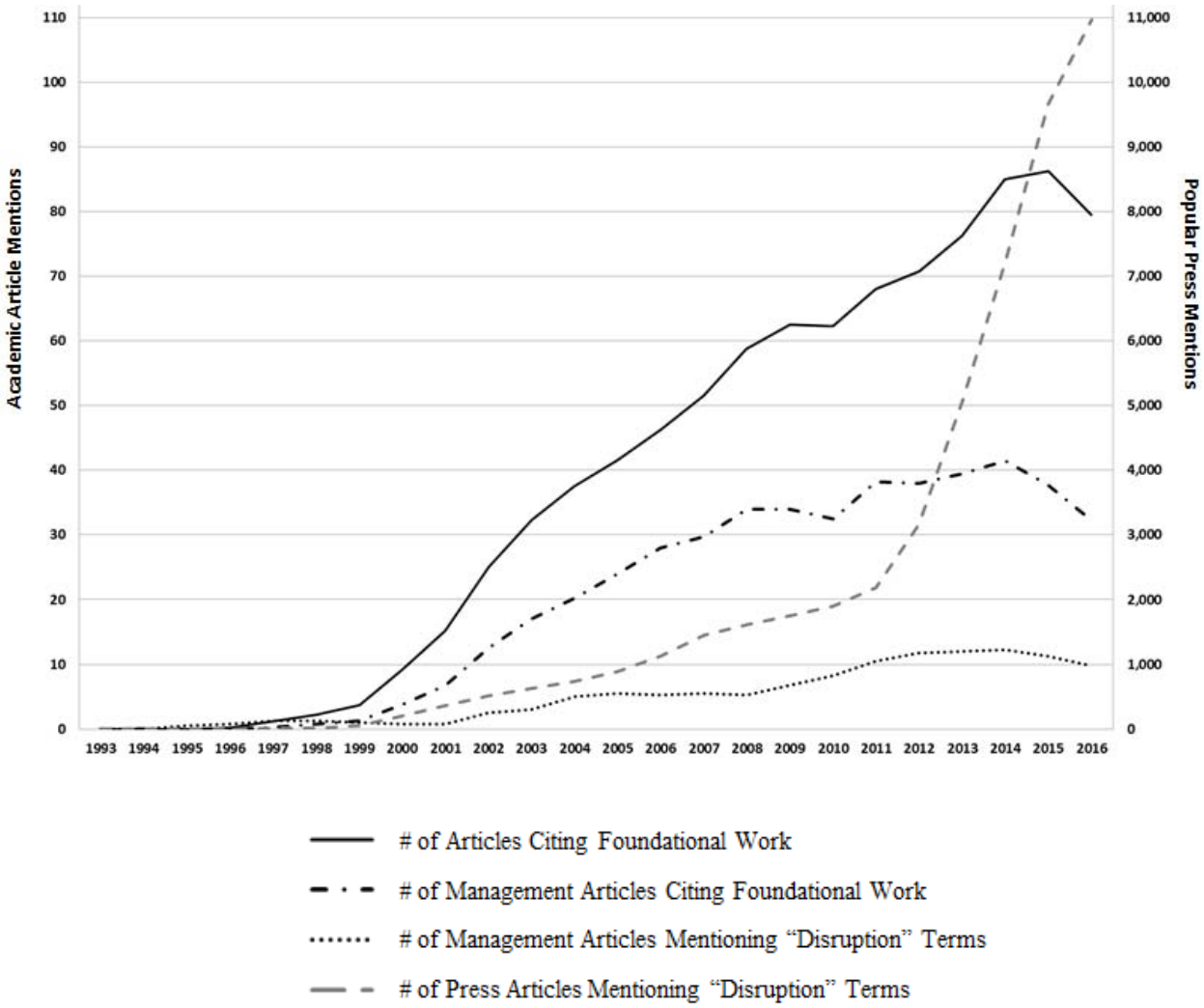

Figure 2: Disruptive innovation model

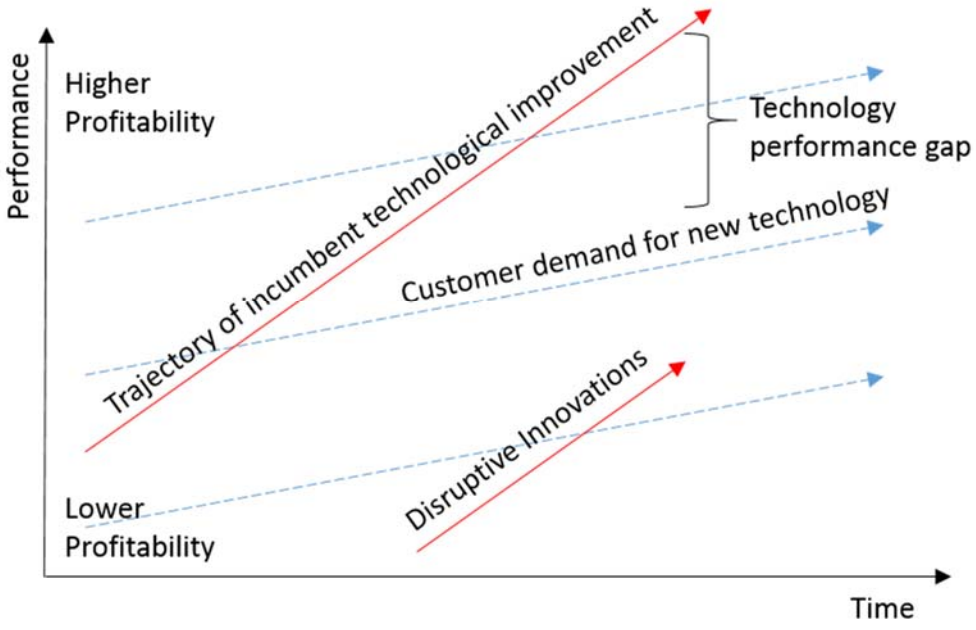

Figure 3: Kinks in improvement trajectories

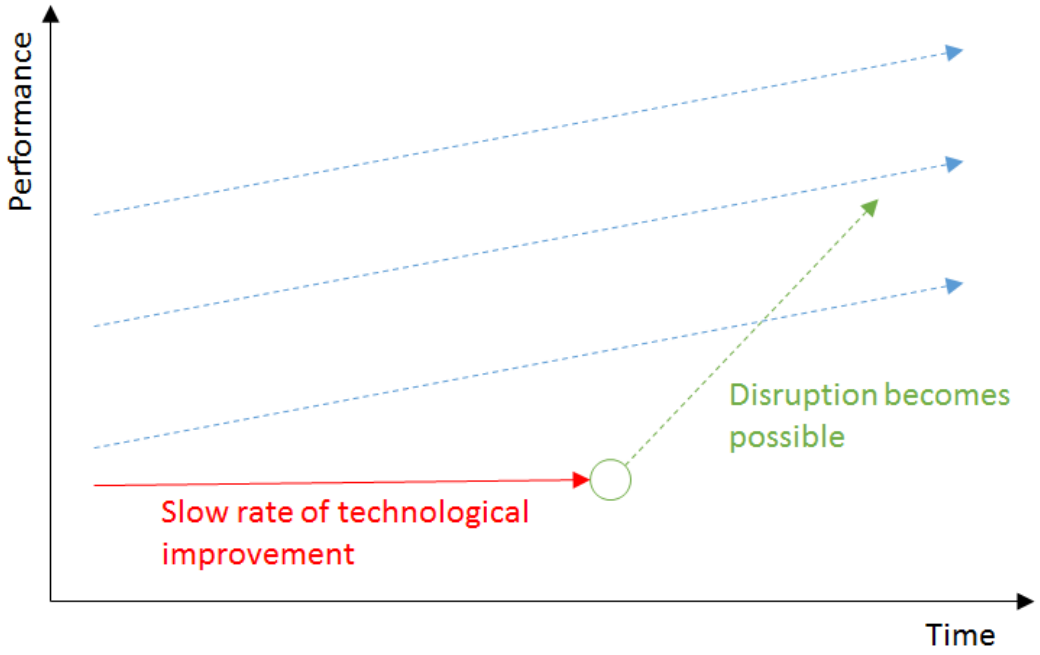

Table I. Select empirical studies related to disruptive innovation

Study	Context	Sample	Focus of Inquiry	Key Findings
Tushman and Anderson (1986)	Minicomputer, cement, and airline industries from births through 1980	Technology changes from three product classes	Technological change	Technology evolves through periods of incremental change punctuated by technological breakthroughs that either enhance or destroy the competence of firms in an industry
Henderson and Clark (1990)	Photolithographic alignment equipment industry	Case studies	Firm knowledge	Architectural innovation (changes in the way product components are integrated into a system) destroys usefulness of architectural knowledge of established firms, which is embedded in the procedures of established organizations.
Burgelman (1991)	Intel's transition from DRAM to microprocessors	Case study	Survival, focus, sales and profits	Consistently successful organizations are characterized by top management who focus on building induced and autonomous strategic processes in addition to strategic content
Henderson (1993)	Technology changes in photolithographic alignment equipment industry	R&D costs and sales by product for 49 projects in 19 firms	Investments in radical or incremental innovation	Established firms invest more than entrants in incremental innovation, but research efforts of incumbents in radical innovation are significantly less productive
Christensen and Bower (1996)	Technological evolution of the world disk drive industry	Attribute data and sales on 1400 product models from 1975 to 1990	Sales	Successfully managing technology disruption is not just an issue of technological competence, but also an issue of investment
Christensen, Suarez, and Utterback (1998)	Technological evolution of the world disk drive industry	Attribute data on rigid disk drive product models from 1975 to 1990	Likelihood of firm exit	Probability of failure decreases if firm uses dominant design; entered in a certain “window of opportunity”; are relatively large; or entered targeting a new market segment
Tripsas and Gavetti (2000)	Polaroid's response to shift from analog to digital imaging	Case study	Extent of technology transition	Search processes in a new learning environment are deeply interconnected to the way managers model the new problem space and develop strategic prescriptions premised on this view of the world

King and Tucci (2002)	Technology change in rigid hard drive industry	208 business units from 174 organizations from 1976 to 1995	Probability of entry into product categories	Static experience (production and sales experience) encourages market entry, but transformational experience (prior transition experience) does not
Gilbert (2003)	Newspaper industry's response to digital publishing and the Internet	Field data from 18 companies and archival data from other companies	Market growth	In every industry changed by disruption, the net effect has been total market growth. Disruption can be a powerful avenue for growth through new market discovery for incumbents as well as for upstarts.
Sood and Tellis (2005)	Finding shape of technological evolution curve	14 technologies from 4 markets	Technology and firm disruption	Technology evolution follows a step function, not an S-curve. Performance curves of competing technologies rarely have a single crossing, and new technologies come as much from new entrants as from incumbents
Husig, Hipp, and Dowling (2005)	W-LAN's potential disruption of mobile network technology	Case study	Ex ante likelihood of disruption	Use methods to help practitioners to make ex ante distinctions between disruptive technologies and other phenomena caused by emerging technologies. Contrary to common assumptions, W-LAN is not likely to represent a disruptive technology
Gilbert (2006)	Newspaper organization's response to digital publishing	Case study	Cognitive processes and organizational rigidity	Opportunities associated with discontinuous change typically do not trigger organizational responses until the opportunity is perceived as a threat.
Govindarajan and Kopalle (2006)	Fortune 500 companies' responses to disruption	Surveys of executives at 199 strategic business units in 38 firms	Scale for disruptiveness of innovations	Develops a well-defined measure of disruptiveness for use in future research
Westerman, McFarlan, and Iansiti (2006)	Adoption to e-commerce of drug stores and retail brokerage	Four paired case studies	Organizational fit to new technology	Differing bases of competition in early and later stages of an innovation's life cycle calls for differing organization designs. Designs that fit early strategic contingencies tend to misfit later ones.

Rao, Angelov, and Nov (2006)	Skype's integration of P2P and VOIP technologies	Case Study	Success in integrating innovations	Demonstrated how two or more disruptive technologies in concert can result in a new discontinuous innovation that can create new forms of market value. The resultant innovation can be discontinuous in that it requires shifting to a different technological learning curve, and enhances and even redefines extant performance metrics
Burgelman and Grove (2007)	Apple's music disruption at the border between media and computers	Case study	Cross-boundary disruption	Calls attention to the importance of inter-industry strategic entrepreneurial action, called “cross-boundary disruption”
Kaplan (2008)	Communications firms' response to fiber-optic technology	Longitudinal data from 71 firms	Investment in optical technologies	CEO cognition, organizational capabilities, and organizational incentives are all separately important in shaping strategic change. The best outcomes are when they are all are aligned.
Benner (2009)	The shift to digital technology in photography, and VoIP technology in wireline telecommunications	Analyst reports in two industries	Analyst reactions to strategy	Public equity markets and the securities analysts affect incumbent firms challenged with technological change. Analysts are more positive towards incumbents investing in sustaining technologies
Lucas and Goh (2009)	Kodak's response to digital technology	Case study	Entry into new technologies	Kodak’s middle managers, culture, and its rigid, bureaucratic structure hindered a fast response to a new technology which dramatically changed the process of capturing and sharing images
Sood and Tellis (2010)	New technologies in utilities, consumer electronics, and pharmaceuticals	36 technologies from 7 markets	Technology and firm disruption	Contrary to extant theory, potentially disruptive technologies are introduced as frequently by incumbents as by entrants, are not cheaper than old technologies, and rarely disrupt firms. However when the price is lower, they are more likely to be disruptive

Bergek et al. (2013)	Technology discontinuities in the gas turbine and auto industries	Comparative case studies	Incumbents' ability to respond to new technology	Intense competition follows in the wake of technological discontinuities. 'Creative accumulation' is a way of conceptualizing the innovative capacity of incumbents that appear to master such turbulence
Furr and Snow (2015a)	Technology discontinuity in automobile fuel delivery systems in 1980s	3,026 car models	Organizational adaptation (via spillbacks and spillovers)	Intergenerational hybrids can play an important role in organizational adaptation and the progression of a technological discontinuity
Marx, Gans, and Hsu (2014)	Technology commercialization strategies in the speech recognition industry	579 firm-year observations from 1952-2010	Likelihood of switching technology commercialization strategy	Commercializing disruptive technologies starts by competing with incumbents followed by a switch to cooperating with them. When start-up innovation involves a potentially disruptive technology, incumbents may be wary of engaging in cooperative commercialization with the start-up
Kim and Min (2015)	Incumbent retailer's adoption of internet retailing as new business model	131 publicly traded store-based retailers as of 1996	Sales	Examines business model innovation rather than technological innovation. Incumbents should manage conflicting assets by setting up an autonomous business unit for the new business model
Igami (2015)	Hard disk drive (HDD) manufacturers response	178 manufacturers from 1981 to 1998	Likelihood of decision to innovate	Despite strong preemptive motives and a substantial cost advantage over entrants, cannibalization makes incumbents reluctant to innovate, which can explain at least 57% of the incumbent-entrant innovation gap
Ansari, Garud, and Kumaraswamy (2016)	Tivo's entrance into the US television industry ecosystem	Case Study	Success entering an ecosystem	Firms introducing disruptive innovations into multisided ecosystems confront the disruptor's dilemma: gaining the support of the very incumbents they disrupt. Disruptions affect the ecosystem, not just specific incumbents

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