Strategic Management Journal
Strat. Mgmt. J., 27: 215–239 (2006)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/smj.513

A DEMAND-BASED PERSPECTIVE ON SUSTAINABLE COMPETITIVE ADVANTAGE

RON ADNER and PETER ZEMSKY*
INSEAD, Fontainebleau, France

We develop an approach to analyzing the sustainability of competitive advantage that emphasizes demand-side factors. We extend the added-value approach to business strategy by introducing an explicit treatment of how firms create value for consumers. This allows us to characterize how consumer heterogeneity and marginal utility from performance improvements on the demand side interact with resource heterogeneity and improving technologies on the supply side. Using this approach, we address a variety of questions including whether technology substitutions will be permanent or transitory; the sequence in which new technologies attack different market segments; how rents from different types of resources change over time; whether decreasing marginal utility and imitation give rise to similar rent profiles; the extent of synergies within a firm's resource portfolio; the emergence of new generic strategies; and the conditions that support strategic diversity in a market. Our focus on consumer utility and value creation complements the traditional focus in the strategy literature on competition and value capture.

INTRODUCTION

The drivers of sustainable competitive advantage are a focal point of debate in the strategy literature. In this debate, the competitive strategy school (e.g., Porter, 1980; Ghemawat, 1991), with its concern for industry structure and firms' choices of strategic positions, and the resource-based school (e.g., Wernerfelt, 1984; Barney, 1991), with its concerns for the value, uniqueness, inimitability, and non-substitutability of resources, are often presented as strong contrasts, the former focused on firms' external environments, the latter focused on firms' internal capabilities. In an important regard, however, these two views are quite similar—both focus primarily on firms' supply-side interactions and largely neglect the demand environment in which these interactions take place. Whether couched in the language of mobility barriers (Porter, 1980), imperfect factor markets (Barney, 1986), or isolating mechanism (Rumelt, 1984), the thrust of their concern is with firms' ability to capture value by excluding rivals from opportunities. This focus on value capture tends to take for granted the prerequisite challenge of value creation.[1]

Keywords: technology competition; resource portfolios; generic strategies; decreasing marginal utility; consumer heterogeneity
* Correspondence to: Peter Zemsky, INSEAD, Boulevard de Constance, Fontainebleau Cedex 77305, France.
E-mail: peter.zemsky@insead.edu

[1] Clearly, the question of value creation has long been present in the literature, but it has tended to be treated as a background concern. As the Priem and Butler (2001)–Barney (2001) debate highlights, in the context of the resource based view, value has largely been considered in terms of firms' ability to capture value when resources are purchased in imperfect factor markets. In contrast, the assessment of how resources create value from a consumer perspective has received less attention. While the competitive strategy school has been more explicit in its treatment

Received 20 October 2003
Final revision received 11 July 2005

Value creation presents a distinct set of challenges. Consider for example the market for computer microprocessors. For over 30 years microprocessors have followed a steep technology trajectory, with processing speed approximately doubling every 2 years in accordance with Moore's law. The market has been controlled by the duopoly of Intel and AMD, with Intel dominating the market based on impressive product and process resources. Despite its strong position, from the late 1990s Intel faced problems that were more fundamental than threats of resource imitation by AMD.

Figure 1 shows the price premium for different microprocessors in Intel's product line in 1996 (Pentium) and 2000 (Pentium and Celeron).[2] It plots the price premium as a function of the performance premium that a given processor offered in comparison with the slowest processor in the annual product line. Note that while higher processing power always commanded a price premium at a point in time, the rightward shift of the curves shows that this premium decreased between 1996 and 2000. This suggests that despite Intel's ability to maintain the pace of performance improvements, its ability to create value for consumers was hampered by consumers' decreasing marginal utility from these performance improvements. This was a major challenge that reshaped Intel's strategy (see Intel Corporation, 1998).[3] Concurrently, Intel faced increasing consumer heterogeneity and responded by introducing the

of valuation by consumers, which underlies the ideas of competitive positions and substitution, its research agenda too seems to have been primarily focused on firm-firm interactions.

[2] We thank Joel Baum for providing these data.

[3] While Figure 1 is consistent with consumers having decreasing willingness to pay for faster processors as highlighted by discussions of Intel in the business press (e.g., 'This is not the Intel we all know,' *Business Week*, August 16, 2004: 32), we expect that some of the shift also reflects increasing capabilities of the rival AMD.

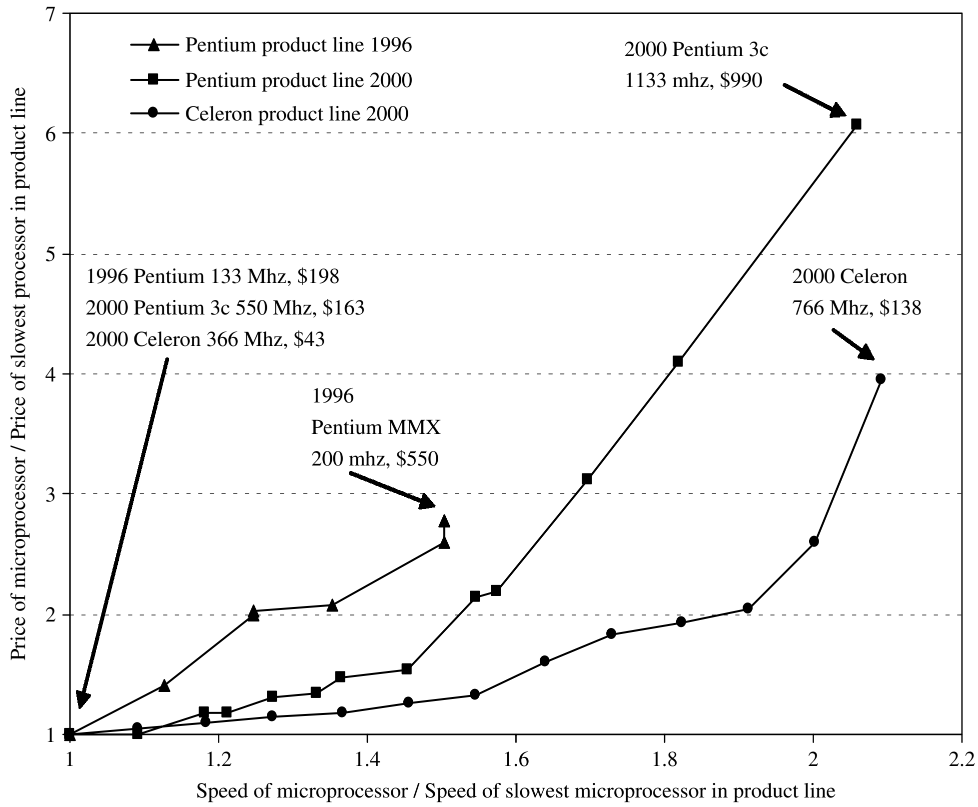

Figure 1. Price premium for performance premium in Intel's product lines in 1996 and 2000, where the rightward shift shows Intel's decreasing ability to extract a price premium for performance improvements. Adapted from Adner (2004)

Celeron product line to target the low-end market segment, maintaining the Pentium line to target the high-end market segment.

In this paper we explore the ways in which decreasing marginal utility and consumer heterogeneity across market segments affect the sustainability of competitive advantage through shifts in consumer willingness to pay.[4] We consider the implications for a variety of threats to sustainability: (i) how the threats from substitute technologies change over time and whether these threats will be permanent or transitory; (ii) how rents from different resources change over time and the extent to which imitation and decreasing marginal utility have similar effects; (iii) how the viability of different competitive strategies changes over time and whether a market can support strategic diversity such that both a cost leader and a differentiator coexist.

Formal foundations of strategy

This paper contributes to three strands in an emerging literature that is developing the formal foundations of strategy. One strand, the added-value approach to business strategy (Brandenburger and Stuart, 1996), seeks to leverage cooperative game theory. This literature starts with value creation by coalitions of different economic actors. In contrast to the non-cooperative approach used in standard IO models, in cooperative games the competition for value capture takes the form of free-form bargaining. Subsequent work in this strand has tended to focus on the conditions that govern the ability of different parties to capture value (e.g., Lippman and Rumelt, 2003; MacDonald and Ryall, 2004). We complement this work by shifting attention toward the drivers of value creation.

A second strand seeks to formalize the resource-based view. Much of this literature draws on information economics to elucidate the workings of strategic factor markets in which firms acquire valuable resources (e.g., Makadok, 2001; Makadok and Barney, 2001). In addition, it explores resource accumulation strategies in the presence of time compression diseconomies (Pacheco de Almeida and Zemsky, 2003, 2004). In both cases the prior work has focused on the competition between firms to acquire resources, and has tended to take for granted how these resources create value for consumers, which is our focus here.

A final strand seeks to articulate a demand-based perspective on strategy. Adner and Levinthal (2001) introduce the construct of decreasing marginal utility to study patterns in the evolution of technology. Adner (2002) considers how decreasing marginal utility interacts with consumer heterogeneity across discrete market segments to study the emergence of disruptive technologies. Adner and Zemsky (2005) build on these simulation studies to develop an analytic model that considers the implications of discrete market segments and disruptive technologies for a variety of classic IO concerns such as industry concentration, social welfare, and the effect of mergers on market structure. These studies, however, focused on questions of technology strategy. The present paper extends the demand-based perspective to address questions at the firm and resource levels of analysis.

Key elements

Just as Lippman and Rumelt (1982) use a simple model to demonstrate the importance of uncertain imitability for explaining differences in firm performance, our objective is to demonstrate the importance of demand-side factors for the analysis of sustainability. We develop a formal model that offers a stylized characterization of firms and competition, which allows us to focus on the implications of the demand-side elements of interest. On the supply side we consider a duopoly setting where firms differ either because they use different technologies or because they hold different resources. The performance of firms' offers improves over time along technology trajectories (e.g., the increasing performance of IT hardware; increasing safety of automobiles; increasing breadth and timeliness of financial information).

Our approach to competitive interactions follows the added-value methodology (e.g., Brandenburger and Stuart, 1996), which assumes that a firm's ability to capture value is governed by its added value. In our analysis, we make the notion of competitive advantage precise by equating it with added value. A firm's ability to sustain competitive advantage is thus equivalent to its ability to sustain added value.

[4] We associate the sustainability of competitive advantage with the extent to which firm rents do not erode over time. This is a common approach in the literature, but it differs from approaches that focus on the extent that firm strategies remain unique despite attempts at imitating their benefits (Barney, 1991; Makadok, 1998).

By explicitly linking firms' supply-side activities to demand-side value creation we are able to derive a typology of resources. *Process resources* reduce a firm's production costs. *Product resources* increase the performance of a firm's offer by a fixed amount. *Timing resources* give a firm a head start in developing its technology. Finally, *innovation resources* enhance a firm's technology trajectory.

We introduce two new elements to the added-value approach. The first is the extent to which consumers have decreasing marginal utility (DMU) from performance improvements. This key demand-side driver of value creation relates the extent to which increases in product performance are reflected in increases in consumers' willingness to pay. DMU reduces the value of performance improvements over time. One implication is that DMU erodes the rents from product resources, and does so in a way that parallels the effects of classic resource imitation. Further, we find that the effects of DMU on entry timing and resource strategy are contingent on the nature of a firm's competitive advantage.

DMU is of interest as an independent variable because it varies across markets and market segments. Generally, in settings where the product is more critical to the consumer, whether in direct consumption or as an input into a process, performance improvements are more highly valued and DMU is lower. In settings where the product is less critical, DMU is higher. For example, improvements in display resolution face different levels of DMU depending on the application (e.g., we would expect lower DMU for display resolution improvements in medical imaging devices, where the stakes are high, than in personal organizers).

The second key element we introduce is consumer heterogeneity. We model such heterogeneity with discrete market segments that vary in their taste for quality. These differences in taste for quality across segments determine the relative importance of performance-based and cost-based competitive advantages. For example, we show how the extent of consumer heterogeneity determines whether a market can support strategic diversity such that firms pursuing different resource strategies can profitably coexist.

In addition to DMU and consumer heterogeneity, an important driver of our results is the discontinuities that arise as new firms begin to create value in a segment. We find, for example, that early in a market's development there are positive synergies to holding multiple resources that arise from advancing the time at which the firm has positive value creation. As markets mature, so that even an unresourced firm creates positive value, we find that most resource combinations exhibit neutral or even negative interactions.

We extend our base model to allow firms to change their competitive positions over time by adjusting their resource portfolio. We identify conditions under which firms pursue a Resource Generalist strategy by investing in product and process resources simultaneously. We find that such firms pioneer markets sooner than Cost Leaders and Differentiators due to the initial synergies in their resource portfolio.

The next section introduces the model and discusses the key assumptions. The following section defines competitive advantage in the context of the added-value approach. Once these preliminaries are in place, we proceed to the results, with the formal proofs given in the Appendix.

MODEL

In our model, there are two firms, which we index by $i = 1, 2$, each of which has a single product or service offer that is improving over time. Consumers belong to one of two market segments, which we index by m. There is a high-end market segment ($m = H$) with $s_H > 0$ consumers and a low-end market segment ($m = L$) with $s_L > 0$ consumers. Each consumer buys at most one unit. Following Brandenburger and Stuart (1996, 2003), we assume that firm i's profit in segment m is proportional to its added value, which we denote by $A_{im}(t)$.

Value creation

A key element of an added-value analysis is a precise specification of the value creation of a firm's offer. From Brandenburger and Stuart (1996), an offer's value creation for a consumer is the difference between the consumer's willingness to pay (WTP) for the offer and the firm's opportunity cost of serving an additional consumer. We denote a consumer's willingness to pay for the offer of firm i by $w_{im}(t)$. Note that WTP varies over time and across firms and segments. We simplify by assuming that there are no capacity constraints so that a firm's opportunity cost is just a constant marginal cost $c_i > 0$. Thus, a firm's value creation, $v_{im}(t)$, is

$$v_{im}(t) = w_{im}(t) - c_i \tag{1}$$

Willingness to pay

We assume that consumers' WTP is given by

$$w_{im}(t) = a_m[x_i(t)]^\beta \tag{2}$$

where $a_m > 0$ is consumer taste for quality, $x_i(t)$ is product performance at time t, and $\beta \in (0, 1)$ parameterizes the extent of consumers' decreasing marginal utility (DMU) from performance improvements.

Consumers' taste for quality a_m can be interpreted in several ways. If consumers are individuals, a_m can be interpreted as an ability to pay which is (usually) increasing in income level, or as the intensity of interest in the category (e.g., audiophiles). If consumers are organizations, a_m can be interpreted as the importance of the input (e.g., airplane engine performance might be more important for military than for civilian buyers) or as the frequency with which the offer will be used. We assume that the high-end segment has a greater taste for quality than the low-end segment, $a_H > a_L$. We characterize consumer heterogeneity in terms of variation in segments' taste for quality $(a_H - a_L)$.[5]

Product performance—the speed of a microprocessor, the accuracy of medical testing, the reliability of logistics services—is given by $x_i(t)$. Although many offers have multiple performance attributes, we simplify the analysis by focusing on a single key attribute. We assume that performance is increasing over time according to

$$x_i(t) = b_i(t + h_i) + r_i \tag{3}$$

where $b_i > 0$ is firm i's technology trajectory, $h_i \geq 0$ allows a firm to have a head start in developing its offer, and r_i allows for a fixed increment to the performance of firm i's offer.

The exponent β parameterizes the extent of DMU. For example, the utility from increasing the maximum speed of an automobile is much greater when the maximum speed is 40 miles per hour than when it is 100 miles per hour. We assume that β is between 0 and 1 so that consumers' willingness to pay increases as performance improves, but at a decreasing rate.[6]

In summary, firm i's value creation for segment m at time t is

$$v_{im}(t) = a_m[b_i(t + h_i) + r_i]^\beta - c_i \tag{4}$$

Firm heterogeneity

We consider two sources of firm heterogeneity in value creation. First, firms might use different technologies. This is our approach when we analyze the threat posed by a substitute technology. Second, firms using the same technology might differ in their resources. This is our approach when we address the sustainability of firm rents and competitive positions. Equation 4 gives rise to a natural typology of resources. For firm resources to impact value creation, they must impact one of the firm-specific parameters (i.e., b_i, h_i, r_i, and c_i). We develop this typology in the section on resource rents.

ADDED VALUE

A critical first step in the analysis is to identify a firm's added value in a market segment at a point in time because this is what drives profitability. Firm i's added value is the total pay-off to all parties when firm i is in the market compared to the total pay-off were firm i to withdraw from the market. In our context, this is the value a firm creates relative to a consumer's next best alternative, which may either be purchasing a rival's offer or not making a purchase at all.

[5] Our simplifying assumption of consumer homogeneity within market segments yields a demand function that decreases in two discrete steps. As the number of segments in a market increases, and as the size of these segments decreases, demand in our model more closely approximates the downward sloping demand curves found in traditional economics textbooks.

[6] Formally, marginal utility is $\partial w_{im}/\partial x_i = a_m\beta/[x_i]^{1-\beta}$. We restrict attention to $x_i > 1$ so that marginal utility is increasing, and DMU is decreasing, in β. We note that DMU is decreasing in a_m as well. For expositional simplicity we focus on the effects of β on DMU; in the proofs we show that the results hold as well when it is shifts in a_m that affect DMU. Finally, note that the exponential form $x_i(t)\beta$ is conservative in that consumer utility is unbounded and hence $\lim_{x\to\infty} w_{ij}(t) = 1$. Imposing an upper bound on WTP would imply that DMU is even more pronounced than with our functional form.

Consider the added value of firm 1 in segment m. When firm 1 creates less value than firm 2 (i.e., $v_{1m}(t) \leq v_{2m}(t)$), then firm 1's added value is 0. This is because the consumer buys at most one unit and that unit is purchased from firm 2; hence, if firm 1 is not in the game, nothing is lost. When firm 1 creates more value than firm 2, three cases arise as illustrated in Figure 2.

First, firm 1 might have negative value creation, which occurs when its marginal costs exceed the consumer's WTP for its offer, in which case the firm has no added value. Second, firm 1 might have positive value creation while firm 2 has negative value creation. In this case, firm 1's added value is the entirety of its value creation, $v_{1m}(t)$, since this is what it brings to the game. Finally, when both firms have positive value creation, firm 1's added value is the difference in value creation, $v_{1m}(t) - v_{2m}(t)$, since firm 2's value creation would remain if firm 1 were to exit the game.

Lemma 1. The added value of firm 1 is

$$A_{1m}(t) = \begin{cases} v_{1m}(t) & \text{if } v_{1m(t)} > 0 \geq v_{2m}(t) \\ v_{1m}(t) - v_{2m}(t) & v_{1m}(t) > v_{2m}(t) > 0 \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

An analogous expression defines $A_{2m}(t)$.

Thus, when a rival begins to create value in a segment, the determinant of the focal firm's added value shifts from its absolute level of value creation to its relative value creation.

What is the connection between added value and consumer choice? If a firm has positive added value in a segment, then consumers purchase its offer. When it is the rival that has positive added value, the firm's offer is not purchased.[7]

Added value and firm profits

Firm 1's profits in a segment are given by $A_{1m}(t)s_m$, recalling that $A_{1m}(t)$ is the added value for a consumer in segment m and s_m is the number of consumers in the segment.[8] Firm 1's total profits across the high-end and low-end segments are given by

$$\Pi_1(t) = A_{1\mathrm{H}}(t)s_H + A_{1L}(t)s_L - F \quad (6)$$

where $F \geq 0$ allows for the possibility of a fixed cost to maintaining resources, which we make use of in the section on how resource strategy changes over time.[9]

[7] Note that when the two best options have the same value creation, added value and hence rents are zero. Although an added-value approach does not specify which offer consumers purchase in this case, from a rent perspective it does not matter.

[8] Note that we are assuming that firms capture all of their added value. One could easily consider the effects of bargaining power in our model by introducing a parameter α_m such that a firm is able to capture a fraction α_m of its added value. Because s_m and α_m are both multiplicative terms, our assumption that firms capture all their added value (i.e., $\alpha_m = 1$) is without loss of generality. That is, s_m can be interpreted as reflecting both a segment's size and its bargaining power.

[9] There are several alternative approaches to linking firm value creation to firm profits. Our approach is to assume that profits are proportional to a firm's added value. We would get the same profit function if we assumed Bertrand price competition. In a working paper (Adner and Zemsky, 2002), we consider Cournot competition. The main difference is that under the added-value approach each segment is winner-take-all, while with Cournot the firms coexist in the segment if their value creation is sufficiently close. Using a Shapley value approach

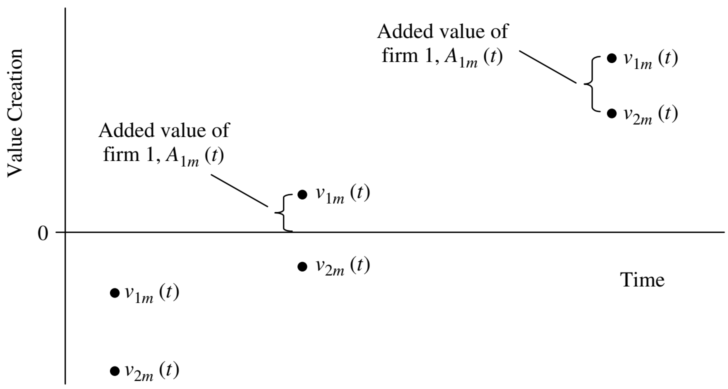

Figure 2. The value creation and added value of the firms at three points in time. Firm 1's added value is calculated relative to the next best alternative, either firm 2's offer or not purchasing

Added value and competitive advantage

We now make explicit the relationship between competitive advantage and added value. It is useful to separate competitive advantage into two parts: relative costs and relative differentiation. Firm 1's cost (dis)advantage is

$$A_1^c = c_2 - c_1 \tag{7}$$

and its differentiation (dis)advantage is

$$A_{1m}^d(t) = w_{1m}(t) - w_{2m}(t) \tag{8}$$

Note that a firm's cost advantage in our model is the same across segments, while its differentiation advantage varies by segment and over time. Analogous expressions define A_2^c and $A_{2m}^d(t)$.

Firm 1's net competitive advantage is

$$\begin{aligned} A_{1m}^d(t) + A_1^c &= (w_{1m}(t) - c_1) - (w_{2m}(t) - c_2) \\ &= v_{1m}(t) - v_{2m}(t) \end{aligned}$$

Thus, we have shown the following.

Lemma 2. When both firms create value in a segment, firm 1's added value $A_{1m}(t)$ is equivalent to its net competitive advantage:

$$A_{1m}(t) = v_{1m}(t) - v_{2m}(t) = A_{1m}^d(t) + A_1^c \tag{9}$$

Recently, there has been renewed interest in the appropriate definition of competitive advantage (e.g., Rumelt, 2003; Barney and Peteraf, 2003). Our contribution to this debate is to take one possible definition and show how it can aid in the study of some central strategy questions.

SUBSTITUTE THREATS IN A SEGMENT

Industry analysis (Porter, 1980) is often criticized as taking too static a view of market boundaries (e.g., Grant, 1998), paying insufficient attention to how the threat from substitute technologies changes over time. The importance of understanding shifts in market boundaries is highlighted, for example, by the phenomenon of disruptive technologies (Christensen, 1997). Disruptions occur when existing industry boundaries are redrawn by the entry of firms using new technologies that start in a niche segment and, as they improve, displace incumbent technologies from mainstream segments. The recent technology bubble, in which many promising new technologies turned out not to be disruptive, underscores the need to critically assess the substitution threat posed by new technologies.

We consider how change in the relative value creation of technologies shapes the evolution of market boundaries. We address whether a new technology will displace an incumbent technology from a given segment; if so, when this will occur; and finally, whether substitution will be permanent or transitory. We show how the answers depend on the extent of DMU, technology trajectories, and cost positions.

Specifically, in this section we consider the following situation. Firm 1 represents the new technology, whose performance depends on its technology trajectory

$$x_1(t) = b_1 t \tag{10}$$

Firm 2 represents the incumbent technology whose performance

$$x_2(t) = b_2(t + h_2) \tag{11}$$

depends on its technology trajectory as well as on its head start in the market. We assume that the incumbent technology's head start is sufficiently great that it creates value in the segment before the new technology. The technologies can vary in their marginal costs ($c_1 \neq c_2$). In this section we consider competition in a single segment.

We take technological progress to be exogenous to the firm's activity in the focal market segment. Such technological progress in the absence of sales in the focal segment can be observed when the technology is developing in other market segments. An example of this is Christensen's (1997) description of the hard disk drive market, in which 3.5-inch hard drives initially serve only notebook computer users and then, after continued development in this niche, eventually improved to the point at which they attracted consumers in the mainstream desktop segment. From the perspective of an observer of the mainstream desktop

(see Lippman and Rumelt, 2003) similarly relaxes competition and allows both firms to profit in the same segment. In both Cournot and Shapley, just as in our model, an important driver of a firm's profits is its added value. The key difference is that in these models absolute value creation also matters.

segment (which is the perspective we will take in this section) the 3.5-inch technology improved over time despite the fact that it had no sales in the mainstream segment.

From the discussion of consumer choice in the previous section, we know that the new technology can only displace the incumbent technology from the segment if it has a net competitive advantage $A_{1m}^d(t) + A_1^c > 0$. The cost advantage A_1^c is fixed, while the differentiation advantage $A_{1m}^d(t)$ changes over time.

Same trajectory

With identical technology trajectories ($b_1 = b_2$), the new technology always has a differentiation disadvantage due to the incumbent's head start. However, the value of the head start erodes over time due to DMU: as performance gets better and better over time, the incumbent technology's performance advantage has less and less impact on consumers' willingness to pay. In the long run, DMU completely erodes the incumbent's differentiation advantage. Thus, if the new technology has a cost advantage, it will eventually substitute. What affects the time to substitution? The lower the marginal utility from performance improvements, which depends on the extent of DMU, the faster the differentiation advantage erodes and the sooner substitution occurs.

> *Proposition 1: If the technologies have the same trajectory, the new technology substitutes for the incumbent technology only if it has a cost advantage. The greater the extent of DMU the sooner substitution occurs.*

Proposition 1 highlights the role of DMU in shifting the emphasis from differentiation to costs as technologies improve. For example, as computer hard drive capacities increased, unit costs played an increasingly important role in determining market outcomes in the desktop segment. Those new hard drive technologies that had lower unit costs than higher performance incumbent technologies (3.5 vs. 5.25-inch; 2.5 vs. 3.5-inch) were able to displace incumbents from the PC segment; disk drive technologies that had a cost disadvantage (1.8-inch and 1.3-inch) were not disruptive (Adner, 2002).

Better trajectory

Now consider the case where the new technology has a better trajectory than the incumbent technology ($b_1 > b_2$). Because the incumbent has a head start, the new technology begins with a differentiation disadvantage; over time it develops a differentiation advantage due to its superior technology trajectory. As the new technology's differentiation advantage grows, it eventually overwhelms any cost disadvantage and substitution occurs.

The effect of DMU on the timing of substitution depends on the relative cost positions of the technologies. With a cost disadvantage, the new technology does not substitute until it has a sufficient differentiation advantage. Because the value of any differentiation advantage is magnified when DMU is lower, lower DMU speeds the onset of substitution in this case. Conversely, if the new technology has a cost advantage, it will enter the segment while it still has a differentiation disadvantage and hence anything that erodes its differentiation disadvantage, such as higher DMU, speeds substitution.

> *Proposition 2: If the new technology has a better trajectory, it will eventually substitute for the incumbent technology. The effect of DMU on the timing of substitution depends on the new technology's cost position: with a cost advantage (disadvantage), the higher is DMU, the sooner (later) substitution occurs.*

Consistent with this proposition, there are numerous cases of new technologies that start with inferior performance but, by improving along a superior technology trajectory, eventually substitute for incumbent technologies. Classic examples are radial tires substituting for bias ply tires and steamships substituting for sailing ships (Foster, 1986).

More subtly, Proposition 2 makes predictions about how the impact of shifts in the demand environment depends on the relative costs of the competing technologies. Consider the effects of the rapid adoption of the World Wide Web in the late 1990s. The ready availability of rich content increased consumers' willingness to pay for communication bandwidth, which, consistent with the proposition, raised the threat posed by higher-cost, broader-band communication technologies such as cable modems and ADSL to the incumbent dial-up technology. Conversely, because the Internet allowed users to exploit the power of remote servers, the Internet lowered the willingness to pay for desktop processing power, which increased the threat posed by lower-cost PC architectures (e.g., the 'sub-$1000' PC).

Worse trajectory

Not all substitutions are permanent. Consider the shifting fortunes of discount brokers such as Schwab and eTrade relative to full service brokers like Merrill Lynch. Consider, also, Bic's entry into the mainstream razor market with its disposable offering, an incursion that was ultimately reversed by Gillette's superior technology trajectory for cartridge razors. How can we account for cases in which a new technology aggressively enters a market but is then driven back by the incumbent technology? Consider a new technology with a worse trajectory in the context of our model. Figure 3 illustrates the evolution of the firm's competitive advantage.

Because of its superior trajectory and its head start, the incumbent technology always has a differentiation advantage. At first, the differentiation advantage falls as DMU erodes the effect of the incumbent's head start. If the new technology has a cost advantage that is large enough to offset its differentiation disadvantage it enters the market at time t_a (see figure). However, the new technology's competitive advantage is not sustainable. Over time, the incumbent's superior trajectory causes its differentiation advantage to grow. Eventually, the incumbent's differentiation advantage offsets the entrant's cost advantage and it re-enters the segment at time t_b.

Decreases in DMU serve to magnify the differentiation advantage of the incumbent, which both delays the onset of substitution and advances the time at which the incumbent retakes the segment.

> *Proposition 3: Suppose the new technology has a worse trajectory. Without a sufficient cost advantage, it never substitutes for the incumbent. With a sufficient cost advantage, it substitutes for the incumbent, but only for a limited interval of time. The duration of substitution is increasing in DMU.*

The logic of Proposition 3 offers an approach to distinguishing between permanent and temporary threats, which informs whether the appropriate response to new technology threats is to continue investing along the existing trajectory or by embracing the new technology.

In this section, we have considered the sustainability of a firm's ability to add value in the face of substitute technologies. One basis for firm heterogeneity is differences in production technologies. An alternative basis for firm heterogeneity is differences in the underlying resources among firms using the same technology. We now turn to the sustainability of such resource-based competitive advantages.

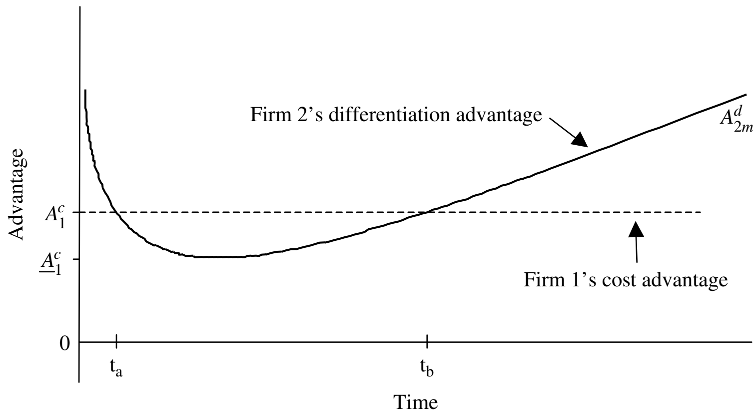

Figure 3. The duration of market entry by a substitute technology when $b_1 < b_2$. Firm 1 is in the segment between time t_a and time t_b, during which its cost advantage exceeds its differentiation disadvantage. Without a sufficient cost advantage (i.e., $A^c_1 < \underline{A}^c_1$) firm 1 never enters the segment

RESOURCE RENTS

A fundamental concern in strategy is the sustainability of resource rents. The question of how the value of resources evolves, however, is largely unexplored. The resource-based view argues that competitive advantage is conferred to those firms that possess valuable, rare, inimitable, and nonsubstitutable resources. The received literature has primarily focused on firms' abilities to acquire resources at favorable prices (e.g., Barney, 1986; Dierickx and Cool, 1989; Makadok, 2001) and on the threat of imitation (e.g., Lippman and Rumelt, 1982; Barney, 1991; Peteraf, 1993).

Although the resource-based view is clearly sensitive to the issue of resource value and substitution, its treatment of these constructs is less well developed than its treatment of barriers to imitation (Priem and Butler, 2001). Further, within the resource-based view, substitution is usually approached from a supply-side perspective, concerned with the emergence of equivalent, or possibly superior, resources for production (e.g., the substitution of charismatic leadership for formal planning systems in Barney, 1991), rather than with buyers' assessments of relative value in consumption.

In this section, we start by using our model to develop a typology of resources. We then characterize the effect of DMU on the evolution of rents from these resources types. Finally, we contrast these rent profiles with those that arise when resources are subject to imitation.

Resources and value creation: A typology

Resources matter to the extent that they affect value creation. In our model, a firm's value creation in a market segment, v_{im}, is a function of the segment's taste for quality, a_m, and four firm specific components; recall from Equation 4 that $v_{im}(t) = a_m[b_i(t + h_i) + r_i]^\beta - c_i$. Each of the four firm-specific components (b_i, h_i, r_i, and c_i) are avenues through which resources can create value. As a benchmark, we assume that a firm without any resources has $c_i = c$, $h_i = 0$, $r_i = 0$, and $b_i = b$. We can now define the following resource typology:

- Resources can lower firm i's production costs, so that $c_i = c - \Delta_c$. We term such resources *process resources*. Dell's superior supply chain management in the PC industry could be characterized as a process resource.
- Resources can increase the performance of firm i's offer so that $r_i = \Delta_r > 0$. We term such resources *product resources*. McKinsey's reputation in management consulting and Sony's advantages in miniaturization could be characterized as product resources.
- Resources can give firm i a head start of $h_i = \Delta_h > 0$ in developing its offer. We term such resources *timing resources*. One can think of firms that are consistently fast to market, such as 3M, as possessing a timing resource.
- Resources can give firm i a better technology trajectory, so that $b_i = b + \Delta_b$. We term such resources *innovation resources*. One could interpret Gillette's superior product development process as an innovation resource.

The effect of DMU on resource rents

We now consider resource rents in the simplest case where only one firm has a resource and there is a single focal segment. Specifically, firms 1 and 2 are identical except that firm 1 has a unique and *inimitable* resource that improves its ability to create value for the focal segment. If not for this unique resource, the firms would have the same costs ($c_1 = c_2 = c$) and their offers would follow the same trajectory ($x_1(t) = x_2(t) = bt$).

Early rent profiles

The early rent profile for each of the resources is broadly the same. Firm 1's unique resource always gives it a competitive advantage over firm 2. Because of its greater value creation, firm 1 is always first to enter the segment. Refer, for example, to the left panel of Figure 4.

Until time t_1 neither firm is in the market because neither firm has positive value creation. From time t_1 to t_2, firm 1 does not face competition in the market because firm 2 does not create value and hence, from Lemma 1, we have that firm 1's rents are proportional to its value creation and the size of the segment: $s_m v_{1m}(t)$. Over time, as the quality of firm 1's offer improves, its value creation and its rents increase (but at a decreasing rate due to DMU). Starting at time t_2, firm 2's offer has improved sufficiently that it too has positive value creation in the segment. From this point

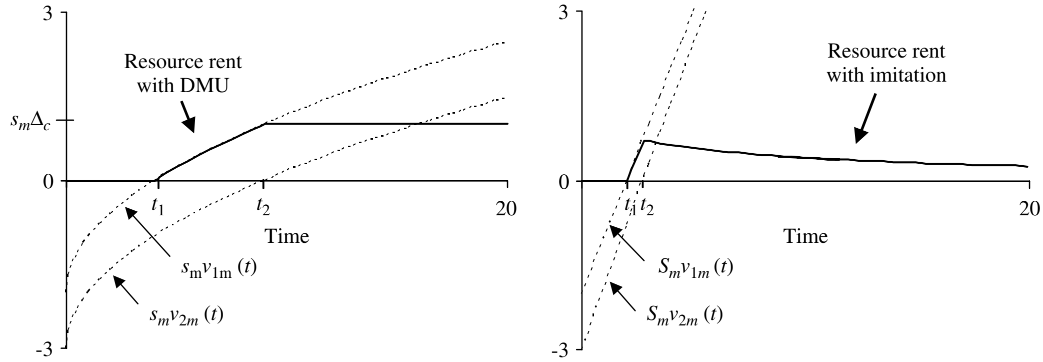

Figure 4. The evolution of resource rents when firm 1 has a process resource (for $\Delta_c = 1$; $c = 3$, $s_m = 1$, and $b = 1$) under assumptions of DMU (left panel, $\beta = 0.5$) and imitation (right panel, $z = 0.15$). The dashed lines show each firm's value creation

on, firm 1's rents are proportional to its relative value creation and the size of the segment.

The evolution of rents from time t_2 onward depends on the type of resource.

Process resources

Suppose firm 1 has a process resource. In this case, value creation is increasing at the same rate for each firm but firm 1's value creation is always higher by the amount of its cost advantage, $A_1^c = \Delta_c$. Figure 4 (left panel) illustrates this. After time t_2, when both firms have positive value creation and firm 1's rents are proportional to its relative value creation, rents stabilize at $s_m\Delta_c$, which is constant over time.

Proposition 4: Suppose that firm 1 has a process resource. From the time of firm 1's entry into the segment, its rents first increase over time and then stabilize at $s_m\Delta_c$.

Product and timing resources

Both product and timing resources improve the performance of firm 1's offer by a fixed amount. In the case of a product resource, we have $x_1(t) = bt + \Delta_r$, such that the performance difference between the firms is $x_1(t) - x_2(t) = \Delta_r$. In the case of a timing resource, we have $x_1(t) = b(t + \Delta_h)$, such that the performance difference between the firms is $b\Delta_h$. Hence, firm 1 always has a differentiation advantage, but this advantage erodes over time due to DMU. From time t_2, firm 1's rents decay as illustrated in Figure 5 (left panel).

Proposition 5: Suppose that firm 1 has either a product resource or a timing resource. From

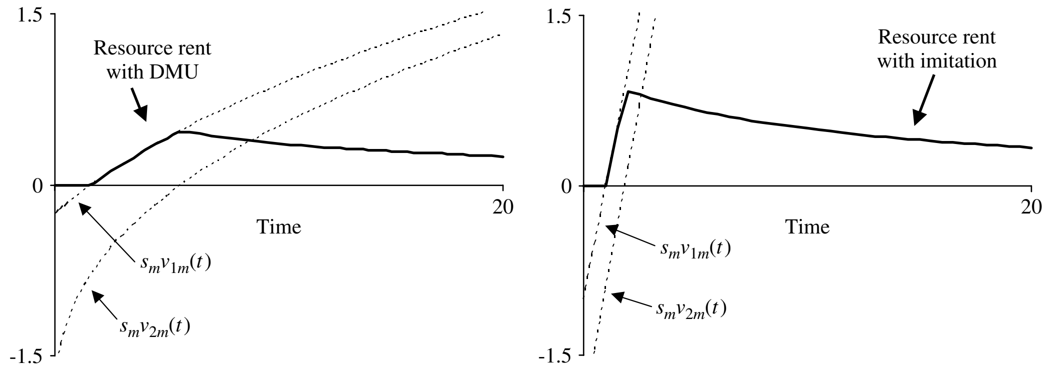

Figure 5. The evolution of resource rents when firm 1 has a product resource (for $\Delta_r = 4$, $c = 2$, $s_m = 1$, and $b = 1$) under assumptions of DMU (left panel, $\beta = 0.4$) and imitation (right panel, $z = 0.1$). The dashed lines show each firm's value creation. The left panel also illustrates the case where firm 1 has a timing resource with $\Delta_h = 4$

the time of firm 1's entry into the segment, its rents first increase and then decrease to zero over time.

Thus, even a firm possessing an inimitable resource, such that it maintains a constant level of performance superiority, can see its resource rents decay over time as DMU erodes consumers' willingness to pay for this performance difference. Consider how this proposition applies to Apple Computer's ability to profit from its head start in developing easy-to-use personal computers. Over time, despite its ability to maintain superior ease of use over rival offers, consumers' WTP for this advantage seems to have declined.

Innovation resources

With an innovation resource, firm 1 again has a differentiation advantage. In this case, $x_1(t) = (b + \Delta_b)t$ and the difference in performance between the firms is $x_1(t) - x_2(t) = \Delta_b t$. In contrast to product and timing resources, this differentiation advantage grows over time. It does so, however, at a decreasing rate due to DMU. Figure 6 (left panel) illustrates this.

Hence, firm 1's rent continues to increase even after firm 2 has positive value creation, although the rate of profit growth decelerates.

Proposition 6: Suppose firm 1 has an innovation resource. From the time of firm 1's entry into the segment, its rents increase over time, but at a decreasing rate.

Thus we find that the rents from an innovation resource are sustainable, but that even in the best case of a non-imitable innovation resource profit growth rates are not.

The effect of imitation on resource rents

How would these rent profiles differ if resources could be imitated? In this subsection we relax the assumption that resources are inimitable.[10] At the same time we assume that there is no DMU (i.e., $\beta = 1$). This allows us to compare rent profiles that result from just imitation with those discussed above that arise from just DMU. We continue to focus on the case where only one firm has a resource and where there is a single focal segment.

We assume that resources are imitated over time. Specifically, the degree of resource uniqueness at some time t is given by the decreasing function $U(t) = 1/(1 + zt)$. With this imitation process, initially resources are entirely unique ($U(0) = 1$) and in the long run uniqueness disappears ($\lim_{t\to\infty} U(t) = 0$). The parameter z gives the ease of imitation in that the larger is z the faster uniqueness erodes.[11] Consider the case where firm 1 has a process resource. Over time, firm 2 acquires this resource as well so that firm 1's cost advantage erodes according to $A_1^c = \Delta_c U(t)$. Refer to Figure 4 (right panel) for the resulting rent profile. As in the case without imitation, the resource asymmetry results in an interval of time during

[10] We thank an anonymous referee for suggesting this section.

[11] In this subsection, we restrict attention to product, process, and innovation resources. In a single segment context it is not clear what it means to imitate a timing resource.

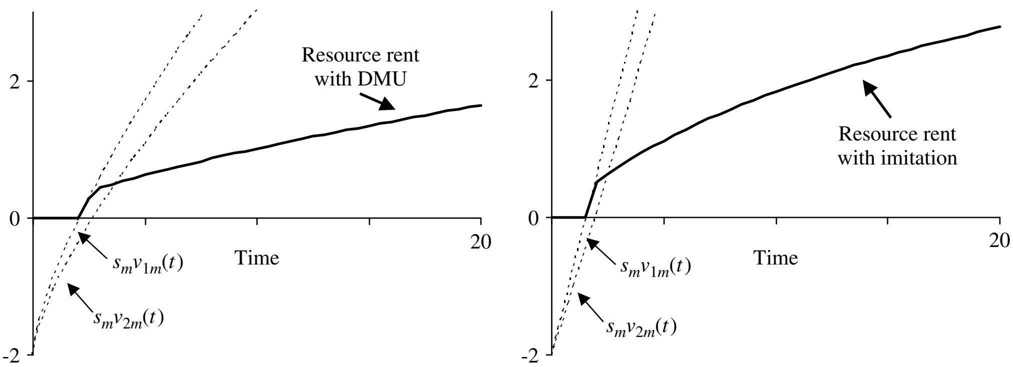

Figure 6. The evolution of resource rents when firm 1 has an innovation resource (for $\Delta_b = 0.3$; $c = 2$, $s_m = 1$, and $b = 1.3$) under assumptions of DMU (left panel, $\beta = 0.7$) and imitation (right panel, $z = 0.15$). The dashed lines show each firm's value creation

which only firm 1 creates value for the segment and in which its rents increase with its level of value creation. After time t_2, when firm 2 starts to create value as well, rents depend on the net competitive advantage $\Delta_c U(t)$, which is eroding due to imitation.

Now consider the case of a product resource, as illustrated in Figure 5 (right panel). Over time, firm 2 acquires this resource so that firm 1's differentiation advantage erodes as the gap in performance, $x_1(t) - x_2(t) = \Delta_r U(t)$, shrinks due to imitation. The resulting rent profile follows the same pattern as with a process resource. Thus we have:

> *Proposition 7: With imitation and no DMU, from the time of firm 1's entry into the segment, the rents from both product resources and process resources first increase and then decrease to zero over time.*

While the rents from product resources are eroded by imitation and DMU in qualitatively similar ways, the rents from process resources are sustainable under DMU but not under imitation. With either imitation or DMU we have an initial period of increasing rents. Without DMU, however, value creation for both firms increases faster. The increase in firm 1's rate of value creation leads its rents to increase at a faster rate. However, because firm 2's rate of value creation benefits from an equivalent increase, the interval of time during which only firm 1 creates value is shorter. Thus we have:

> *Proposition 8: With imitation and no DMU, the rate of increase in rents from product and process resources is greater than with DMU and no imitation, but the period during which rents increase is shorter.*

Finally, consider the case where firm 1 has an innovation resource, as shown in Figure 6 (right panel). With imitation, Firm 2's technology trajectory increases over time, converging to the trajectory of firm 1. What matters for value creation, however, is not the rate of increase at a point in time, but rather the absolute levels of performance that have been achieved. Consequently, convergence in trajectories only implies a deceleration in the growth of firm 1's competitive advantage. This results in an increasing rent profile that parallels the profile with DMU.

> *Proposition 9: With imitation and no DMU, from the time of firm 1's entry into the segment, the rents from innovation resources increase over time, but at a decreasing rate.*

For both product and innovation resources we find that DMU and imitation give rise to qualitative similar rent profiles. Hence, sustainability of advantages rooted in superior product performance is threatened not only by imitation but also by consumers' decreasing willingness to pay for a superior product. Thus, imitation and DMU are substitute threats such that it is worth expending resources to neutralize one only to the extent that the other threat can be avoided as well. Broadly, strategy formulation needs to anticipate not only competitor imitation but also shifts in the bases of consumer value creation. Consequently, it would be useful to extend the empirical literature on sustainability (e.g., McGahan and Porter, 2003) to decompose the sources of rent erosion into supply-side and demand-side drivers.

A MULTI-SEGMENT, MULTI-RESOURCE EXAMPLE

To this point we have restricted the analysis to a single segment and to the rents from a single resource. These simplifications are useful for developing some basic intuitions about demand-side drivers of sustainability. Reality, of course, is more complex. A market can have multiple segments, a firm can hold multiple resources, and its rivals can hold their own unique resource bundles. In this section, we begin to extend our model to incorporate these complexities to more closely approximate empirical settings.

We consider an example, loosely inspired by the competition between Sony and Matsushita in consumer electronics. Firm 1 (Sony) holds both a product resource ($\Delta_r = 1$) and a timing resource ($\Delta_h = 2$), while firm 2 (Matsushita) holds a process resource ($\Delta_c = 0.7$). We return to the assumptions that there is DMU ($\beta = 0.5$) and that resources are inimitable. The high-end segment has a taste for quality of $a_H = 2$, the low-end segment has a taste for quality $a_L = 1.4$, $b = 1$, $s_H = s_L = 100$, $c = 3.5$. Figure 7 shows each firm's rent profile.

Due to the combined strength of its timing and product resources, firm 1 is the first to create value

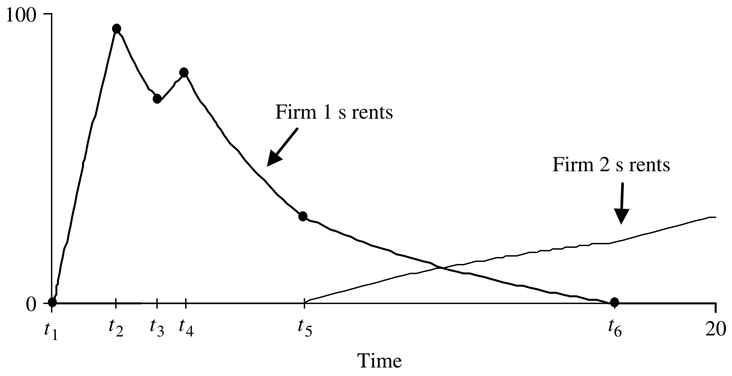

Figure 7. The evolution of firm rents in a two segment setting where firm 1 holds performance and timing resources and firm 2 holds a process resource

in the market. Firm 1 creates value first in the high-end due to that segment's higher taste for quality. From time t_1 until time t_2, it is only firm 1 that is creating value and therefore its rents increase as its offer improves. From time t_2, firm 2 joins firm 1 in creating value in the high-end segment. Firm 1's rents from that segment, which are now proportional to its relative value creation, decay over time as DMU erodes its differentiation advantage. To this point, the rent profiles are the same as those illustrated in Figure 5 (left panel).

At time t_3, firm 1 returns to a period of profit growth as its offer begins to create sufficient value to serve the low-end segment. Now, firm 1 starts earning rents from the low-end segment which are proportional to its value creation and which increase as its offer improves. The increasing rents from the low-end segment more than offset the continuing decay in rents from the high-end segment.

At time t_4, firm 2 begins to create value in the low-end segment, triggering a permanent decline in firm 1's fortunes. Now, firm 1's rents from both segments are decaying over time.

Note that until time t_5 firm 2 does not sell to either of these segments. It is firm 2's increasing relative value creation that limits firm 1's rents.[12] At time t_5 DMU has eroded firm 1's differentiation advantage sufficiently that firm 2's cost advantage gives it superior value creation in the low-end segment. Consequently, at time t_5 firm 1 is displaced from the low-end segment. At time t_6, its differentiation advantage has eroded so much that firm 1 is displaced by firm 2 in the high-end segment as well. After time t_6, firm 2's rents continue to increase as firm 1's differentiation advantage further erodes, converging to a final profit level of $s_m \Delta_c = 70$ in each segment.

Thus, by assembling different elements of our simple model, one can characterize relatively complex patterns that include shifts in market leadership across segments and shifts in firms' absolute and relative profits over time.

The example raises several questions that are worthy of further exploration. First, what is the interaction among multiple resources held by a single firm and how does it change over time? Second, what explains firms' order of entry into different market segments? Third, what are the conditions that allow firms with heterogeneous resources to coexist in a market? We address these questions in the remainder of the paper.

MULTIPLE RESOURCES

There is a prior literature exploring the value to firms of combining multiple resources (e.g., Amit and Schoemaker, 1993; Teece, Pisano, and Shuen, 1997; Makadok, 2001). This literature focuses on how internal firm capabilities govern the effectiveness with which firms can deploy their resources. Our focus in this section complements the internal focus of the received literature, with an external focus on how different resource combinations affect value creation in the market.

[12] Note, however, per the discussion of exogenous technological progress in the section on substitute threats, that firm 2 might be selling its products to consumers in an (unanalyzed) niche segment. See also footnote 9.

In the above section on resource rents, we characterized the rent profiles from holding individual resources on their own. We now consider the rents from combining multiple resources within a single firm.[13] When is the rent profile of a multi-resourced firm different from the simple sum of the rents from holding each of the resources on its own? Holding two resources together can result in rents that are less than, equal to, or greater than the sum of the rents from holding each on its own. This leads to the following definitions:

- *Definition 1.* Two resources are *subadditive* when the rent from holding both resources simultaneously is less than the sum of the rents from holding each on its own.
- *Definition 2.* Two resources are *additive* when the rent from holding both resources simultaneously is equal to the sum of the rents from holding each on its own.
- *Definition 3.* Two resources are *superadditive* when the rent from holding both resources simultaneously is greater than the sum of the rents from holding each on its own.

All types of resources increase firm value creation and a firm holding two resources must create more value than a firm holding either resource on its own. Hence, a firm with two resources starts creating value in a segment earlier, and starts earning rents sooner, than a firm holding either resource on its own. Consequently, rents must initially be superadditive because neither resource held on its own would have yielded positive value creation. Even at a time when one of the resources is enough for positive value creation, the resources remain superadditive because adding the second resource increases rents even though this second resource, on its own, would not be have positive value creation.

Therefore:

Proposition 10: Consider a firm with two resources facing an unresourced rival in a segment. There is an interval, starting at the time where the firm has positive value creation, during which the two resources are superadditive.

One significance of superadditivity, or resource synergies, is that resources cannot be valued in isolation. Rather, resource valuation depends on interactions within a firm's portfolio of resources. In contrast to prior work on resource combination, the synergies in our model do not arise from internal capabilities. Our synergies arise from the interaction between the resource portfolio and the demand environment, which ultimately determines the threshold for value creation. One implication is that firms pioneering new market segments have greater incentives to acquire resources because each additional resource speeds the time of entry and the onset of rents.

Do these synergies persist as markets mature? As firm value creation increases, it is no longer the ability to break into the market that matters, but rather the level of value creation. Consider a firm holding a timing and a product resource. Both of these resources increase the performance of the firm's offer and hence its value creation. Due to DMU, the greater the level of performance, the lower the effect of an additional performance enhancement on WTP. Hence, the net effect on WTP (and therefore on value creation) of the two resources in combination is less than the sum of the effects when the resources are held on their own. Therefore, timing and product resources become subadditive as the market matures.

Next consider a firm that holds a process resource and some other, performance-enhancing resource type. Since the shift in value creation is the sum of the cost reduction and the increase in WTP from the performance enhancement and since DMU does not impact the value of cost reductions, there is an additive interaction between process resources and the other resource types.

Finally, consider a firm holding a timing and an innovation resource. Here there is a superadditive interaction between the two resources: the greater the technology trajectory, the greater the benefit to having a head start on development; and the greater the head start, the greater the benefit to increasing the firm's trajectory.

Proposition 11: Consider a firm with two resources facing a rival with none. After the initial interval of superadditivity, the resources can be additive, subadditive, or they may remain superadditive, depending on the identity of the resources. (See Table 1 for details.)

[13] Alternatively, one could interpret the discussion below as applying to resources spread across multiple firms that are using an alliance, joint venture, or other contractual mechanism to jointly deploy their resources.

Table 1. Resource interactions after the initial interval of superadditivity, classified as subadditive (−), additive (+), or continued superadditivity (++)

Resource type	Process	Product	Timing	Innovation
Process	+	+	+	+
Product	+	−	−	−
Timing	+	−	−	++
Innovation	+	−	++	−

In a mature market segment, the nature of the interaction between firm resources depends on the type of resources involved. Table 1 lays out the full set of contingencies, including the interactions between two resources of the same type. The broad results are clear: process resources are additive with other resource types and, with the exception of timing and innovation resources, the interactions among other performance-enhancing resources are subadditive due to DMU.

The different additivity paths identified in these propositions complement traditional perspectives on resource combinations. The logic for the transition from early superadditivity to later subadditivity suggests that declines in the effectiveness of resource combinations in generating rents need not be rooted in a degradation of the resources themselves or in a firm's internal capability to combine resources. Neither do they need to be rooted in discrete shifts in the competitive environment. Rather, we observe that shifts from superadditivity to subadditivity can be driven by the effect of DMU in a maturing market.

The synergies between timing and innovation resources, which remain superadditive, suggest that there are lasting benefits for combining these two resources in a single firm. One possible example is Amazon.com, which aggressively improves its e-commerce capabilities and at the same time aggressively pioneers new e-commerce market segments. Similarly, Cisco's strategy of acquiring startups with promising technology trajectories and exploiting its existing resources to speed their access to product markets might be viewed as exploiting the superadditivity of innovation and timing resource combinations.

Splitting resources across firms

To this point, we have considered multiple resources held by the same firm. What happens when resources are split among competing firms? In any given segment, the combined profits of the two firms depend on the added value of the firm with the greatest value creation. Splitting the resources between the firms necessarily lowers the value creation of the leading firm. At the same time, it necessarily increases the value creation of the lagging firm. The net result is lower added value and hence lower industry profits.

Proposition 12: Suppose that there are two firms and two resources. Industry profits are higher when one firm holds both resources than when both firms hold one resource.

A level playing field is bad for firms since it reduces their added value and allows consumers to capture more value. This poses a puzzle to which we will return in the section on strategic diversity: how to explain the coexistence of multiple resource-holding firms?

MULTIPLE SEGMENTS

In contrast to rents from multiple resources, going from one segment to multiple segments is straightforward. Because our stylized model has no interdependencies between a firm's value creation across segments, rents can be calculated in each segment separately and then aggregated to get the firm's total rent profile.

Proposition 13: With multiple segments, a firm's total rents are the sum of the rents in each segment.

More subtle is the order in which firms enter segments that vary in their taste for quality (i.e., $a_H > a_L$). In terms of value creation, there is a clear ordering. Because the high-end segment always has a higher WTP for any given product, a firm's offer first has positive value creation in the high-end segment.

Proposition 14: In an industry with a high-end and a low-end segment, all firms first create value in the high-end segment.

Hence, an unserved market is going to be pioneered in the high-end segment. However, once there is an incumbent that needs to be displaced, the order of entry is contingent. Echoing the logic of Proposition 2, if the new firm has a cost advantage relative to the incumbent, then entry occurs while the new firm still has a differentiation disadvantage. The new firm therefore enters the low-end segment first since that is where differentiation is less important. Conversely, if the new firm has a cost disadvantage, then entry only occurs when it has an offsetting differentiation advantage. In this case, the new firm enters the high-end segment first since that is where differentiation is more highly valued.

Proposition 15: In an industry with a high-end and a low-end market segment both being served by an incumbent, a new technology enters the low-end segment first when it has a cost advantage. It enters the high-end segment first when it has a cost disadvantage.

Thus, low-cost mini-mill technology started in low-end segments like reinforcement bars before moving into higher-end segments like structural steel, while jet engine technology was first adopted in high-end military market segments before moving into long-haul commercial segments. The proposition can be applied not only at the technology level, but at a firm level of analysis as well. For example, the discount broker Schwab began in low-end segments and has gone on to penetrate higher-end segments as the quality of its offer has improved, while Dolby's noise reduction technology moved from the professional recording market to the mass market.

RESOURCE STRATEGY OVER TIME

To this point, we have considered how the value of resources changes over time, taking resource endowments as given. We now take a first step toward endogenizing a firm's resource strategy. We restrict attention to three generic strategies for holding product and process resources. As in Porter (1980), a firm can be a Differentiator, by holding a product resource, or a Cost Leader, by holding a process resource. Porter argues that firms face a choice between positioning with a cost or a performance focus, and that those firms that do not choose one of these positions risk being stuck in the middle. Others, however, have observed that firms that simultaneously pursue both cost and differentiation advantage are sometimes very successful (e.g., Kim and Mauborgne, 1997; Besanko, Dranove, and Shanley, 2000). To explore this, we allow a firm to pursue a Resource Generalist strategy, by holding a product and a process resource simultaneously.

We first explore the sustainability of different resource strategies. We then consider the conditions under which a market can support strategic diversity, where firms pursuing different strategies can profitably coexist.

In every period firms first choose their resource strategy, which determines their value creation, and then compete in the market as before. Formally, we are studying a biform game as introduced by Brandenburger and Stuart (2003). We assume that there is a fixed per-period cost to maintaining resources of $F_c > 0$ for process resources and $F_r > 0$ for product resources. If a firm holds both resources simultaneously, there is an additional fixed cost associated with organizational complexity of $K \geq 0$. Following Porter (1996), the parameter K captures the extent to which internal trade-offs make it difficult to pursue cost and differentiation advantage simultaneously.

Single segment analysis

Suppose that there is a single segment. To justify the fixed investment in maintaining resources, a firm must have rents and therefore positive added value for some customers. Since at most one firm can have added value in a segment, with a single segment at most one firm will maintain resources. How will the firm's resource strategy change over time? The three main drivers of resource strategy in a single segment are time, the costs of complexity, and the stand-alone profitability of each resource. From Proposition 4, the profitability of maintaining the process resource on its own reaches its maximum at the time when the unresourced firm starts creating value, and is a constant thereafter. Let $\overline{\Pi}_c$ be the maximum profitability of maintaining the process resource on its own. From Proposition 5, the profitability of maintaining the product resource is highest at the point where the unresourced firm starts creating value, and declines thereafter. Let $\overline{\Pi}_r$ be the maximum profitability of maintaining the product resource on its own. We consider the case where $\overline{\Pi}_r > \overline{\Pi}_c > 0$.

Figure 8 shows how the firm's resource strategy varies over time and with the cost of complexity.

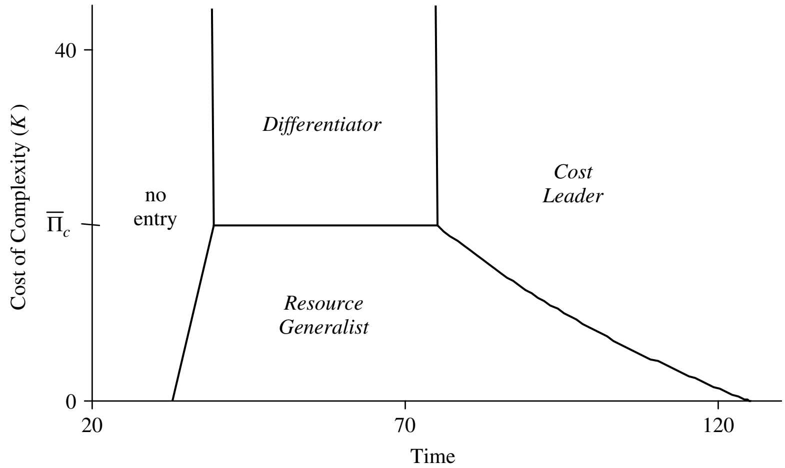

Figure 8. The effect of the cost of organizational complexity on a firm's resource strategy over time in a single segment (for $c = 10$, $\Delta_c = 1.4$, $F_c = 100$, $\Delta_r = 90$, $F_r = 60$, $\beta = 0.4$, $a_m = 1$, $s_m = 100$)

At first the firm is out of the market and holds no resources because no resource combination results in consumer willingness to pay that is greater than firm costs. What happens next depends on the cost of complexity. Suppose that the cost of complexity is high, specifically $K > \overline{\Pi}_c$. Then firms will only maintain one resource at a time. The firm starts with a Differentiator strategy because, initially, the profits from maintaining the product resource are greater (an implication of $\overline{\Pi}_r > \overline{\Pi}_c$). Over time, however, DMU erodes the rents from the product resource so that at some point the process resource offers higher returns. At this point, the firm shifts to a Cost Leader strategy.

Now suppose that the costs of complexity are low, specifically $K < \overline{\Pi}_c$. Then the firm enters the market with a Resource Generalist strategy. Recall from Proposition 10 that when pioneering a market any two resources are superadditive. As a result, the entry time for a Resource Generalist is earlier than that for a Differentiator. Resource superadditivity is partly offset by the cost of complexity and hence the lower is K the earlier the entry. Over time the rents from the product resource erode and the firm eventually drops the product resource from its portfolio, shifting to a Cost Leader strategy, as in the case with a high K.

Proposition 16: Suppose $\overline{\Pi}_r > \overline{\Pi}_c > 0$ and there is only a single segment.

(i) If the cost of complexity is sufficiently small ($K < \overline{\Pi}_c$), then the firm enters the market segment with a Resource Generalist strategy.
(ii) For higher costs of complexity ($K > \overline{\Pi}_c$), the firm enters the market segment with a Differentiator strategy.
(iii) For any value of K, in the long run the firm pursues a Cost Leader strategy.

The proposition shows how one can place boundary conditions on the pursuit of different generic strategies.[14] While one may see a firm pursuing the classic generic strategies of Cost Leadership or Differentiation, we identify conditions under which a firm does better, for a limited interval of time, with a Resource Generalist strategy. The shift over time away from product resources and towards process resources echoes the technology life cycle literature, where a central empirical regularity is the shift from product to process innovation as markets mature (Utterback, 1994). Unlike classic explanations based on the emergence of a dominant design (Utterback and Abernathy, 1975), in our theory the transition is driven by DMU (see also Adner and Levinthal, 2001).

Consider the effects of DMU on resource strategy. Not only does it accelerate the erosion of the

[14] For simplicity, we restricted the analysis to the case of $\overline{\Pi}_r > \overline{\Pi}_c > 0$. Consider the case where $\overline{\Pi}_c > \overline{\Pi}_r > 0$. For low K the firm still enters as a Resource Generalist and subsequently switches to be a Cost Leader, while for high K the firm now enters directly as a Cost Leader.

returns from the product resource, it also delays the time at which the firm is able to enter the market. Thus there is a clear negative relationship between the extent of DMU in the market and the time during which the firm maintains the product resource. In contrast, the effect on the holding of a process resource is contingent: for low costs of complexity, the two resources are deployed simultaneously and hence higher DMU delays the deployment of the process resource. On the other hand, for high costs of complexity, the firm is choosing between the two resources and higher DMU speeds the shift from the product to the process resource.

> *Proposition 17: Suppose $\overline{\Pi}_r > \overline{\Pi}_c > 0$ and there is only a single segment. Increases in DMU reduce the time during which the firm maintains the product resource, but have an ambiguous effect on the time during which the firm maintains the process resource.*

Our basic model and the associated intuitions on the evolution of resource rents can be extended, in a straightforward way, to look at the choice of resource strategy. This extension is a step toward addressing a weakness in the received literature on positioning, that 'our understanding of the dynamic processes by which firms perceive and ultimately attain superior market positions is far less developed [than our understanding of advantage at a point in time]' (Porter, 1991: 95; see also Rumelt, 1987). We think that explicitly linking resource choice to the evolution of value creation is a promising avenue for deepening our understanding of the dynamics of positioning.

Strategic diversity

Under what conditions would one expect to observe strategic diversity, where one firm pursues a Cost Leader strategy and the other firm a Differentiator strategy? From the single segment analysis, we need a sufficient cost of complexity to preclude the industry from being dominated by a Resource Generalist. Moreover, because each firm must have added value in some segment, there must be at least two different market segments. How different must they be? As before, consider a market with a high-end segment and a low-end segment that vary in the taste for quality, $a_H > a_L$. A higher taste for quality places greater emphasis on product performance and hence results in greater relative value creation for the Differentiator. Thus, the Differentiator must have added value in the high-end segment, which implies that the Cost Leader must have added value in the low-end segment to be viable.

Both firms must have sufficient added value in their respective segments to cover their resource costs. For the Differentiator, this means that the taste for quality in the high-end segment cannot be too low ($a_H \geq \underline{a}_H$). For the Cost Leader, the taste for quality in the low-end segment cannot be too high ($a_L \leq \bar{a}_L$), as otherwise the Differentiator would create too much value there. However, neither can the low-end segment's taste for quality be too low ($a_L \geq \underline{a}_L$) because decreases in a_L increase the Cost Leader's added value only until the point where the Differentiator no longer creates value for the segment. After that, further decreases in the segment's taste for quality reduce the Cost Leader's added value, eventually driving it to zero.

> *Proposition 18: Strategic diversity, where one firm has a process resource and the other has a product resource, requires a sufficiently high cost of complexity, a sufficiently high taste for quality in the high-end market segment, and an intermediate level of taste for quality in the low-end market segment.*

Thus, beyond internal trade-offs in the form of costs of complexity we find that sufficient consumer heterogeneity is required to support strategic diversity. For example, in the airline sector the high level of consumer heterogeneity (e.g., business vs. leisure travelers) helps support strategic diversity (e.g., full service vs. no-frills airlines).

How do changes in market size and in the fixed costs of maintaining resources affect the level of consumer heterogeneity ($\underline{a}_H - \bar{a}_L$) required to support strategic diversity? For example, in 2001–02 the airline sector experienced reductions in market size, especially at the high end, as well as higher fixed costs due to increased security requirements. The greater is the fixed cost of maintaining the product resource and the smaller the size of the high-end segment, the higher must be the Differentiator's added value for each high-end customer and hence the lower bound on the high-end segment's taste for quality, $\underline{a}_H$, must increase. Conversely, the greater is the fixed cost of maintaining the process resource relative to the size of the low-end segment, the higher must be the Cost Leader's added value for each low-end customer and hence the lower must be $\bar{a}_L$ and the higher must be $\underline{a}_L$.

Proposition 19: The extent of consumer heterogeneity ($\underline{a}_H - \bar{a}_L$) required to support strategic diversity is increasing in the level of fixed costs required to maintain the resources and decreasing in the size of the segments.

CONCLUSION

Our approach to sustainability starts on the supply side with product market competition and improving technologies. The novelty is that we introduce an explicit treatment of how technology improvements affect consumer choice among competing offers. This leads us to focus on demand-side drivers: marginal utility from performance improvements, consumer taste for quality, and the extent of consumer heterogeneity. We combine these elements in a simple model that allows us to address a wide range of issues related to the sustainability of competitive advantage. By explicitly linking resources and utility, we have attempted to complement the traditional focus in strategy on competition and value capture with a focus on consumers and value creation.

At the level of firm resources, we show how competitive advantage can erode not only because imitation undermines the uniqueness of resources, but also because consumer valuation of firm differences declines due to the effects of decreasing marginal utility. At the level of firm positions, we show that strategic heterogeneity is rooted not only in differences between firms' internal resources, but also in the extent of consumer heterogeneity in the firms' demand environment.

While DMU and consumer heterogeneity are characteristic of many (though perhaps not all) settings, they have been largely ignored in strategy studies. We note that the assumptions of DMU and consumer heterogeneity are critical to our results and without them most of our observed patterns would disappear. This, of course, is precisely the point: to highlight the role of demand-side elements in determining sustainability, and to assure that these demand-side threats are not overlooked. We thus hope, first, to encourage the field to be more sensitive to their existence; and second in those settings where DMU and consumer heterogeneity are important, to develop intuitions regarding their effects on sustainability.

Incorporating a demand-based perspective into empirical research will enrich the hypotheses that can be tested in both cross-sectional and longitudinal studies. Although new tools will be needed to characterize the demand environment, many have already been developed for the purpose of constructing quality-adjusted price indices (e.g., Griliches, 1961; Trajtenberg, 1990) and in the new empirical industrial organization literature (e.g., Berry, Levinsohn, and Pakes, 1995). These tools can provide the inputs that would be used to study strategy questions.

One limitation of our approach is that firms are assumed to engage in intense (i.e., Bertrand) price competition and thus we cannot address changes in the intensity of rivalry. This is a substantive limitation because technological progress and DMU might affect the intensity of rivalry in some settings. Similarly, firm choices regarding market entry and resource portfolios could also impact the extent of rivalry. While these interactions are beyond the scope of the current paper, we highlight them as potential avenues for future research.

There are two additional elements in this paper that we think are a promising basis for future theoretical work. First, the formalization of competitive advantage as superior value creation provides a simple and yet compelling foundation for strategy theorizing. A natural way to build on this foundation is to incorporate firm actions that shape value creation. Our analysis of resource strategy is one step in this direction. Second, a focus on the interaction between consumer heterogeneity and firm strategy offers a promising avenue for building a richer theory of firm–environment fit. In this paper, we focus on the link between consumer heterogeneity and strategic diversity. Future work along this trajectory might fruitfully explore how firms should respond to consumer heterogeneity by their market segmentation choices, and relatedly, their market diversification decisions.

The interactions between firm strategy and the demand context suggest new dimensions along which to consider firm strategy. In particular, important features of demand are subject to influence by firms. For example, Intel responded to decreasing marginal utility for processing power by investing billions in venture capital directed at suppliers of complements that would increase demand for processing power. In addition to investing in complements, firms can influence thresholds for acceptable performance through advertising, standard setting, and regulation. This raises the question of how firms' resource allocation processes should incorporate the possibility for such demand-side strategies (see Adner, 2004, for further discussion).

The fit between a firm and its environment has been a fundamental concern in strategy since the inception of the field. Over time, a tendency has developed to equate environmental analysis with competitor analysis. We hope to have demonstrated the value of focusing attention not just on firm resources and competition, but on the demand environment as well.

ACKNOWLEDGEMENTS

We would like to thank seminar participants at the Atlanta Competitive Advantage Conference, BYU Winter Conference, Duke, Michigan, NYU, Ohio State, Strategy Research Forum, Tel Aviv University, Toronto, Washington University, and Wharton, as well as Jay Barney, Adam Brandenburger, Ramon Casadesus-Masanell, Pankaj Ghemawat, Javier Gimeno, Constance Helfat, Anne Marie Knott, Bruce Kogut, Michael Leiblein, Dan Levinthal, Rich Makadok, Anita McGahan, Patrick Morton, Mary O'Sullivan, Subi Rangan, Miles Shaver, and Louis Thomas for their helpful comments.

REFERENCES

Adner R. 2002. When are technologies disruptive: a demand-based view of the emergence of competition. *Strategic Management Journal* **23**(8): 667–688.

Adner R. 2004. A demand-based perspective on technology lifecycles. In *Business Strategy Over the Industry Lifecycle: Advances in Strategic Management*, Vol. 21, Baum J, McGahan A (eds). Elsevier: Oxford; 25–43.

Adner R, Levinthal D. 2001. Demand heterogeneity and technology evolution: implication for product and process innovation. *Management Science* **47**(5): 611–628.

Adner R, Zemsky P. 2002. Strategy dynamics through a demand-based lens: the evolution of market boundaries, resource rents, and competitive positions. INSEAD working paper series 2003/01/SM.

Adner R, Zemsky P. 2005. Disruptive technology and the emergence of competition. *Rand Journal of Economics* **36**(2): 229–254.

Amit R, Schoemaker PJH. 1993. Strategic assets and organizational rent. *Strategic Management Journal* **14**(1): 33–46.

Barney J. 1986. Strategic factor markets: expectations, luck and business strategy. *Management Science* **31**: 1231–1241.

Barney J. 1991. Firm resources and sustained competitive advantage. *Journal of Management* **17**(1): 99–120.

Barney J. 2001. Is the resource-based 'view' a useful perspective for strategic management research? *Academy of Management Review* **26**(1): 41–56.

Barney J, Peteraf M. 2003. Unraveling the resource-based tangle. *Managerial and Decision Economics* **24**: 309–323.

Berry S, Levinsohn J, Pakes A. 1995. Automobile prices in market equilibrium. *Econometrica* **63**(4): 841–890.

Besanko D, Dranove D, Shanley M. 2000. *Economics of Strategy* (2nd edn). Wiley: New York.

Brandenburger A, Stuart HW. 1996. Value-based business strategy. *Journal of Economics and Management Strategy* **5**: 5–24.

Brandenburger A, Stuart HW. 2003. Biform games. mimeo, New York University.

Christensen CM. 1997. *The Innovator's Dilemma*. Harvard Business School Press: Boston, MA.

Dierickx I, Cool K. 1989. Asset stock accumulation and sustainability of competitive advantage. *Management Science* **35**(12): 1504–1511.

Foster R. 1986. *Innovation, the Attacker's Advantage*. Simon & Schuster: New York.

Ghemawat P. 1991. *Commitment: The Dynamic of Strategy*. Free Press: New York.

Grant RM. 1998. *Contemporary Strategy Analysis: Concepts, Techniques, Applications* (3rd edn). Blackwell Business Press: Cambridge MA.

Griliches Z. 1961. Hedonic price indexes for automobiles: an econometric analysis of quality change. In *Price Statistics of the Federal Government*. National Bureau of Economic Research: New York; 173–196.

Intel Corporation. 1998. Letter to our stockholders. Annual Report.

Kim C, Mauborgne R. 1997. Value innovation: the strategic logic of high growth. *Harvard Business Review* **75**(1): 102–112.

Lippman SA, Rumelt RP. 1982. Uncertain imitability: an analysis of inter-firm differences in efficiency under competition. *Bell Journal of Economics* **13**(3): 418–438.

Lippman SA, Rumelt RP. 2003. A bargaining perspective on resource advantage. *Strategic Management Journal* **24**(11): 1069–1086.

MacDonald G, Ryall M. 2004. How do value creation and competition determine whether a firm appropriates value? *Management Science* **50**(10): 1319–1333.

Makadok R. 1998. Can first-mover and early-mover advantages be sustained in an industry with low barriers to entry/imitation? *Strategic Management Journal* **19**(7): 683–696.

Makadok R. 2001. Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic Management Journal* **22**(5): 387–401.

Makadok R, Barney J. 2001. Strategic factor market intelligence: an application of information economics to strategy formulation and competitor intelligence. *Management Science* **47**(12): 1621–1638.
McGahan A, Porter ME. 2003. The emergence and sustainability of abnormal profits. *Strategic Organization* **1**: 109–115.
Pacheco de Almeida G, Zemsky P. 2003. The effect of time-to-build on strategic investment under uncertainty. *Rand Journal of Economics* **34**(1): 166–182.
Pacheco de Almeida G, Zemsky P. 2004. Time compression diseconomies and sustainable competitive advantage. Mimeo, INSEAD.
Peteraf MA. 1993. The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal* **14**(3): 179–191.
Porter ME. 1980. *Competitive Strategy*. Free Press: New York.
Porter ME. 1991. Towards a dynamic theory of strategy. *Strategic Management Journal*, Winter Special Issue **12**: 95–118.
Porter ME. 1996. What is strategy? *Harvard Business Review* **74**(6): 61–79.
Priem RL, Butler JE. 2001. Is the resource-based 'view' a useful perspective for strategic management research? *Academy of Management Review* **26**(1): 22–40.
Rumelt RP. 1984. Towards a strategic theory of the firm. In *Competitive Strategic Management*, Lamb R (ed). Prentice-Hall: Englewood Cliffs, NJ; 556–570.
Rumelt RP. 1987. Theory, strategy and entrepreneurship. in *The Competitive Challenge: Strategies for Industrial Innovation and Renewal*, Teece D (ed). Ballinger: Cambridge, MA; 137–158.
Rumelt RP. 2003. What in the world is competitive advantage? UCLA, policy working paper 2003-105.
Teece DJ, Pisano G, Shuen A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* **18**(7): 509–534.
Trajtenberg M. 1990. *Economic Analysis of Product Innovation: The Case of CT Scanners*. Harvard University Press: Cambridge, MA.
Utterback JM. 1994. *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change*. Harvard Business School Press: Boston, MA.
Utterback JM, Abernathy W. 1975. A dynamic model of process and product innovation. *Omega* **3**(6): 639–656.
Wernerfelt B. 1984. A resource-based view of the firm. *Strategic Management Journal* **5**(2): 171–180.

APPENDIX

Proof of Proposition 1

Suppose $b_1 = b_2$. We have $A^d_{1m}(t) = a_m b_1^\beta (t^\beta - (t + h_2)^\beta)$ and hence $A^d_{1m}(t) < 0$ and $\partial A^d_{1m}/\partial t > 0$ for all $t > 0$ and $\lim_{t\to\infty} A^d_{1m}(t) = 0$. If $A^c_1 \leq 0$, then $A^d_{1m}(t) + A^c_1 < 0$ for all $t > 0$ and substitution does not occur. Conversely, if $A^c_1 > 0$, then there exists a t_E such that $A^d_{1m}(t) + A^c_1 > 0$ iff $t > t_E$ where t_E satisfies $a_m(b_1 t_E)^\beta - a_m(b_2(t_E + h_2))^\beta + A^c_1 = 0$. Using this equality and the implicit function theorem,

$$\frac{\partial t_E}{\partial a_m} = -\frac{(b_1 t_E)^\beta - (b_2(t_E + h_2))^\beta}{\partial A^d_{1m}/\partial t} = \frac{A^c_1/a_m}{\partial A^d_{1m}/\partial t} \tag{12}$$

which is positive since $A^c_1 > 0$. Similarly, we have

$$\frac{\partial t_E}{\partial \beta} = -\frac{a_m(b_1 t_E)^\beta \ln(b_1 t_E) - (a_m(b_1 t_E)^\beta + A^c_1)\ln(b_2(t_E + h_2))}{\partial A^d_{1m}/\partial t} \tag{13}$$

which is positive since $A^c_1 > 0$ and $\ln(b_2(t_E + h_2)) > \ln(b_1 t_E) > 0$ as we are assuming that $b_1 t_E > 1$ so that DMU is increasing in β. *Q.E.D.*

Proof of Proposition 2

Suppose $b_1 > b_2$. Since $A^d_{1m}(0) + A^c_1 < 0$, $\partial A^d_{1m}/\partial t > 0$ and $\lim_{t\to\infty} A^d_{1m}(t) = \infty$, there exists a $t_E > 0$ such that $A^d_{1m}(t) + A^c_1 > 0$ iff $t > t_E$ where t_E satisfies $a_m(b_1 t_E)^\beta - a_m(b_2(t_E + h_2))^\beta + A^c_1 = 0$. Thus, $\partial t_E/\partial a_m$ is given by Equation 12, which is positive iff $A^c_1 > 0$. Finally, $\partial t_E/\partial \beta$ is given by Equation 13, which is positive if $A^c_1 > 0$ since in this case $b_1 t_E < b_2(t_E + h_2)$, while conversely $\partial t_E/\partial \beta < 0$ if $A^c_1 < 0$ since in this case $b_1 t_E > b_2(t_E + h_2)$. *Q.E.D.*

Proof of Proposition 3

Suppose $b_1 < b_2$. Then $A^d_{1m}(t) < 0$ for all $t \geq 0$ and there exists a t^* such that $\partial A^d_{1m}(t)/\partial t > 0$ iff $t < t^*$. If $A^c_1 < -A^d_{1m}(t^*)$, firm 1 never enters the segment. If $A_c \geq -A^d_{1m}(t^*)$ then firm 1 enters the segment at some $t_a \in (0, t^*]$. As $\lim_{t\to\infty} A^d_{1m}(t) = -\infty$, entry is reversed at some time $t_b > t^*$. We have that $\partial t_E/\partial a_m$ and $\partial t_E/\partial \beta$ are given by Equations 12 and 13 with t_E replaced by t_j for $j = a, b$. The numerators of both equalities are positive since $A^c_1 > 0$. Since $\partial A^d_{1m}(t_a)/\partial t > 0$, we have $\partial t_a/\partial a_m > 0$ and $\partial t_a/\partial \beta > 0$. Since $\partial A^d_{1m}(t_b)/\partial t > 0$, we have $\partial t_b/\partial a_m < 0$ and $\partial t_b/\partial \beta < 0$. Hence, the interval of entry $[t_a, t_b]$ is falling in a_m and β. *Q.E.D.*

Proof of Propositions 4–6

For all four resource types, $A^d_{1m}(t) + A^c_1 > 0$ for all $t > 0$ and hence firm 1 enters the segment first and is never displaced. We have that t_i is defined by $v_{im}(t_i) = 0$. From Lemma 1, we have that firm 1's rent from its resource is 0 if $t \leq t_1$, $s_m v_{1m}(t)$ if $t \in (t_1, t_2]$, and $s_m(v_{1m}(t) - v_{2m}(t))$ if $t > t_2$. For all resource types, $v'_{1m}(t) > 0$ as performance increases in t and hence rents are always increasing for $t \in (t_1, t_2)$. For a process resource, $v_{1m}(t) - v_{2m}(t) = A_1^c$ such that rents are constant for $t > t_2$. For all other resources, $v_{1m}(t) - v_{2m}(t) = A_{1m}^d(t)$, which varies with time. For performance and timing resources, $\partial A_{1m}^d/\partial t < 0$ and rents decline for $t > t_2$ with $\lim_{t\to\infty} A_{1m}^d(t) = 0$. For innovation resources, $\partial A_{1m}^d/\partial t > 0$ and rents increase over time but at a decreasing rate since $\partial^2 A_{1m}^d/\partial t^2 < 0$. *Q.E.D.*

Proof of Propositions 7–9

For all four resource types, $A_{1m}^d(t) + A_1^c > 0$ for all $t > 0$ and hence firm 1 enters the segment first and is never displaced. We have that t_i is defined by $v_{im}(t_i) = 0$. From Lemma 1, we have that firm 1's rent from its resource is 0 if $t \leq t_1$, $s_m v_{1m}(t)$ if $t \in (t_1, t_2]$, and $s_m(v_{1m}(t) - v_{2m}(t))$ if $t > t_2$. For all resource types, $v'_{1m}(t) > 0$ as performance increases in t and hence rents are always increasing for $t \in (t_1, t_2)$. For a process resource, $v_{1m}(t) - v_{2m}(t) = \Delta_c U(t)$ such that rents decrease to zero for $t > t_2$. Similarly, for a product resource we have that $v_{1m}(t) - v_{2m}(t) = \Delta_r U(t)$ and rents decrease to zero for $t > t_2$. This completes the proof of Proposition 7.

For innovation resources, the willingness to pay for firm 2's offer at time t is given by $\int_0^t (b + (1 - U(t))\Delta_b)dt = (b + \Delta_b)t - \frac{\Delta_b}{z}\ln(1 + zt)$. We then have $v_1(t) - v_2(t) = \frac{\Delta_b}{z}\ln(1 + zt)$, which is increasing in t but at a decreasing rate because of the concavity of the ln function. This completes the proof of Proposition 9.

Suppose firm 1 has a process resource. With imitation and no DMU, we have that $v'_{1m}(t) = b$ and with DMU and no imitation we have that $v'_{1m}(t) = b\beta/(bt + \Delta_r)^{1-\beta}$. For $t > t_1$ we have that $bt + \Delta_r > 1$ and hence $b\beta/(bt + \Delta_r)^{1-\beta} < b$ and the rate of increase in rents is greater with imitation and no DMU than with DMU and no imitation. With DMU and no imitation, we have that $t_1 = (c^{1/\beta} - \Delta_r)/b$ and $t_2 = c^{1/\beta}/b$, and hence $t_2 - t_1 = \Delta_r/b$. This difference is independent of β and hence it holds when there is no DMU and no imitation. As imitation reduces t_2, we have that the period during which rents increase is shorter with imitation and no DMU than with DMU and no imitation.

Suppose firm 1 has a process resource. With imitation and no DMU, we have that $v'_{1m}(t) = b$ and with DMU and no imitation we have that $v'_{1m}(t) = b\beta/(bt)^{1-\beta}$, which is less than b when $t > t_1$. With DMU and no imitation, we have that $t_1 = c_1^{1/\beta}/b$ and $t_2 = c_2^{1/\beta}/b$ and hence $t_2 - t_1 = c_2^{1/\beta}/b - c_1^{1/\beta}/b$, which is decreasing in β. Hence no DMU ($\beta = 1$) and imitation results in a smaller $t_2 - t_1$ than DMU and no imitation. This completes the proof of Proposition 8. *Q.E.D.*

Proof of Propositions 10 and 11

Suppose that firm 1 has two resources which we index by $\rho = A$ and B. As usual, let $v_1(t)$ be firm 1's value creation. Define $v_{1A}(t)$ and $v_{1B}(t)$ as firm 1's value creation when it only has resource A and B respectively. Define the following critical times: $v_1(t_1) = 0$, $v_2(t_2) = 0$, $v_{1A}(t_{1A}) = 0$, $v_{1B}(t_{1B}) = 0$ and then define $t_{1M} = \max\{t_{1A}, t_{1B}\}$ and $t_{1m} = \min\{t_{1A}, t_{1B}\}$. Note that $t_1 < t_{1m} \leq t_{1M} < t_2$. We now consider resource interactions for various values of t.

For $t < t_1$ even the firm with both resources has negative value creation and there are no rents; the resources are additive. For $t \in (t_1, t_{1m})$, we have that possession of both resources yields positive value creation and rents, while possession of either individually results in negative value creation and no rents; hence any two resources are superadditive. For $t \in [t_{1m}, t_{1M}]$, there is one resource that yields rents with or without the other. However, value creation and rents are greater with both resources and the second resources has negative value creation and no rents on its own; hence any two resources are superadditive. What happens for $t > t_{1M}$ depends on the identity of the two resources.

Suppose that the firm has a product and a timing resource. When $t \geq t_2$, then rent to holding both resources is $s_m(v_1(t) - v_2(t)) = s_m a_m(b(t + \Delta_h) + \Delta_r)^\beta - (bt)^\beta)$, while the sum of the rents from holding both individually is $s_m a_m((bt + \Delta_r)^\beta - (bt)^\beta) + s_m a_m(b(t + \Delta_h))^\beta - (bt)^\beta)$. For $\Delta_r = 0$, these expressions are equal and the second expression increases faster in Δ_r; hence this resource combination is subadditive for $t \geq t_2$. For $t \in [t_{1M}, t_2]$, the difference in rents between holding the resources together and holding each individually is $s_m(a_m(b(t+\Delta_h)+\Delta_r)^\beta - c) - s_m(a_m(bt+\Delta_r)^\beta + a_m(b(t+\Delta_h))^\beta - 2c)$, which is falling in t. Thus there exists a $\hat{t} \in (t_{1M}, t_2)$ such that for $t_1 < t < \hat{t}$ the resources are superadditive and for $t > \hat{t}$ the resources are subadditive.

Similar arguments establish the existence of a critical $\hat{t}$ for a portfolio with a product and innovation resource as well as for a portfolio with two timing, two product, or two innovation resources.

Suppose that resource A is a process resource. For $t \in [t_{1M}, t_2)$, the rents from holding both resources are $s_m v_1(t) = s_m(v_{1B}(t) + \Delta_c)$ while the rents from holding both individually are (recalling that only one resource gives positive value creation on its own) $s_m \max\{v_{1B}(t), v_2(t)+\Delta_c\} < s_m(v_{1B}(t)+\Delta_c)$; hence the resources are superadditive in this range. For $t \geq t_2$, the rent from holding both resources is $s_m(v_{1B}(t)+\Delta_c - v_2(t))$, the same as the sum of the rents from holding both individually, and the resources are additive. Hence, for $t_1 < t < t_2$ the resources are superadditive and for $t \geq t_2$ the resources are additive.

The final case to consider is a timing and an innovation resource. For $t \geq t_2$, the difference in rents between holding both and holding each separately is $s_m a_m((b+\Delta_b)(t+\Delta_h))^\beta - (b(t+\Delta_h))^\beta - ((b+\Delta_b)t)^\beta + (bt)^\beta)$, which is equal to zero for $\Delta_b = 0$ and increasing in Δ_b. Hence, the difference is positive and the resources are superadditive. It is straightforward to show that the difference in rents is monotonic in t for $t \in [t_{1M}, t_2]$. Hence, timing and innovation resources are superadditive for all $t > t_1$. *Q.E.D.*

The proofs of Propositions 12, 13 and 14 are straightforward and are omitted.

Proof of Proposition 15

Suppose that firm 2 (the incumbent) is in both segment H and L at some point in time but that firm 1 displaces it from these segments. The proofs of Propositions 1, 2, and 3 characterize the effect of a_m on the time at which firm 1 displaces firm 2 from segment m and show that the entry time is increasing when firm 1 has a cost advantage and decreasing when firm 1 has a cost disadvantage. Since $a_H > a_L$, firm 1 first displaces the incumbent from the high-end segment if it has a cost disadvantage and from the low-end segment if it has a cost advantage. *Q.E.D.*

Proof of Propositions 16 and 17

Suppose that $s_L = 0$ and let $a_H = a$ and $s_H = s$. With only a single segment, at most one firm will pay the fixed costs to maintain resources. Let $v_c(t) = a(bt)^\beta - c + \Delta_c$ be the value created by a Cost Leader; let $v_r(t) = a(bt+\Delta_r)^\beta - c$ be the value creation by a Differentiator; and let $v_{rc}(t) = a(bt+\Delta_r)^\beta - c + \Delta_c$ be the value creation by a Resource Generalist. Firm 2 starts creating value at time $t_2 = c^{1/\beta}/b$. From previous analysis, the rents from the Cost Leadership strategy are maximized for $t \geq t_2$ and are $\bar{\Pi}_c = s\Delta_c - F_c$, and the rents from the Differentiator strategy are maximized at $t = t_2$ and are equal to $\bar{\Pi}_r = s(a(c^{1/\beta}+\Delta_r)^\beta - c) - F_r$. Suppose that $\bar{\Pi}_r > \bar{\Pi}_c > 0$.

Suppose that $t \leq t_2$. The firm chooses the strategy at each point in time that maximizes its profits where a strategy without any resources yields profits of 0. Being a Cost Leader yields $sv_c(t) - F_c$, being a Differentiator yields $sv_r(t) - F_r$, and being a Resource Generalist yields $sv_{rc}(t) - F_c - F_r - K$. Since $v_c'(t) > v_r'(t)$ and $\bar{\Pi}_r > \bar{\Pi}_c$, we have that a strategy of Differentiation dominates Cost Leadership for $t \leq t_2$. Subtracting the profits from being a Resource Generalist from those of being a Differentiator yields $\bar{\Pi}_c - K$ and hence for $K < \bar{\Pi}_c$ the firm enters the market segment as a Resource Generalist and for $K > \bar{\Pi}_c$ the firm enters the market segment as a Cost Leader.

Suppose $t > t_2$. Being a Cost Leader yields $\bar{\Pi}_c$, being a Differentiator yields $sa((bt+\Delta_r)^\beta - (bt)^\beta) - F_r$, and being a Resource Generalist yields $sa((bt+\Delta_r)^\beta - (bt)^\beta + \Delta_c) - F_c - F_r - K$. The latter two are both falling in t and converge to a value of less than $\bar{\Pi}_c$ and hence in the long run the firm pursues a strategy of Cost Leadership. This completes the proof of Proposition 16.

For $K > \bar{\Pi}_c$, the firm starts maintaining the product resource when $sv_r(t) - F_r = 0$ and the start time is decreasing in β and a. The firm stops maintaining the product resource when $sa((bt+\Delta_r)^\beta - (bt)^\beta) - F_r = \bar{\Pi}_c$ and the stop time is increasing in β and a. For $K \leq \bar{\Pi}_c$, the firm starts maintaining the product resource when $sv_{rc}(t) - F_r - F_c - K = 0$ and the start time is decreasing in β and a. The firm stops maintaining the product resource when $sa((bt+\Delta_r)^\beta - (bt)^\beta) - F_r - K = 0$ and the stop time is increasing in β and a.

For $K > \bar{\Pi}_c$, the firm starts maintaining the process resource when it stops maintaining the product resource and hence the start time for the product resource is decreasing in β and a. For $K < \bar{\Pi}_c$, the firm starts maintaining the process and product resource at the same time and hence the start time for the product resource is increasing in β and a. *Q.E.D.*

Proof of Propositions 18 and 19

Formally, we consider the one-shot game where firms simultaneously choose their resources. For it to be a Nash equilibrium that one firm is a Differentiator and the other is a Cost Leader, it must be that each firm has non-negative profits and that neither can increase its profits by pursuing a Resource Generalist strategy. As the Differentiator has more added value in the high end than the low end, we can restrict attention to parameters for which the Differentiator has positive added value in the high end and the Cost Leader has positive added value in the low end. Note that if the Cost Leader has added value in the low end then it has positive value creation in both segments, while it is not the case that the Differentiator necessarily has positive value creation in the low end. Define $D = (bt + \Delta_r)^\beta - (bt)^\beta$.

The profits of the Differentiator are $s_H(a_H D - \Delta_c) - F_r$ and these are non-negative for

$$a_H \geq \underline{a}_H = \frac{\Delta_c}{D} + \frac{F_r}{s_H D} \tag{14}$$

which is increasing in F_r and decreasing in s_H. If the Differentiator has positive value creation in the low-end segment, then the profits of the Cost Leader are $s_L(\Delta_c - a_L D) - F_c$ and these are non-negative for

$$a_L \geq \bar{a}_L = \frac{\Delta_c}{D} - \frac{F_c}{s_L D} \tag{15}$$

which is decreasing in F_c and increasing in s_L. Note that $\underline{a}_H > \bar{a}_L$. Suppose that the Differentiator does not create value in the low end, which occurs for $a_L(bt + \Delta_r)^\beta - c < 0$. Then the profits of the Cost Leader are $s_L(a_L(bt)^\beta - c + \Delta_c) - F_c$, which are non-negative for

$$a_L \geq \underline{a}_L = \frac{F_c}{s_L(bt)^\beta} + \frac{c - \Delta_c}{(bt)^\beta} \tag{16}$$

A Differentiator does not increase its profits from shifting to a Resource Generalist strategy if $s_H(a_H D - \Delta_c) - F_r \geq s_H a_H D + s_L a_L D - F_r - F_c - K$ or $K \geq s_H \Delta_c + s_L a_L D - F_c$. Suppose that the Differentiator creates value in the low end. A Cost Leader does not increase its profits from shifting to a Resource Generalist strategy if $s_L(\Delta_c - a_L D) - F_c \geq s_L \Delta_c + s_H \Delta_c - F_c - F_r - K$ or $K \geq s_H \Delta_c + s_L a_L D - F_r$. Suppose that the Differentiator does not create value in the low end. A Cost Leader does not increase its profits from shifting to a Resource Generalist strategy if $s_L(a_L(bt)^\beta - c + \Delta_c) - F_c \geq s_L(a_L(bt + \Delta_r)^\beta - c + \Delta_c) + s_H \Delta_c - F_c - F_r - K$ or $K \geq s_L a_L D + s_H \Delta_c - F_r$. Hence, a necessary condition for strategic diversity to be a Nash equilibrium is that $K \geq \bar{K} = \max\{0, s_H \Delta_c + s_L a_L D - F_c, s_H \Delta_c + s_L a_L D - F_r\}$. Note that it is possible that $\bar{K} = 0$.

So far we have been concerned with the conditions for the existence of an equilibrium with a Cost Leader and Differentiator. These conditions do not assure uniqueness. For uniqueness one needs to rule out the equilibrium where one firm is a Resource Generalist and the other does not invest in resources. The pay-off to the resourced firm in this case is $s_H(a_H D + \Delta_c) + s_L(a_L D + \Delta_c) - F_c - F_r - K$. Note that for K sufficiently small, the conditions $a_H \geq \underline{a}_H$ and $a_L \geq \underline{a}_L$ assure that the Resource Generalist equilibrium exists as well. Hence, for Cost Leadership and Differentiation to be the unique Nash equilibrium we require that $K > s_H(a_H D + \Delta_c) + s_L(a_L D + \Delta_c) - F_c - F_r$, which is greater than zero whenever the Cost Leader–Differentiator equilibrium exists. *Q.E.D.*