

A Critical Analysis of the “Innovator’s Dilemma”: Why Should New Technologies Cause Great Firms to Fail?

Michael Alles. Rutgers University. USA.
alles@business.rutgers.edu

Abstract. The disruptive innovation (DI) theory developed by Clayton Christensen has been one of the most influential management concepts in recent years, being required reading at such prominent companies as Microsoft, AT&T and Cisco Systems. In this paper we describe the disruptive innovation process and analyze the underlying assumptions of both the theory and of its practice implications. We argue that there is much misunderstanding in the business world as to the exact meaning of the theory and a clear need for greater clarity on when it arises and what firms can do about it. In particular, we find that the theory makes implicit assumptions about the availability of information that may be hard to sustain in most circumstances. Our analysis gives rise to the conclusion that the standard models of management control cannot fully explain why disruptive innovations should necessarily cause well-run firms to fail, while at the same time startups are able to succeed. That leaves two possibilities: that the process is invalid as a descriptive phenomenon, or alternatively, that some other force is driving the DI phenomenon. It is the second possibility that we focus on in this paper, developing a model based on Prospect Theory that more fully explains why managers at large firms would react differently to a DI than those at startups. Better understanding the assumptions underlying DI theory and its practice implications is critical for those whose responsibility it is to develop the firm’s strategic control systems, in particular, to management accountants.

Key words: *Disruptive innovation; Innovator’s Dilemma; Christensen; Prospect theory; Endowment effect.*

1. INTRODUCTION

Disruptive Innovation: “Technologies that result in worse product performance, at least in the short-term” They bring to a market a very different value proposition than has been previously available. Generally, disruptive

technologies underperform established technologies in mainstream markets. But they have other features that a few fringe (and generally new) customers value. By and large, a disruptive technology is initially embraced by the least profitable customers in a market. Hence, most companies with a practiced discipline of listening to their best customers and identifying new products that promise greater profitability and growth are rarely able to build a case for investing in disruptive technologies until it is too late.” Christensen (1997, p. xv)

The Disruptive Innovation (DI) theory developed by Clayton Christensen (Bower and Christensen, 1995; Christensen, 1997) has been one of the most influential management concepts in recent years. His work is required reading at such prominent companies as Microsoft, AT&T and Cisco Systems, is frequently cited in the New York Times, Business Week and other publications in discussions on the impact of technology on business and is an essential element in management consulting¹. It is not surprising then that Christensen has been described in the pages of Business Week (July 31st, 2000, page 128) as “the most important business thinker in the world today”.

The interest by business in DI is quite understandable, because it represents a firm’s worst nightmare—the failure to anticipate a product that comes from behind and completely demolishes established industry players. Taking as given the underlying model of disruptive change and the inability of firms to control it, Christensen *et al* (2001) have further extended the DI model into a broad hypothesis about how firms and industries evolve, while Christensen *et al* (2000) applies the DI model to the health care and education sectors. Given the prominence of DI theory, it is all the more surprising, therefore, that there has been so little analysis undertaken of the underlying DI hypothesis, especially by management accountants whose job it is to create the firm’s strategic control systems—obviously such controls are incomplete if they do not address a threat to the very survival of the company. Much of the current literature on DI is largely practice oriented and being devoted more to dissemination than examination, accepts the DI theory without question, while even in business schools, DI features more prominently on teaching rather than research agendas.

¹ The May 8th, 2000 issue of the New York Times has the following quote: “William H. Gates complains that everyone at Microsoft pitching a new project seems to invoke the notion of the innovator’s dilemma. The term, Mr. Gates told Forbes magazine last year, is ‘a required slide in every funding presentation.”

We feel that it is important for the assumptions underlying DI to be rigorously and independently analyzed and its nature, causes and possible solutions subjected to critical analysis. Only then can the DI model be extended with confidence into new industries and applications, and businesses justify putting in place the practice recommendations on how firms should react to DI.

In this paper we describe both the disruptive innovation process and the practice implications of DI theory and establish the underlying assumptions of each. We argue that the theory makes implicit assumptions concerning the availability and interpretation of information that are hard to sustain except in very narrow circumstances. Indeed, it is more precise to say that the theory ignores the question of information in DI settings altogether, resulting in customers assumed to have more information than is likely to be the case in practice, while firm managers are assumed to have unrealistically low levels of information. Moreover, the cutting edge of the DI theory is that established firms fail when startups introduce the DI that they ignore, but it presents an incomplete story of whether startups succeed with DI because they have superior information, or because through blind luck, they happen to be in the right place at the right time. Obviously DI poses a less compelling threat to existing firms when success with DI is based purely on good fortune rather than on good planning.

Our analysis gives rise to the conclusion that DI theory cannot fully explain why disruptive innovations should invariably cause well-run firms to fail, while at the same time startups are able to succeed. That leaves two possibilities: that the DI theory has been oversold, with DI posing less of a consistent threat to established firms than is popularly feared; or alternatively, that some previously unstated force is driving the DI phenomenon. It is the second possibility that we focus on in this paper, on the assumption that the demonstrated interest of firms in DI argues against it being entirely descriptively invalid.

We put forward the hypothesis that the cognitive failures identified by Kahneman and Twersky (1979) helps complete the explanation for the management control failures underlying the DI process. Kahneman and Twersky's work has

generated a major literature consisting of analytic, empirical and field based research on their proposed modification to standard economic theory: the Prospect Theory model of decision-making. That theory has been applied in a wide variety of fields, from economics, accounting, finance and marketing to politics and the law, and moved firmly into the mainstream and forefront of models of human behavior when Kahneman was awarded the 2002 Nobel Prize in Economics². However, in accounting the use of cognitive analysis has been largely restricted to the study of auditors and audit errors. Management accounting research has by and large remained within the domain of the standard economic theory of decision-making. One contribution we make in this paper is to argue that management accountants have much to gain from the richness of cognitive theory. Further, our analysis suggests that there is a wider applicability of Prospect theory to the management control problem, with our application of it to the DI problem being just one special case.

The next section of the paper begins by describing the disruptive innovation theory, emphasizing that it is a portrayal of a process rather than of a technology. In section 3 we analyze the underlying assumptions of the DI theory, drawing out the role of information in initiating the process—in particular, information by customers as to the innovations being pursued by the firm. Sections 4 and 5 provides a similar analysis of the theory's practice implications, beginning in section 4 with a brief outline of the recommendations for how firms should deal with DI, and continuing, in section 5, with a detailed examination of the assumptions underlying those recommendations. Once again, we establish that the key is the availability of information—in this instance, the information that managers have on trajectories of innovation and their profit potential. Section 6 then introduces our Prospect Theory based explanation for why managers at large firms may interpret that information differently than those at startups, which is the basis of the "Innovator's Dilemma". Section 7 offers some concluding comments.

² See Kahneman and Twersky (1982, 2000) for a review of this literature. Chase and Dasu (2001) is a very recent application to customer relationship management, while Vera-Munoz, Kinney and Bonner (2001) is the latest in a long line of research on the role of cognitive heuristics in auditing.

2. WHAT MAKES AN INNOVATION DISRUPTIVE?

There are several pre-conditions that must hold in technology, marketing, control systems and firm culture if DI is to impact the firm. We begin our analysis with the recognition that technological and product change is not smooth but step-wise. There are long periods (albeit, periods getting shorter in the new economy) of gradual change punctuated by bursts of rapid and dramatic innovation that raise the trend line to a new level. These **discontinuous innovations** result in a period of uncertainty and upheaval while new techniques supplant the old. Eventually a dominant product specification emerges and more gradual change can resume (figure 1):



Figure 1. Stepwise Evolution of Technology

The reason for first laying out this description of the evolution of technology is to emphasize that it has *nothing* to do with the disruptive innovation process. There is no necessary reason for DI to be a discontinuous innovation, in the sense of being a dramatic product or technological enhancement. We make this point so strongly now, because as we shall see later, there is considerable confusion about the relationship between disruptive and discontinuous innovation.

In contrast to the distinction between gradual and discontinuous technological change, Christensen (1997, page xv) defines disruptive innovation as being the opposite of **sustaining innovations (SI)**, which “*improve the performance of established products, along the dimensions of performance that mainstream customers in major markets have historically valued.*” It is important to understand

that sustaining innovation can be either gradual or discontinuous, and most important of all, that SI is not often associated with the demise of a firm in the way that DI is. Indeed, for obvious reasons, it is the existing firms that have the greatest incentives and resources to advance the technologies on which their products are based.

The first critical assumption underling the DI theory is that the scope and direction of SI development is subject to **resource dependence**: the imperative to enhance existing products and technology comes mainly from existing customers who are the most likely purchasers of the new products. As Christensen (1997, page xix) puts it: “*while managers may **think** that they control the flow of resources in their firms, in the end it is really customers and investors who dictate how money will be spent because companies with investment patterns that don’t satisfy their customers and investors don’t survive. The highest-performing companies, in fact, are those that are best at this, that is, they have well-developed systems for killing ideas that their customers don’t want.*”

Moreover, it is not all customers, but the most demanding ones, the ones with the most pressing need for an improved product, who have the loudest voice in the SI process. With the scope and direction of product improvement dictated by these marginal customers, the firm devotes resources to bring about the improvement they demand, which will then take place in the cycle of gradual and discontinuous innovation outlined above. The rate of improvement along these customer-determined characteristics is spurred along by competition between firms for market share and their desire to be first-to-market with the latest product enhancement.

The second critical assumption underlying the DI theory is that since it is the most demanding marginal customers who are driving this SI process, the trajectory of product improvement can often “overshoot” the needs of less demanding customers. This would not be a concern if the majority of customers also valued the enhanced products. But often the enhancements come at a cost and with features that mainstream customers are not willing to pay for. In other words, the trajectory of product improvements is steeper than the rate of increase of demand for product capability for all but marginal customers (figure 2):

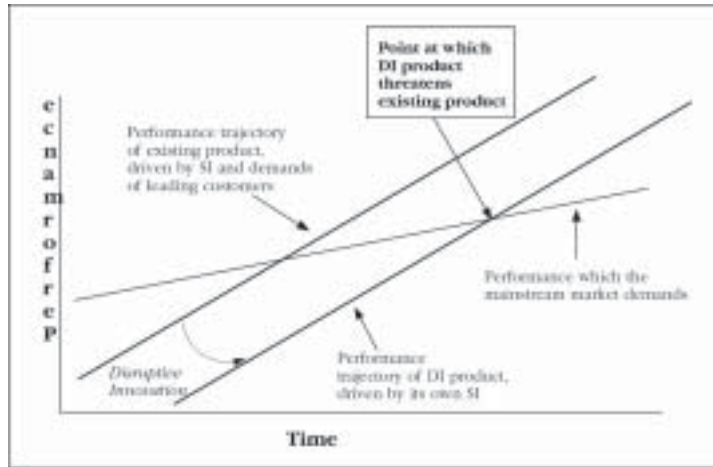


Figure 2. Trajectories of Technological and Market Demand Change.

Hence companies are driven “up-market” rather than down because their customers, in particular the most demanding and vocal ones, are moving up-market. Of course, there are likely to be higher margins up-market where there is a greater need for the sustaining innovation. The problem is that by going up-market, the product’s cost structure may change in such a way that it becomes much harder for the firm to profitably compete down-market for other customers who do not value, and therefore, will not pay for the improvements.

Moreover, parallel with the SI driven changes in technology, the underlying mass market is also evolving. Originally the basis of competition is the payment of premium prices for a distinctive product or technology. Over time, though, the technology becomes pervasive and demand shifts to other strategic differentiators. For example, many products undergo the following progression in strategy space: functionality–reliability–convenience–value. But when their most demanding customers drive firms, they maintain an excessive focus on improving product capability to the exclusion of other characteristics. These firms then risk losing touch with an ever-increasing group of customers who come to desire other attributes, having reached the point of satisficing for functionality. Consequently, a widening market opportunity opens up for new products that provide some of the other attributes desired by non-marginal customers, such as convenience or lower price, even if that is at the expense of cutting edge performance. It is these products that Christensen labels as **disruptive innovations**, ones which “gives

rise to a new value proposition” by substituting a different strategic differentiator for the one desired by the marginal customers who determine the direction of sustaining innovation³.

The context within which a DI arises illustrates two central facts about it, a) that DI is defined entirely from the point of view of customers, and b) because the main characteristic of a DI is that it changes the strategic landscape, it is more likely to be a *marketing* innovation than a technological one. That is why DI has to be carefully distinguished from the discontinuous innovations described earlier, which, by contrast, are technological advances virtually by definition. Indeed, often a DI consists of a repackaging of an existing product, or even one that is a generation or two older. Even when a DI represents a new technology, such as in Christensen’s (1997) examples of disk drives or hydraulic shovels, the DI cannot substitute for the existing market-leading product because of its lower capability. But they offer *something* previously unavailable that appeals to an underserved segment of the market, or creates an entirely new market space. However, because of their lack of performance along the dimension most valued by the leading customers of the existing products, DI products tend to have correspondingly lower prices and margins.

The story thus far, however, is nothing more than a description of a long understood process of product and market evolution, of strategic shifts and technological change. The distinctive features of DI theory are its two assumptions on how DI evolves and how firm’s react to it. First, while a DI may start out as a niche product with a lower capability than existing products, once introduced it is assumed to be subject to the same process of SI driven technological improvement discussed earlier. Consequently, the DI product too tends to improve at a faster rate than the evolution of market demand, which implies that at some point the DI becomes capable enough in the minds of many customers to be a substitute for the original product. Note that the DI does not

³ “Dominant players in most markets focus on sustaining innovations on improving their products and services to meet the needs of the profitable high-end customers. Soon, those improvements overshoot the needs of the vast majority of customers. That makes a market ripe for upstart companies seeking to introduce disruptive innovations—cheaper, simpler, more convenient products or services aimed at the lower end of the market. Over time, those products improve to meet the needs of most of the market, a phenomenon that has caused many of history’s best companies to plunge into crisis”. Christensen, Bohmer and Kenagy (2000).

have to have an improvement trajectory that is steeper than that of the existing product, only that its trajectory exceeds that of the market's demand for product improvement. Since the existing products—designed to meet the needs of the most demanding clients—are already over-enhanced as far as most other customers are concerned, further improvements in them are of no value to the mass market, however fast that improvement may come. The opportunity is then created for the DI to come from behind and directly threaten the original product by offering sufficient capability on the original basis of competition as well as new capabilities that the old product never offered (figure 2).

Second, the most important aspect of the DI process is Christensen's argument that the firms that dominate the market for the existing products are not the same ones that usually succeed with the DI. It is this claim that has gripped the imagination and fears of managers in large firms. Christensen's contention goes further than the resource dependence theory. That, by itself, states that firms will direct their SI towards meeting the needs of its most demanding customers. But why don't they, in addition, go after the types of markets that DI serves? Christensen puts forward a variety of reasons for this ultimately disastrous failure by managers, a failure that he argues is most pronounced in the "best-run" firms.

For example, the capabilities of the first generation DI products are far removed from the current demands and expectations of the bulk of existing customers. Hence, if the firm's managers rely on their most demanding customers to tell them what kinds of products they should develop, it is argued that they will almost inevitably fail to see the opportunities of the DI. Further, if current customers are not interested in the DI, then it may be harder for managers to justify devoting resources to it, especially if that involves taking resources away from the SI efforts devoted to the mainstream products and customers. Resource dependence also has a more pernicious effect, as personnel in front-line contact with important customers are "captured" by them and effectively become their advocates within the firm. They can then lose the ability to maintain a distinction between the interests of the firm and that of its customers.

The initial low margins of the DI product also serve to give managers a reason to give them a low priority, or even, to proactively cede the market for them to

competitors (Christensen *et al*, 2001). What managers fail to foresee is how the trajectory of improvement of the DI will eventually undermine their existing product space. The DI may never produce the margins that the firm enjoys with the existing product, but the emergence of the DI ensures that those margins are not sustainable in the long run either. Another problem is that the larger the company, the larger the market opportunity has to be before it appears on managers' "radar screens". As Christensen puts it, a \$40 million company perceives an \$8 million market opportunity very differently from the way managers at a \$4 billion company do. Consequently it is the smaller, scrappier startup that is more likely to take the plunge into the initial DI market than the larger established firm, with its secure existing market.

But, of course, neglecting a truly disruptive innovation is a potentially fatal mistake. There is an enormous first mover advantage with DI, an effect exacerbated by network effects: the first mover can determine product standards, and if the product is subject to a natural monopoly effect as a result (think Windows), then future competition can be severely constrained, or excluded altogether. By the time the existing firm realizes what is happening it is often too late and the firm ends up being supplanted by the entrant. This is the bleeding edge of the DI process, the reason why, Christensen claims, new technology causes great firms to fail: not because management is bad, but paradoxically, because it is so good. It is precisely when the firm is listening closely to its customers and carefully managing its SI process that it fails to recognize the dangers posed by DI. Its own customers lead the firm astray and it waits until it is too late to seek new strategies for competing.

It is the counterintuitive nature of the DI process—that the best-run, most successful companies are the ones most vulnerable to complete annihilation by a disruptive innovation—that has made Christensen's work so widely read and discussed. But perhaps precisely because the theory is so compelling, it has been accepted virtually without question and little attention has been paid to the series of assumptions and hypotheses that underlie the DI process.

3. THE ROLE OF CUSTOMER INFORMATION IN THE DI PROCESS

The critical characteristic of a DI is that it is an innovation undervalued by the most influential customers of existing products because it falls short along the product dimension that is of primary importance to them. But that by itself is not sufficient for the DI process to commence. After all, there are an infinite number of products that would be considered inferior on some dimension to the current product. What is also needed is that the DI product substitutes for that inferiority by superiority along another dimension that is valued by other–non-marginal or new–customers. In other words, the DI product has to appear at the right time and with the right set of characteristics to take advantage of an existing product that has overshot the market demand trajectory and opened up a strategic opportunity.

How prevalent is this set of conditions? One can readily think of a variety of scenarios when the DI process will be “stillborn”. For example, consider an innovation that offers new features without sacrificing its old characteristics. Such a product may appeal to existing customers as well as generating new demand, and resource dependence theory implies that even marginal customers will then push the firm to bring this product to market, not inhibit it as happens under the DI process. While DI theory makes the implicit assumption that one product feature can only be emphasized at the expense of another, a trait of the new economy are products that are simultaneously improved on multiple dimensions, such as fiber optic cables, which are both cheaper and far more capable than the copper wire they replace. Also, to take Christensen's (1997) seminal example of disk drives, new disk drives tend to be smaller and cheaper, as well as more powerful, with each new generation. In the time period that he examined, by contrast, smaller size was only obtained at the expense of memory capacity. In other words, the SI process for disk drives now encompasses a wider range of product dimensions than it did before.

Even more important to an analysis of DI is the recognition that there exist products that have all the technical attributes of a potential DI but are adopted by existing customers and firms anyway. An example of this phenomenon actually comes from Christensen's (1997) own signature study of the disk drive industry.

He bases his theory of DI largely on the fact that each generation of drive—14-inch, 8-inch, 5.25-inch, 3.5-inch and 1.8-inch—was introduced and the subsequent market captured by entrants, even though in each case the incumbent firm also had the technology, which they failed to bring to market. However, there is one glaring exception to this argument: when the 3.5-inch disk was supplanted by the 2.5-inch disk there was no equivalent transformation of the market players, even though the 2.5-inch disk had the same characteristics of a DI in this industry as the other size disk drives—smaller size and lower power consumption traded off against reduced memory capacity. This is how Christensen (1997, page 22, emphasis in original) explains this anomaly: *“Although the 2.5-inch drive had significantly less capacity than the 3.5-inch drives, the portable computing markets into which the smaller drives were sold valued **other** attributes: weight, ruggedness, low power consumption, small physical size, and so on. Along **these** dimensions, the 2.5-inch drive offered improved performance over that of the 3.5-inch product: It was a **sustaining** technology. In fact, the computer makers who bought” the 3.5-inch drive” were [also] the leading makers of notebook computers, and these firms needed the smaller 2.5-inch drive architecture. Hence, [the manufacturers of 3.5 inch drives] followed their customers seamlessly across the transition into 2.5-inch drives.”*

Christensen’s explanation raises more questions than it answers. It appears that the 2.5-inch disk drive had all the characteristics of a DI—inferior performance on the market’s primary strategic dimension, superior on others—but one: the existing customers liked the tradeoff the product offered since they had a use for it. This example makes it clear that the definition of a DI is heavily dependent on the perspective of customers and looking at product attributes alone can be quite misleading. All the other size disk drives, without exception, offered the same tradeoff in performance versus other features that the 2.5-inch drive did, but they did prove to be disruptive because in their case the existing customers did not have a current need for them and so the existing manufacturers failed to bring them to market.

The problem is that for DI to be a theory with practical implications, it has to be predictive. It is facile to use hindsight to find instances where an ex-post successful innovation was not introduced by existing firms or adopted by existing customers and declare that a disruptive innovation, while labeling as a sustaining

innovation any product that did not fit that pattern, regardless of its technical characteristics. What of firms that take an innovation that does not initially appeal to its customers and successfully market it to them, or create new markets with it? Does resource dependency rule out firms proactively shaping market demand, when that is as an obvious attribute of good management? Since few firms are content with selling to the same old customers over and over again instead of seeking new markets, where do new product introductions fit into the DI framework?

What these examples illustrate is the need to take a much closer look at the information assumptions underlying DI theory: in particular, **what do customers know about the innovations pursued by their suppliers**, which, according to resource dependence, they either encourage or discourage? Christensen does not address this issue of customer information at all, but it is of particular importance in the case of the technology popularly associated with DI: discontinuous innovation. Since they represent a break from the gradual trend line of technology that they are familiar with, discontinuous innovations are arguably ones that customers are least able to evaluate before experiencing. When even veteran managers and industry analysts are unsure about how to react to such advances as the Internet, HDTV and Peer-to-Peer computing, is it likely that customers will take steps to block the firm from pursuing them because they potentially fall short on some product dimension? If customers don't take a position then it will then be left to the discretion of the firm to determine the way in which the discontinuous innovation is brought to market.

We examine this point by a case study of compact disks. Compact disk technology was clearly discontinuous in relation to recording on LPs and despite the enormous installed base and decades of customer familiarity with vinyl records they were rapidly supplanted by CDs. Initially though, the digitally recorded CDs also had inferior sound reproduction compared to analog records and so they were potentially a disruptive innovation as well, trading off size and durability for sound quality. Many audiophiles, the most dedicated end of the record buying market, strongly opposed the phase out of vinyl records—and interestingly, there still remains a group that holds out against switching to CDs and supports a small but thriving industry in high-end record players.

This is a situation that would appear to be tailor-made for the DI process, since sound quality is surely a highly salient product characteristic for the most demanding music lovers. Yet, CDs were the most successful new technology introduction in history and within a few years the decades long vinyl age was consigned to history. Moreover, the very same companies that dominated the vinyl era remain as the dominant players in the CD recording industry, and even, to a large extent, in the industry for the players too.

Why didn't the DI process apply to this example? Our suggestion is that most consumers—as opposed to audiophiles—were simply unable to imagine the reality of CD technology until they listened to it themselves. Hence, they were agnostic about it, and waited for the firms to bring it to market so that they could make up their own minds. Once they did experience the new technology, the convenience CDs offered simply overwhelmed any concerns about sound quality for all but the most diehard vinyl fans. The firms were also aware of this openness by the bulk of their customers and so simply ignored the objections of the audiophiles, since it was these marginal customers that were perceived as the niche market, not the average music lover. The promise of vast profits from inducing customers to replace their inventory of LPs by CDs, which also cost less to produce, swept away any attachment that companies had to vinyl records.

The implication of this example is that discontinuous innovations will, almost by default, fall into the category of a SI—a technology led by the firm rather than the customer—because **when customers lack information to assess the innovation, they cannot shape the firm's decisions on what do with it and so the DI process will not commence.**

This view is reinforced by Christensen and Donovan (2000) recent argument that whether a product is disruptive or sustaining depends on how the firm brings it to market. Specifically, they argue, *“Technologies are rarely inherently disrupting or sustaining. An organization can develop a technology and enter it into the market either way—it is not the technology itself that determines whether the product is disruptive or sustaining, but rather the strategy the organization takes to enter the market.”* Thus if the firm chooses to sell the product to existing customers then it is marketed as another step in the SI evolution of the product. On the other hand, the product is disruptive if the firm looks for new customers for it. An

incentive to do the latter is to avoid entering an existing market subject to already fierce competition from well-entrenched firms. Even a superior product in such circumstances arrives with a “*target on its back, firmly in the crosshairs*” of the competitors. Note that Christensen and Donovan (2000) are not saying that technology can be either a DI or a SI depending on how it is handled, but that resource dependency results in an established firm always seeing it as a SI. In the examples that they cite, firms clearly felt that they had the freedom to introduce the new technology in any way they choose.

This implies a considerable degree of discretion on the part of firms on how they perceive and develop technology, and a fair amount of passivity on the part of customers to the product offered to them by firms. The problem with Christensen and Donovan (2000) is that is hard to reconcile with Christensen's previous (and subsequent) arguments about the way in which the behavior of firms with respect to DI is highly constrained by its customers, resources, processes and values. Moreover, the contention that introducing a new technology into the SI market is an open invitation to brutal competition is surely an argument for firms to look aggressively for DI, which again undercuts the original theory that they ignore DI altogether.

Our analysis suggests that there is a need for empirical guidance as to what kind of change is prevalent in business. In other words, is the coincidence of technological and market changes and their differing trajectories intersecting in the right way and the right time to open up new strategic spaces, a common or uncommon occurrence? When will customers feel that they have the information to dictate what innovations the firm should pursue and which it should not?

In the absence of any formal empirical research on DI, one argument is that the worldwide interest in the DI theory is evidence of its descriptive validity: surely such enthusiasm for the theory would not exist unless DI was seen as an authentic and significant problem in the real world? The problem with this hypothesis is that it is clear that at least some of that interest is the result of a serious misunderstanding of Christensen's work. Specifically, in much of the discussion in business and the media concerning DI, the concept of **disruptive** innovation is used synonymously with that of **discontinuous** innovation. This is despite the fact that, as we have seen, the latter is often a sustaining innovation,

while the former has a specific meaning in the context of marketing rather in terms of technology alone.

The DI process is a subtle and sophisticated one—more so than is perhaps commonly realized—relying on the perceptions of customers and the differing trajectories of product improvement and market demand. It is only to be expected that in the popular press, the threat to firms posed by DI be confused with the ferment caused by discontinuous innovations and for some to see one as the outcome of the other⁴. This misunderstanding is also not hard to understand when one considers that Christensen's work came out at the beginning of the most rapid period of technological change impacting business in decades. The emergence of the Internet, a discontinuous innovation if there ever was one (though not a disruptive one: "*Christensen stresses that the Internet itself is not a disruptive technology, just a framework for innovation.*" Business Week, July 31st, 2000, page 130), as well as simultaneous advances in computers, networking, cellular communication and biotechnology has resulted in tremendous challenges and uncertainties for businesses. Managers trying to cope with such rapid and unprecedented change see in DI a worst-case scenario of what could happen to their firms. Yet, few of these are disruptive innovations in the very precise sense of that term, of providing a new value proposition that is unwelcome to existing customers. Existing customers and firms may not know how to cope with such advances as the Internet, but that is not to say that they systematically fail to understand the threat that they pose and their potential to transform their business.

Thus we cannot conclude from the widespread popular interest in DI that it is descriptively valid. What this confusion makes clear is the need to clarify exactly what kind of product change qualifies as a disruptive innovation. More to the point, the fact that many managers mistakenly seem to consider discontinuous

⁴ A typical example is the New York Times (June 5, 2000) article on the development of new protocols for the Ethernet that promise to greatly increase broadband capacity. The article goes on to discuss how managers in companies in industries affected by this development, such as AT&T and WorldCom, are "all reading *The Innovators Dilemma* by Clayton Christensen." But it is the large business customers of these companies that are in the forefront of pushing for greater broadband capacity so that, amongst other things, they can provide new entertainment options to customers (indeed, AT&T is itself is one of the largest customers for broadband technology, through its cable television division) videoconferencing, real-time prototyping and so on. Hence, this undoubtedly discontinuous innovation fails to meet the criterion for it to be also a DI. The problem that managers at these firms face is not in failing to appreciate the significance of the new technology but in figuring out what they are supposed to do with it.

innovation as synonymous with disruptive innovation is particularly troubling given our argument that it is precisely discontinuous innovations that are the least conducive for being subject to the DI process.

4. WHAT SHOULD FIRMS DO TO AVOID THE INNOVATOR'S DILEMMA?

As far as most managers are concerned, however, their concern about DI is not whether it occurs but what they should do about it. Christensen offers a variety of suggestions as to what firms can do to avoid the Innovator's Dilemma, even while warning that it is easier said than done (see also Moore, 2000). These practice recommendations directly challenge long held management control practices, requiring radical changes in organizational design, methods of resource allocation and performance evaluation. The rationale is that existing ways of running large organizations are simply unable to deal with the challenge of DI. It is important to understand and analyze the practice implications of DI theory because the only way managers can be said to be facing an innovator's "dilemma" is if they have the ability to predict and avoid the threat that DI poses to their firms—as opposed to DI being a "bolt from the blue" that no reasonable control system can hope to anticipate and absorb.

A response to the DI threat must a) develop criteria on how managers are to identify a candidate disruptive innovation, and b) construct new management control practices to ensure that the DI avoids succumbing to resource dependence on existing customers. Consistent with the critical role of the customer in defining a DI, the way to identify one according to Christensen is to look for innovations that are undervalued by influential current customers, or products whose continued development existing customers actively lobby as not serving their needs. Indeed, given the capture of some firm personnel, especially in marketing and finance, by these customers, Bower and Christensen (1995) suggest that another source of potential disruptive innovations are those products that are the basis of disagreement within the firm between customer advocates and technologists.

Identifying a DI is one thing, bringing it to market is another. The DI has to be removed from the mainstream management control architecture to shield it from resource dependence and to give it time to reach fruition. Christensen and Overdorf

(2000) argue that the responsibility for DI within large firms be delegated to autonomous corporate units, whose explicit task is to develop products that have the potential to kill off existing product lines. This is not an undertaking that is likely to be welcomed by managers of those existing products, and so the DI initiative must take place behind a firewall, which prevents attempts to undermine, starve or sabotage the DI unit.

The call for established firm to set up or acquire separate units to develop DIs is based on the argument that large firms need to mimic the startup entrants who are the ones who typically bring disruptive innovations to market. The implicit assumption is that small startups are not subject to the same constraints that discourage large firms from pursuing DI, since they are not dependent on an existing base of customers who dictate what they do, and nor do they have an emotional stake in existing products. It is also said that managers in small, lean organizations can make quicker decisions, and take risks on low margin projects because they don't have a large overhead to cover. They are also more likely to be excited by niche markets and the smaller returns that they offer. Hence, the firm's unit responsible for the DI also should be small enough to match the likely smaller scale of the initial DI market. Moreover, the unit has to be given room to grow and learn by trial and error the kinds of products that are desired by the emerging market. Thus, top management must ensure that the DI unit is not subject to pressure to become profitable as quickly as possible, especially since premature comparisons between existing products and DI will always favor the former.

Christensen (1997, page 103) also argues that the firm's resource allocation process is central to the development of innovation, since innovations that are not funded will not be brought to market by the firm⁵. In particular, only a small subset of funding proposals reach the attention of top management, with the rest screened out by lower level employees, who are the ones closest to customers and therefore likely to favor SI rather than the DI which undermines current product lines. In other words, the way in which resource dependence actually impacts the firm's product development process is principally through capture of the resource allocation process.

⁵ "Good resource allocation processes are designed to weed out proposals that customer's don't want." Christensen (1997, page 103)

The problems that DIs face with the firm's standard resource allocation policies are exacerbated in Christensen's (1997) view, by the fact that markets that don't exist can't be analyzed as well as ones that do. Product spaces for disruptive technologies often must be discovered by happenstance, while the well-established markets for SI are routinely analyzed using standard techniques. In particular, investment processes that demand quantification of cash flows, such as DCF, are hard to apply to DI proposals. The recommended solution to these problems is for firms to adopt new types of resource allocation and project planning methodologies, such as "discovery planning" which continually scan the environment for strategic opportunities, unconstrained by preconceived notions of what are appropriate products and markets for the firm⁶.

5. THE ROLE OF FIRM INFORMATION IN THE DI PROCESS

The two critical hypotheses that underlie the practice implications of DI theory are a) that DIs will almost inevitably fall through the cracks in standard management control systems, and b) that startups are able to avoid this fate and succeed with DI at the expense of the large, "well-run" firms. Both these assertions are predicated on implicit underlying assumptions about the role of information in the DI process. We have already discussed whether customers possess the information to be able to take a stand on an innovation, particularly a discontinuous one. If they don't, then the customer led resource dependency that underlies the DI process will be short-circuited. Similarly, possessing information about products and their trajectories are essential if firms are to adequately respond to the threat of DI.

Consider the issue of recognizing a DI: the first part of the criterion used is that the product falls short of the needs of leading customers. But there are many such products, most of which will turn out not to be disruptive, and it is obviously not a feasible strategy to develop a product precisely because it is unpopular with customers. A candidate DI must also be tested against the criterion of diverging trajectories of product improvement versus market demand. But do firms always have the information to make such an extrapolation about future developments of both the product and its potential market?⁷ If either trajectory cannot be derived

⁶ Christensen (1997, Chapter 7) discusses discovery planning. See also Christensen (1998b, 1998c) for an extension of discovery planning, "aggregate project planning".

⁷ For example, even the famed Moore's Law on the velocity of improvements in processor power only looks at the technological side of the equation, and does not predict what that power will be used for.

then the process of identifying a DI becomes problematic—as we showed earlier, simply looking at the technical attributes or customer perceptions of a product by themselves is not sufficient to determine whether a product is truly disruptive. This is a point also made by Christensen and Donovan (2000), while Christensen and Baird (1997, page 6) warn that: *“it is very difficult to discern, until after the fact, when a company has overshot the market”*.

A striking omission in DI theory is any formal recognition of the presence of uncertainty in the DI process. But there certainly is uncertainty, which extends not just to the rate of change of improvements in technology and of market demand, but also to what the parameters of change are in the first place—whether all dimensions of the product are susceptible to improvement at the same rate, and what product characteristic will be the next strategic differentiator for each segment of the market. Indeed, the trajectories of the DI and the market are presented in DI theory as simple straight lines (as in figure 2), which is only possible under the implicit assumption that there is no uncertainty whatsoever⁸.

To reflect at least the uncertainty associated with the rate of change of product capability and market demand, confidence intervals must be drawn around the trajectories. Doing so makes it much harder to assess whether and where the trajectories intersect, and so, if the SI is really facing a DI threat (figure 3):

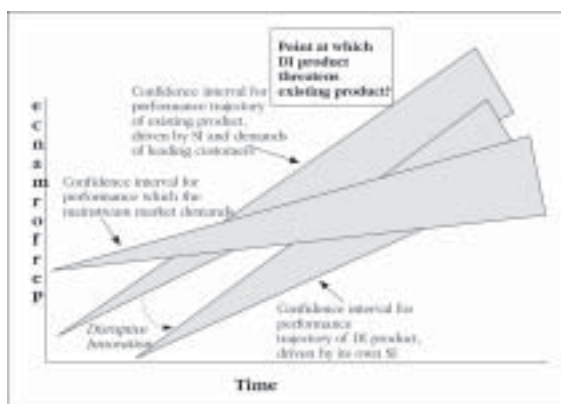


Figure 3. Trajectories of Technological and Market Demand Change with Uncertainty.

⁸ By contrast to the certainty implicit in the traditional DI diagrams, the literature at times also discusses the impossibility of ever predicting the future evolution of DI, which if true, describes a state of ambiguity rather than uncertainty (i.e. uncertainty about uncertainty). But there is no attempt to reconcile these two mutually exclusive perspectives on the evolution of innovation.

This, despite the fact that Figure 3 is already simplified to the extent that it assumes away the more fundamental uncertainty about which product is a DI and which SI it should be compared against. By omitting uncertainty entirely in the DI model, also ignored are any implications of *relative* uncertainty, and therefore, of risk. However, judging from Christensen's own arguments concerning capital budgeting for DI, it is clear that trajectories associated with SI are likely to be far more predictable than those of DI, given the firm's greater experience with the existing product's technology and demand. If that is the case, then differences in risk should to be taken into account when comparing SI against DI.

Of course, the DI argument is that even if the firm does possess the information to plot the trajectories with certainty, resource dependence leads it to incorrectly make the comparison only between technology and the needs of existing, rather than emerging, customers, a comparison in which the DI will always lose to the SI. But this hypothesis should not be accepted at face value. It is one thing to conclude that the DI does not meet the needs of current customers, and another for managers to conclude from that fact that there is no market for the DI *anywhere* with *anyone*. As we argued earlier, if that is indeed the mindset of managers, we would observe firms doing nothing else but selling to the same existing customers over and over again and never attempting to enter new markets.

This discussion on uncertainty and information raises the question of what drives the decisions of startups that *do* introduce the DI. The key issue here is whether the startup's managers correctly recognize the potential of the DI to create a mass market, because they have information on the trajectories, or whether they are simply lucky to introduce a product that turns out to develop unexpectedly fast and become unexpectedly successful. If it is the latter, then the startup succeeds only because it happens to be in the right place at the right time and many of the implications of the DI theory for business become less relevant.

For example, take the argument that as firms become larger, their culture change so that they find the niche markets that DI initially offers less appealing than a smaller firm would. There is, however, no reason for a large firm to take an

interest in a small opportunity that *remains* small. The implication of the DI theory is that the small market is actually the tip of the iceberg of a very large market opportunity. But does the startup know that? If it does, why doesn't the large firm? One might well accept that managers at large firms are influenced by their customers when assessing new technologies, but it is going much further to say that managers would give up a *known* large profit opportunity as a result. What do these managers make of the decision of the startup to introduce the DI? Does it lead them to update their priors about the potential of the technology? If neither the startup nor the existing firm is in a position to foresee that the small DI opportunity actually offers very large profits down the road, then we are back in a world of dumb luck determining winners and losers. There is certainly an air of serendipity in the arguments for discovery planning and for funding projects to learn by trial and error, leading to "emergent" strategies for products, as opposed to "intended" strategies (Christensen and Dann, 1999). In the absence of information to plot trajectories, however, discovery planning is reduced to relying on good fortune to actually find the rare DI amongst a host of projects that go nowhere because they simply do not meet the needs of a sufficiently large group of customers in any realistic time frame.

The role of startups in bringing DIs to market *also* needs to be contrasted against the recommendation that the firm's internal DI development units be shielded from pressure for quick profits. It may be feasible for large firm to take such a tolerant experimental approach, but how does the startup sustain itself without profits? Why would it actually enter such an unpromising market in the first place when, unlike the large firm, it does not have the ability to diversify risk across a large portfolio of projects? Even if a small opportunity is more tempting to a small startup than to a large firm, that opportunity has to promise *profits*, not just revenue—as dotcoms belatedly discovered—and profits should be desirable for any manager. Consider also the argument that standard resource allocation methods cannot and should not apply to DI products, since they represent markets that do not yet exist. If that is indeed the case, then what kinds of metrics do the startup and its financial backers use? And again, don't firms in fact often enter entirely new markets far removed from their existing customer base, using such techniques as real options to evaluate their opportunities?

6. AVAILABILITY VERSUS PERCEPTIONS OF INFORMATION IN THE DI PROCESS

By failing to address the role of uncertainty and the availability of information in the DI process, and in particular, how that role differs between large firms and startups, these questions are left unasked and unanswered by DI theory, undermining its practice impact. The DI theory would be far less compelling to managers at a Microsoft or Cisco if it were only from good fortune and not good planning that startups choose to market a product that turns out to be a DI. The pressure on large firm to react to DI also becomes less urgent if the startup entrepreneurs who threaten them really know no more about the profit potential of the DI than do the managers at the large firms. The reason that many large businesses have taken so much notice of DI theory is their belief that its message is that startups are systematically better than they are at recognizing the potential of DI. Given our analysis, are there circumstances under which this is the case?

There are at least two explanations for why a startup might introduce a DI with full awareness of its potential profit, while established firms simultaneously fail to do so. One is the traditional view of startups as being founded by visionary entrepreneurs who can see opportunities that others can't. Indeed, some of the cases that Christensen himself cites can be reinterpreted as examples of good entrepreneurship rather than the outcome of the DI process⁹. Unfortunately, if flashes of insight are needed to identify a DI, there is not much that can be done to protect large firms from the threat of disruption. The question of whether large firms can encourage entrepreneurial like thinking from their employees is a long-standing problem and not one related to disruptive innovations in particular.

⁹ For example, the decision by Honda to re-launch its motorcycles as dirt bikes came after some managers observed the vehicles being used in that fashion one weekend. Consider also another example from Christensen's (1997), of Eli-Lilly losing its market share in insulin to the Novo Corporation's insulin pen. While he argued that this is an example of the DI process in action, note that Novo is itself a very large pharmaceutical company rather than a startup. If Eli-Lilly, because of the pressure from patients and doctors dealing with complications resulting from impurities, kept focusing on increasing the purity of its insulin to beyond the point at which most customers cared, why didn't Novo fall into the same trap? To be consistent, DI theory has to imply that all existing manufacturers of insulin, including Novo, are subject to resource dependency. Perhaps a better explanation is that this was really the case of a clever manager at Novo coming to the conclusion that the only way to tackle the market leader was to shift the basis of competition, rather than attacking them head on a well known recommendation of strategy theory.

But there is also another possibility: that managers at startups and large firms can look at the same information and come to different conclusions about the profit potential of the DI. The DI theory already discusses how managers' perception of information can be affected by resource dependence, but only in the limited sense that pressure from customers leads them to ignore the potential of DIs altogether. It is difficult to accept, however, that managers will consistently fail to even seek out information on innovations that the firm has itself developed, especially since firms routinely conduct market research without committing themselves. Moreover, there has to be an explanation for why, by contrast, managers at startups do feel confident enough about the prospects of DIs to pursue them.

In this section we put forward an extension to the DI theory that makes it more comprehensive and complete, by explaining how the DI process *can* take place differentially in large firms and in startups, even when their managers have access to the same raw information about the likely profitability of the innovation. Whether the process *will* take place is another matter, and the question of the theory's empirical validity has ultimately to be left for users to decide for themselves. But our point is that the DI theory, as stated, is incomplete and the mechanism by which it operates unclear, and so if its validity is assumed then a better explanation must be found for why the process takes place.

Our model explicitly takes as given the availability of information, and focuses instead on how that information—in the form of estimates of the future profitability of the DI, and of the possible trajectories of changes in its capability and in market demand—is *interpreted* by managers. This is not to say that the issue of availability of information should be ignored, as it is in the standard DI model. But from our earlier analysis it is clear that without assuming information availability there can be no meaningful Innovator's Dilemma.

The starting point for our model is the recognition that the DI process is fundamentally inconsistent with the assumptions of standard management theory as taught in business schools, which posits a rational, far-sighted, fully optimizing manager. Such a manager should not be swayed by the cheap talk of existing customers to ignore potentially profitable opportunities. Other things equal, a manager who has an incentive to maximize profits prefers more information to

less, and a larger investment set to a smaller one. And while they may lower the costs of information gathering by turning to the expertise of leading customers, rational managers should also recognize the bias inherent in such sources and update their beliefs upon observing the actions of third parties, such as startup entrants. The driving force for such managers is the imperative to always seek profits, however large or small the opportunity may be, regardless of any sunk costs associated with existing products and customers. And further, unless they face resource constraints, they will adopt all profit opportunities, and rationally choose the best one if they have to make a tradeoff, but not eliminate any from consideration simply because someone asks them to.

Clearly, though, how management decisions should be made bears little resemblance to how they actually are, as the variety of shortsighted decisions by managers catalogued in the DI literature, amongst others, makes clear. A now widely accepted alternative paradigm of management decision making with greater descriptive validity is Prospect Theory, originally introduced by Kahneman and Twersky (1979). It attempts to develop a normative theory of decision making that takes into account systematic patterns of observed behavior that are inconsistent with the standard rational model.¹⁰ What we show is that the circumstances under which these departures from rationality are likely to arise also fit the profile of the DI process. As such, Prospect Theory provides an alternative explanation for why managers at large firms may fail to develop a DI even while managers at startups successfully avoid the Innovator's Dilemma.

What is the essential difference between the startup and the large firm when it comes to the DI process, assuming that managers at both in a position to obtain information about the technical and market potential of the DI? We suggest that the most striking distinction is, exactly as the DI literature argues, that the larger firm has existing customers and products while the startup does not. This should not matter in standard decision making theory where existing customers are akin to an irrelevant, if not sunk, cost. But there is ample evidence that in the real world that is not how managers actually think. In particular, they are subject to

¹⁰ The particular anomalies that Prospect Theory tries to incorporate include the non-linearity of decision weights, reference dependence and loss aversion, framing effects and mental accounting. Kahneman and Twersky (2000) survey the vast literature on these topics and explain them in depth.

two of the main anomalies described in Prospect Theory: the endowment effect and loss aversion.

The “endowment effect” is defined by Kahneman and Twersky (2000, page 13) as *“the reluctance of people to part from assets that belong to their endowment. When it is more painful to give up an asset than it is pleasurable to obtain it, buying prices will be significantly lower than selling prices. That is, the highest price that an individual will pay to acquire an asset will be smaller than the minimal compensation that would induce the same individual to give up an asset, once acquired.”*

This phenomenon has been observed with real transactions as well as in the laboratory, and with participants ranging from college students (some in MBA programs) to consumers, purchasers of auto-insurance, investors and even economics professors¹¹.

The explanation for the endowment effect put forward by Prospect Theory is that it is the consequence of two other cognitive shortcuts routinely followed by individuals, despite both being contrary to standard decision-making theory: the asymmetric weighting of gains versus losses, combined with the framing effect in which decisions are “edited” to look like gains and losses in the first place, rather than being seen in absolute terms¹². The net result of this combination of loss aversion, framing and the endowment effect is *“that individuals have a strong tendency to remain at the status quo, because the disadvantages of leaving it loom larger than advantage.”* (Kahneman, Knetsch and Thaler, 1991).

Relating this phenomenon to the DI process, the problem that managers face at large firms is that the very salient presence of their existing products and most demanding customers, along with the effort that the firm has put into developing and maintaining them, results in these products and customers coming to be seen as the firm’s endowment, a set of assets that must be protected. When a DI emerges,

¹¹ Knetsch (1989) summarizes the literature as well as providing evidence of his own.

¹² *“A central conclusion of the study of risky choice has been that such choices are best explained by assuming that the significant carriers of utility are not states of wealth or welfare, but changes relative to a neutral reference point. Another central result is that changes that make things worse (losses) loom larger than improvements or gains.”* Kahneman, Knetsch and Thaler (1991).

it is perceived as a threat to this endowment, and so the gain it offers is interpreted as coming at the expense of the current market position. In other words, the DI is associated with losses as well as gains, and because of loss aversion, the former tend to receive more weight than the latter.

By contrast, startups begin with nothing and so DI is unambiguously a gain to them, albeit an uncertain one. The point is that the large firm managers feel that they have to *give up* something if they are to pursue the DI, while the startup managers have little to lose. It is this sense of loss that triggers the endowment effect, which results in the losses being overstated relative to the gains¹³. The resource dependency pressure that customers place on managers of large firms also exacerbates the emotional identification that they develop with products and customers that they have long valued. Taken together, these cognitive effects can result in managers at large firms looking at the same information as managers at startups on the potential profitability of the DI and drawing very different conclusions about what that information is saying. The larger firm managers are likely to require a much more positive profit outlook than the entrepreneurs, who are not comparing the DI with the seemingly assured profit stream of the SI. A higher threshold to accept a DI project than a SI one by the large firm managers corresponds to the higher “willingness to sell” price than “willingness to buy” price predicted by the endowment effect.

Kahneman and Twersky (1984, emphasis added) state “*loss aversion and the consequent endowment effect are unlikely to play a significant role in routine economic exchanges*”. Their argument is that everyday buying and selling

¹³ It is ironic that the framing of decisions about DI as losses or gains around the status quo of the existing products is similar to the way in which relevant cost analysis, long advocated by management accountants, would tackle the problem. However, while relevant cost theory also focuses only on incremental changes, it does not differentially weigh gains and losses, and it reduces all alternatives to their profit impact, which individuals patently do not, so giving rise, for example, to the “sunk cost fallacy”. Relevant cost theory also would not consider the fate of existing customers and products as a loss, since a true assessment of the DI threat would result in a recognition that existing market conditions are unlikely to persist in the future: even if the firm chose not to introduce the DI, competitors almost certainly will, so making the margins currently earned by the existing product unsustainable. Nonetheless, a persistent failing in capital budgeting analysis is the comparison of the new opportunity against a benchmark of current conditions, implicitly assuming that the status quo will prevail unchanged, indefinitely (Kaplan, 1986; Howell and Soucy, 1987). Further, Kaplan (1986) points out that there is a pervasive problem in investment decision-making of excessively high hurdle rates for projects that would change the status quo. This is another instance of framing decisions around the natural reference point of where the firm is now, rather than considering whether that will remain a viable standard in the future.

transactions are perceived as simple exchanges of cash and not as losses and gains. But the whole point of DI is that it is not a routine event, but one that confronts managers very rarely in their careers and in the lifetime of their firms. Further, the resource dependency that they feel for their existing customers and products makes it hard for managers to reduce them to their monetary equivalent and so makes the endowment effect much more likely to impact their decision-making process.

A counterargument is that the high stakes involved in real-world DI cases makes it more likely that managers will behave in accord with standard, rational decision-making theory (Arlen *et al*, 2001). There are two objections to this sanguine view. First, there is evidence that cognitive biases persist even in circumstances where large amounts of money are at stake (Kachelmeier and Shehata, 1992; Camerer *et al*, 1997; Odean, 1998). Second, this argument applies as compellingly, if not more so, to the original DI theory, where it is assumed that pressure from customers causes managers to forgo even investigating the profit potential of their own innovations. That is a cognitive failure for which little justification is offered.

By identifying the cognitive drivers of the DI mechanism, our model allows firms to better deal with the challenge of DI. The practical implications of the standard DI theory are deficient in this regard because of their failure to explicitly address informational issues, especially how managers differentially perceive information. Thus even if firms adopt discovery planning to identify candidate DIs the problem will remain that the output of these new control systems will be interpreted by managers subject to their cognitive shortcomings, and so established products and markets will still be favored over the DI. Simply hiring consultants to educate managers about the possibility of the Innovator's Dilemma is not sufficient if they are also not taught how to better process information and not differentially weigh gains and losses.

The endowment effect is not the only cognitive bias that potentially impacts the way in which manager react to DI. The information that managers are presented with about the potential of the DI is probabilistic in nature. There is considerable evidence that when considering outcomes, especially unfamiliar and extreme ones

such as DIs, decision weights on outcomes do not correspond to the raw probability and neither are they treated linearly, as required by standard theory. Further, framing effects, source dependence and loss aversion all affect how the decision weights are formed (Kahneman and Twersky, 1979, 1984; Twersky and Kahneman, 1992). There is little doubt that these effects will impact the assessment that managers make of DI, but whether there is a differential effect between managers at large firms and at startups is unclear. The point is that by ignoring the impact of uncertainty and information in the DI process altogether, the standard theory is not rich enough to provide a structure for dealing with these issues¹⁴.

7. CONCLUSION

The point of our analysis is not to undermine the importance of the DI theory or the need for firms to examine their control procedures in the light of its practice implications. DI is rightly held to be a highly important phenomenon in a new economy characterized by rapid changes in technology and consumer tastes. Rather, given the degree of both widespread interest in DI and the all too frequent misidentification of discontinuous innovation with disruptive change, there is a need to better understand the DI process and especially its underlying assumptions. In particular we have shown that the role of information needs to be clarified. DI focuses on the way in which customers and managers filter and perceive information. As much attention needs to be placed on the availability of the information that determines customer and firm reaction to disruptive innovation.

However, even when the availability of information is given, the fact remains that the DI process is fundamentally inconsistent with the assumptions of rationality underlying standard management theory. Hence, a new approach is needed to understand how managers interpret information about DI and we suggest that

¹⁴ The endowment effect can also explain other anomalies observed in management control. Take re-engineering, which calls for managers to adopt a "clean-sheet" approach to designing their processes, rather than assuming that existing processes are optimal. The question is why managers should ever take as given existing processes, many are which in fact quite obsolete and detrimental to firm performance, rather than continually reevaluating what are the best possible ways of running the firm. The fact that existing processes are not considered as the equivalent of a sunk cost is another indication of the bias towards the status quo that is induced by the endowment effect. A similar analysis can be undertaken of an even more venerable management practice, zero-based budgeting.

when they do so, circumstances arise in which cognitive biases are likely to play a role. How viable is an explanation for the DI process based on cognitive biases by managers? The advantage of our model is that it explains why there should be a differential effect by managers at large firms and at startups when they have equal access to information about a DI. That is perhaps more appealing than the argument that the former simply choose to turn a blind eye to DI altogether, while startup managers have near perfect insight into the opportunities that DI offers.

The point of introducing Prospect theory into the DI process is to enable a model to be developed that does not ultimately rely on an assumption that relative to their startup colleagues, managers at large firms are shortsighted at best, if not outright stupid. Cognitive failures affect all aspects of human behavior, but through better training and awareness they can be overcome. That is a role that management accountants can play a vital role in, given their core competency in the management of information and the large body of research on the role of human cognition in accounting practice, especially in auditing. By better identifying the mechanism through which the DI process operates, our model allows managers to frankly question their own perceptions, assumptions and actions. Only managers that understand rather than simply fear the Innovator's Dilemma can successfully avoid it.

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