Strategy Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Specialist versus Generalist Positioning: Demand Heterogeneity, Technology Scalability and Endogenous Market Segmentation

Ron Adner, Francisco Ruiz-Aliseda, Peter Zemsky

STRATEGY SCIENCE
Vol. 1, No. 3, September 2016, pp. 184–206
ISSN 2333-2050 (print) | ISSN 2333-2077 (online)

http://dx.doi.org/10.1287/stsc.2016.0016

Specialist versus Generalist Positioning: Demand Heterogeneity, Technology Scalability and Endogenous Market Segmentation

Ron Adner
Tuck School of Business, Dartmouth College, Hanover, New Hampshire 03755, ron.adner@dartmouth.edu
Francisco Ruiz-Aliseda
Escuela de Administración, Pontificia Universidad Católica de Chile, Santiago, Chile, f.ruiz-aliseda@uc.cl
Peter Zemsky
INSEAD, Fontainebleau Cedex 77305, France, peter.zemsky@insead.edu

At the heart of competitive strategy is the question of where firms choose to position themselves within an industry. We characterize when generalists desegment markets, and when they are "stuck in the middle" because they are outcompeted by specialists. In our formal equilibrium model, firms face a positioning trade-off between cost and quality that is moderated by a choice of technologies that vary in their scalability. On the demand side, we incorporate consumer heterogeneity via two segments that vary in their willingness to pay for quality. Specialists in our model correspond to Porter's generic strategies, with a "cost leader" targeting the low-end segment and a "differentiator" targeting the high-end segment. Generalists target both segments and hence have greater ability to exploit economies of scale. Central to our analysis is the interplay between the extent of demand heterogeneity and technology scalability. We show that this interplay determines when a Generalist is stuck in the middle; when it dominates from the middle with an intermediate quality level that outcompetes Specialist firms optimally positioned for cost leadership and differentiation; and when it dominates from above with a quality level greater than even that of a Differentiator. We explicitly link positioning on a cost-quality frontier to the value-bar analysis that is widely used in strategy teaching, and show how cost allocation rules impact positioning choices and competitive outcomes.

Keywords: competitive strategy; game theory; strategic positioning; value added; industrial organization; industry analysis
History: Received November 29, 2015; accepted May 16, 2016. Published online September 7, 2016.

1. Introduction

The question of how to choose positions within an industry is at the heart of competitive strategy. At the most fundamental level, firms face a choice between specializing their activities to serve specific market segments or broadening to become generalists that serve multiple market segments (e.g., Hannan and Freeman 1993). Porter (1980, 1985) argues that firms should specialize, positioning as either cost leaders or differentiators, where the latter have higher quality offers and higher costs than the former due to underlying technological and organizational trade-offs. Those firms that attempt a generalist position risk being "stuck in the middle" and outcompeted by specialists. Countering the stuck-in-the-middle hypothesis is the observation that some firms that take on generalist positions and pursue both cost and differentiation advantage simultaneously are, in fact, very successful (e.g., Barney 1997, Besanko et al. 2000, Kim and Mauborgne 2005). Empirical support for Porter's generic strategy construct and the prediction of the stuck-in-the-middle hypothesis has been mixed (e.g., Miller and Dess 1993, Cronshaw et al. 1994, Campbell-Hunt 2000, Thornhill and White 2007). Although the specialist strategies of cost leadership and differentiation remain enduring elements of strategy thinking and strategy teaching, the dissonance around the stuck-in-the-middle claim suggests an important conceptual gap with respect to the boundary conditions for the use of specialist and generalist strategies.

In this paper we develop an analytic model to clarify the logic of generic strategies and the conditions under which the logic does and does not hold in a particular setting. We first identify the conditions under which an industry is served by specialists targeting low- and high-end segments and positioned according to the generic strategies of cost leadership and differentiation, with firms attempting a generalist position outcompeted and hence "stuck in the middle." We then show the conditions under which these conditions break down, such that a generalist can successfully outcompete specialists and desegment an industry. We show when generalists "dominate from the middle" with an intermediate level of quality that outcompetes specialist firms optimally positioned for cost leadership and differentiation, and when they can even "dominate from above" with a quality level that exceeds that of a differentiator.

At the core of our analysis is the interplay between demand heterogeneity and the scalability of production technologies. On the demand side, we consider an industry with two distinct market segments that vary in their taste for quality. We characterize demand heterogeneity as the taste for quality in the high-end segment relative to the low-end segment. On the supply side, firms face a trade-off between cost and quality that can be shifted by exploiting economies of scale. In particular, firms can increase quality by both increasing marginal production costs (e.g., shifting from plastic to leather in a car model's interior) and by making fixed investments (e.g., advertising or R&D). We allow firms the choice between a pure marginal cost technology and a more scalable technology. We define the scalability of a technology as the extent to which quality is increased through marginal versus fixed costs.

We bring the demand side and the supply side together in an equilibrium model. We study a two-stage game. In the first stage, firms decide whether to enter the industry, and those that do pick a technology and a cost-quality position. In the second stage, firms engage in Bertrand price competition in each of the market segments.

Endogenous segmentation plays a central role in our theory. In particular, we characterize whether or not demand heterogeneity manifests itself in strategic heterogeneity (that is, whether multiple customer segments on the demand side give rise to multiple specialist positions on the supply side, as opposed to a generalist serving multiple segments from a single position). We identify two opposing forces that determine where competitive advantage lies. Demand heterogeneity acts to increase the attractiveness of the specialist strategies of a cost leader targeting the low-end segment and a Differentiator targeting the high-end segment, with each using the marginal cost technology. Each specialist is able to optimally trade off marginal cost and quality according to the specific preferences of its target segment. The competitive advantage of the Generalist comes from exploiting fixed investments that can be spread across multiple segments. The weakness of the generalist, though, is its inability to tailor the quality level of its offer to the tastes of each segment. When scalability is low relative to heterogeneity, the generalist's economies of scale are insufficient to offset the advantages of optimizing the offer to a single segment, and the generalist is outcompeted by specialists. When scalability is high relative to heterogeneity, the generalist is able to outcompete the specialists in both segments and desegment the market.

In developing and solving our formal model, we generate a number of additional insights for competitive strategy. We translate the cost-quality productivity frontier into a cost-WTP (willingness-to-pay) value frontier, which is more consistent with modern value-based analysis (Brandenburger and Stuart 1996). From this perspective, we see that firms in a market with two different customer segments confront two distinct value frontiers, and we derive the optimal position on each. We develop an explicit link between these positions and the value-bar analysis increasingly employed in strategy teaching (e.g., Ghemawat and Rivkin 2006). We extend such a value-bar analysis to explicitly incorporate fixed and variable costs. This allows us to elucidate how the allocation of fixed costs impacts firm strategy and competitive outcomes. Finally, we advance the demand-based perspective on strategy (Adner and Levinthal 2001, Adner and Zemsky 2006) to consider how demand heterogeneity impacts firms' technology choices and the possibility that an industry is desegmented. With its focus on business-level strategy, this paper complements Adner and Zemsky (2016), which characterizes the choice of specialist and generalist corporate-level strategies.

The paper proceeds as follows. Section 2 specifies the formal model. Section 3 shows how the specialist positions of cost leader and differentiator necessarily dominate the industry when firms only have access to the marginal cost technology. Section 4 characterizes when the generalist can enter using the scalable technology and how this depends on the allocation of fixed costs. Section 5 characterizes how firm and industry profits vary with changes in heterogeneity and scalability. Section 6 extends the model to allow for asymmetric segment sizes. Sections 7 and 8 discuss the results and conclude the paper.

2. The Model

We develop an equilibrium model of positioning based on vertical differentiation on quality (Shaked and Sutton 1982), discrete market segments (Adner 2002; Adner and Zemsky 2005, 2006), and technology choice by firms (Cohen and Klepper 1996). Our focus is on how the balance between fixed and variable costs of differentiation shape entry and positioning choices (see Karnani 1984, for an early contribution along these lines). We build on Sutton (1998) in considering the interactions among scale economies, technology choice and demand heterogeneity, but while Sutton focuses on the implications of these elements for market structure, our focus is on the implications for competitive positioning. In an important related paper, Stuart (2016) considers a value-based model with multiple firms and multiple buyer segments. However, that work takes each firm's cost-quality position as given, whereas our focus is precisely on firm choice of cost-quality positions.

2.1. Supply Side

There are up to three active firms in the industry. Each firm produces a single product. We index the firms and their products by $i = 1, 2, 3$. We equate the quality of a firm's product with its level of differentiation $d_i \geq 0$, which determines the willingness-to-pay (WTP) of consumers for the firm's product. Differentiation requires effort and resources from firms such that they face a trade-off between product quality and cost (Porter 1996, Saloner et al. 2001).

We examine two technologies that differ in their cost structures. With technology M, a firm's costs come entirely from marginal production costs of each unit, which we denote by c_i. Specifically, differentiation is an increasing linear function of marginal production costs $d_i = c_i$.[1,2] Note that a firm's total costs under technology M are then determined by its level of differentiation and its output quantity Q_i:

$$\begin{aligned} TC_i^M(Q_i; d_i) &= c_i Q_i \\ &= d_i Q_i. \end{aligned}$$

With technology F we incorporate the possibility that quality can be increased by fixed investments, such as R&D or advertising, rather than just by higher marginal production costs, as emphasized by Sutton (1991, 1998). With technology F quality is given by

$$d_i = c_i + \frac{1}{K} F_i, \tag{2.1}$$

where c_i are again the level of the marginal production costs and F_i are fixed costs. The parameter K determines the relative effectiveness of fixed and marginal costs in raising quality.

Consider, for example, an automaker differentiating its offer with autonomous driving technology. Greater fixed investments in R&D and software development (i.e., higher F_i) can increase the quality of the solution. At the same time, these advances can require complementary investments in sensors and processors in every vehicle that increase marginal production costs (i.e., higher c_i) as well. We introduce a single parameter $f \in [0, 1]$ that determines the relative importance of fixed and marginal costs and therefore parameterizes the scalability of technology F. In particular, as firms increase quality, they increase both fixed and variable costs in a constant ratio:

$$\frac{F_i}{c_i} = \frac{f}{1-f} K. \tag{2.2}$$

Equations (2.1) and (2.2) imply there is a simple linear mapping from a firm's choice of quality level d_i to its variable costs c_i and fixed costs F_i:

$$\begin{aligned} c_i &= (1-f) d_i, \\ F_i &= f K d_i. \end{aligned}$$

Total costs under technology F are then

$$\begin{aligned} TC_i^F(Q_i; d_i) &= c_i Q_i + F_i \\ &= ((1-f) Q_i + f K) d_i \end{aligned}$$

and hence average costs are $AC_i^F(Q_i; d_i) = (1-f) d_i + f K d_i / Q_i$. Note that technology M is a special case of technology F with $f = 0$.

Figure 1 illustrates the average cost curves for the two technologies. By definition, technology M has no scale economies and the average costs are a constant. Average costs for technology F fall in Q_i and rotate in f around the point (K, d_i). Note finally that in the reduced form of the model, K parameterizes the extent of fixed costs.

2.2. Demand Side

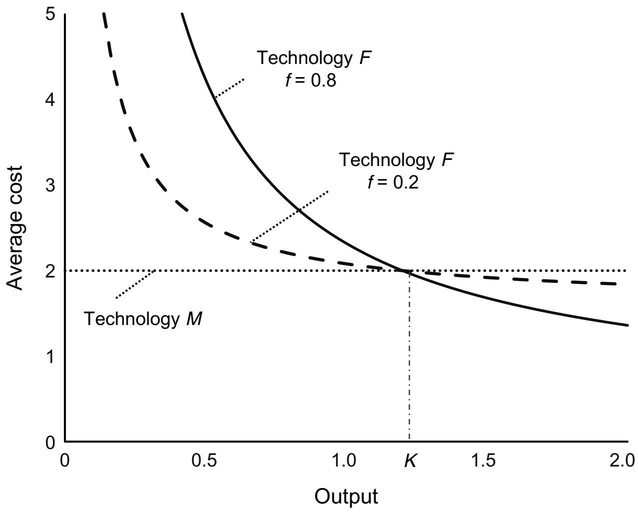
Consumers are split into two discrete market segments that vary in their taste for quality. There is a low-end segment with a taste for quality of $a_L > 0$, and there is a high-end segment with a taste for quality of $a_H > a_L$. In addition to an appreciation of product quality (e.g., audiophiles, "foodies"), the taste for quality can also reflect the ability to pay for quality due to income differences. We parameterize demand heterogeneity by $h = a_H / a_L$. The greater h is, the greater the heterogeneity across segments.[3]

[1] Adding a slope to the cost function as in $d_i = \gamma c_i$ does not affect the analysis. It would serve to scale up or down the taste for quality parameters a_L and a_H introduced later. Adding a positive constant to the cost function would serve to shift down firm profits. This does not affect the analysis as long as the constant is small, relative to the taste for quality so that profits remain positive.

[2] In this paper we make the standard economic assumption of a known and smooth trade-off between cost and quality and hence a smooth productivity frontier, which has become an influential tool for thinking about positioning. In organizational economics, Milgrom and Roberts (1990) highlight the possibility that complementarities in organizational design can sometimes allow for a positive association between cost and quality. The strategy literature also emphasizes that complementarities can mean that firms are positioning on "rugged landscapes" (Levinthal 1997). See Adner et al. (2014) to understand how such interdependencies across policies can give rise to a rugged productivity frontier where there need not be a smooth trade-off between cost and quality. In the present paper, an increase in cost and quality comes from a shift in the frontier due to the adoption of a more scale-intensive technology (F) rather than complementarities.

[3] Consumer heterogeneity is often modeled as a continuous distribution in industrial organization (e.g., work on Hotelling's linear

Figure 1 Average Cost Curves for Technology M and Technology F for Two Different Values of f When $d_i = 2$ and $K = 1.2$



We index the market segments by j in $\{L, H\}$. Denote by WTP_{ij} segment j's willingness-to-pay for product i. We assume that $WTP_{ij} = a_j(d_i)^{1/2}$; raising d_i to the 1/2 incorporates decreasing marginal utility from quality improvements. The demand side of the model is adapted from Adner and Zemsky (2006).

We simplify the analysis by assuming both market segments have the same number of consumers denoted by $m > 0$; Section 6 extends the model to consider asymmetric market sizes.

To make the choice of technology nontrivial, we restrict attention to values of K such that $m < K < 2m$.[4]

2.3. Competition

Firms play a two-stage game. In the first stage, firms simultaneously decide whether to enter with a product and if they do, which technology to use and where to position (i.e., what d_i to choose). In the second stage, firms engage in Bertrand-style price competition in each segment. That is, we assume price discrimination is possible across segments.[5] We solve for a subgame perfect equilibrium of this two-stage game, where firms enter in the first stage if and only if they expect to have positive profits in the second stage.

2.4. Link to Value-Based Strategy

We use noncooperative game theory and Bertrand competition, which are mainstays of traditional IO theorizing. Nonetheless, there is a strong link between competitive outcomes in our model and added value as defined using concepts from cooperative game theory (Brandenburger and Stuart 1996, MacDonald and Ryall 2004). Recall that the added value of a firm i is defined as the difference between the total value created with all players and the value created without firm i, where value creation is the difference between the WTP of all customers less the total production costs of the firms. Note that sunk costs do not factor into added value calculations, although they will matter for measures of profitability.

We have the following formal result:

Lemma 2.1. *For any set of firms that are already active in the industry and any product positions they may have, the profit of firm i is given by its added value less its sunk investment costs F_i.*

Proof. All proofs are in the appendix.

The intuition is as follows. With price competition in each segment, firms that the customer does not choose are willing to price at their marginal cost and effectively offer their full value creation to the customer as potential surplus. As a result, the firm that does serve the customer has to offer at least this much surplus, leaving it with its added value as profit from the segment.

A growing strand of strategy research interprets added value as a formalization of competitive advantage (e.g., Adner and Zemsky 2006, Siggelkow and Wibbens 2015). In a cooperative game, a firm's added value is an upper bound on its value capture and profits (Brandenburger and Stuart 1996). Actual profits can be lower due to bargaining by buyers. With Bertrand competition, there is no bargaining, as buyers are price takers, and hence firms in our model capture their full added value.

A key assumption for Lemma 2.1 to hold is that the firms in our model have constant marginal costs and hence do not face capacity constraints. Otherwise, rivalry would be less intense and not separable across segments, breaking the close link to added value. This same distinction holds in cooperative game theory models as well (Chatain and Zemsky 2007, Stuart 2016).[6]

city). Here we consider discrete segments. As discussed in Adner and Zemsky (2005), discrete segmentation is a good representation of heterogeneity in many settings, such as when the product is a component used in multiple end products (e.g., hard disk drives, which were used in notebook, desktop and mainframe computers). Other examples of discrete consumer heterogeneity are personal versus professional users, industry segments (in business-to-business markets) and national markets.

[4] If $K < m$, then technology F necessarily dominates technology M, while if $K > 2m$, the inverse is true. See Section 4.1 for the derivation.

[5] We follow Stuart (2004) in introducing price discrimination into a model of product differentiation. While his focus is on horizontal differentiation, we consider a model of vertical differentiation. The case where vertically differentiated products have a single price in both segments is considerably more complex; see Adner and Zemsky (2005). The formulation here allows for a close link to value-based strategy as demonstrated in Section 2.4.

[6] Chatain and Zemsky (2007) characterize firm profits for a class of models with constant production costs using cooperative game

See Section 3.4 for further value-based analysis for technology *M* and Section 4.5 for further analysis of the more complex case of technology *F*. Section 4.5 considers situations where the fixed investments are not yet sunk and hence it makes sense to include them as well in an added value analysis.

3. Classic Generic Strategies and Stuck-in-the-Middle

A fundamental idea in business strategy—going back at least to the introduction of the SWOT (strengths-weaknesses-opportunities-threats) framework—is that a firm's distinctive organizational policies need to fit with its external environment. Central to Porter's contribution to the field is advancing the general notion of environmental fit by linking it to an economic-based notion of competitive advantage, which arises from the pursuit of his generic strategies of cost leadership and differentiation.

> Underlying the concept of generic strategies is that competitive advantage is at the heart of any strategy, and that achieving advantage requires a firm to make choices. If a firm is to gain advantage, it must choose the type of competitive advantage it seeks to attain and a scope within which it can be attained.... The worst strategic error is to be stuck in the middle, or to try simultaneously to pursue all the strategies. This is a recipe for strategic mediocrity and below-average performance, because pursuing all the strategies simultaneously means that a firm is not able to achieve any of them because of their inherent contradictions.
>
> (Porter 1990, p. 40)

The need for firms to make explicit positioning choices is rooted in the notion of trade-offs between cost and quality. "[Trade-offs] create the need for choice and purposefully limit what a company offers. They deter straddling or repositioning, because competitors that engage in those approaches undermine their strategies and degrade the value of their existing activities" (Porter 1996, p. 12). These trade-offs arise from the technological and production requirements (e.g., higher quality materials are more costly) and organizational requirements (e.g., higher quality staff require higher compensation) that support the different positions.

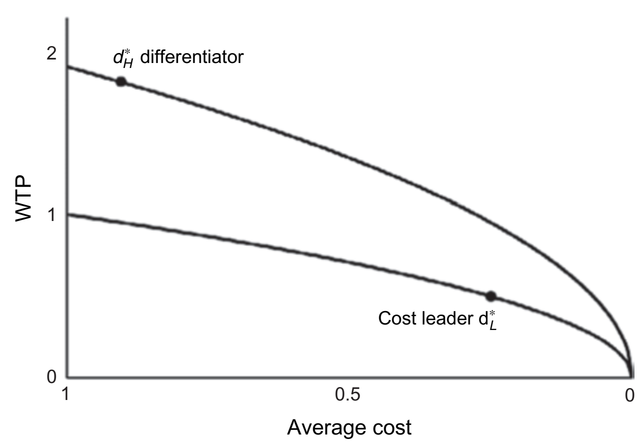
In this section we show that our model captures the Porterian logic in which the specialist strategies of cost leadership and differentiation are the two routes to competitive advantage in an industry. Specifically, in a world where the available production technology yields quality as a function of marginal cost—technology *M*—our model recreates the Porterian view of positioning where the industry is dominated by a cost leader and differentiator, and where a generalist positioned between them is stuck in the middle. We then show how these generic strategies map to the modern treatment of competitive advantage grounded in an explicit treatment of WTP and added value. The section thus offers a rigorous clarification of some popular (if at times loose) strategy concepts, and serves as the baseline from which we extend our model in the subsequent sections to consider alternative production technologies and the limits of the stuck-in-the-middle assertion.

3.1. From Productivity to Value Frontiers

Although the notion of trade-offs has become central to discussions of competitive positioning, it has been treated almost exclusively as a supply-side phenomenon: the trade-off is characterized as between production costs and product quality. Because of this supply-side focus we have the now familiar depiction of a single cost-quality frontier (e.g., Porter 1996 and Saloner et al. 2001). Note that this depiction fails to reflect demand heterogeneity. In contrast, a value-based perspective considers both supply and demand. The difference is the consideration of willingness-to-pay for quality rather than quality per se. Consumers in different market segments, by definition, will vary in their appreciation for the same offer. This means that in value space—where we consider trade-offs between WTP and cost—a market with two different segments will have two distinct frontiers. Figure 2 shows value frontiers for Technology *M* for two segments.

An advantage of working in value space is that one can identify optimal positions.

Figure 2 The Value Frontiers for Technology M for a Low-End Segment with $a_L = 1$ (Lower Curve) and a High-End Segment with $a_H = 1.9$ (Upper Curve) and Hence $h = 1.9$



theory and the bargaining power parameter from Brandenburger and Stuart (2007). They show that firm profits are proportional to a firm's added value. Stuart (2016) shows how firm profits are no longer proportional to added value in the presence of capacity constraints.

3.2. Choice of Specialist Positions with Technology M

As is well-recognized in the literature, firms at any position trade off cost and willingness-to-pay. "Any successful strategy, however, must pay close attention to *both* types of advantage while maintaining a clear commitment to superiority on one. A low-cost producer must offer acceptable quality and service to avoid nullifying its cost advantage through the necessity to discount prices, while a differentiator's cost position must not be so far above that of competitors as to offset its price premium" (Porter 1990, p. 40; emphasis in the original). This logic is made explicit in our model.

Consider a firm that uses technology M and expects to serve only low-end customers. From Lemma 2.1, the firm maximizes it profits by maximizing its value creation and hence its added value for the low-end segment. Value creation for such a firm is $m(WTP_{iL} - c_i) = m(a_L\sqrt{d_i} - d_i)$ and the optimal quality level for a firm serving the low-end segment using technology M is then

$$d_L^* = \tfrac{1}{4}(a_L)^2.$$

Similarly, the optimal quality level for a firm serving the high-end segment using technology M is

$$d_H^* = \tfrac{1}{4}(a_H)^2.$$

Figure 2 illustrates these optimal generic strategies. Each firm increases quality up to the point where the marginal increase in WTP is equal to the increase in marginal costs (that is, where the slope of the value frontier for the target segment is -1).

3.3. Equilibrium Analysis with Technology M

We now consider the equilibrium of the model with technology M.

Proposition 3.1. *Suppose firms only have access to technology M. The unique equilibrium has a* cost leader *positioned at d_L^* serving the low-end segment and a* differentiator *positioned at d_H^* serving the high-end segment.*

When firms only have access to technology M, there is a unique outcome where viable firms use one of two possible strategies: a cost leader serving only the low end and optimizing its activities for that segment, and a differentiator optimizing its activities for the high end. Each firm's position (d_L^* and d_H^*) maximizes its value creation for its specific segment. This is precisely what is illustrated in Figure 2.

With these positions occupied, there is no other position for which another firm using technology M can enter with positive added value. In particular, any firm that positions itself in the middle in an attempt to serve both segments from some generalist position d_G between d_L^* and d_H^* is outcompeted: Its higher quality is not enough to offset its cost disadvantage in the low-end segment relative to the cost leader at d_L^*; while its lower cost is not enough to offset its quality disadvantage for the high-end segment relative to the differentiator at d_H^*. Fundamental to the result of two viable equilibrium positions is the assumption that there are two market segments.[7]

Thus, when firms only have access to technology M, our model captures Porter's generic strategies and their trade-off-based dominance over alternatives. We show that, under these conditions, Porter's original maxim does indeed hold true: "The firm stuck in the middle is almost guaranteed low profitability. It either loses the high-volume customers who demand low prices or must bid away its profits to get this business away from low cost firms. Yet it also loses high margin businesses—the cream—to the firms who are focused on high-margin targets or have achieved differentiation overall" (Porter 1980, p. 41).

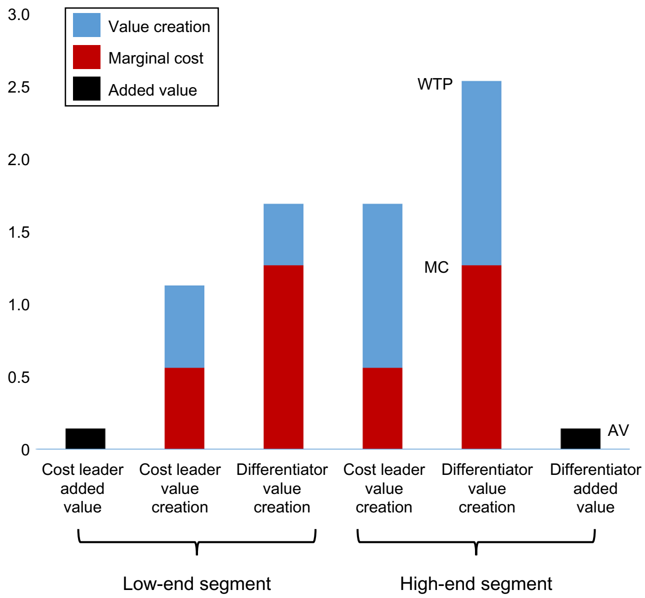
3.4. Link to Value-Based Strategy

Our model allows us to move from generic strategies on a productivity frontier to the value bar approach to competitive advantage (e.g., Ghemawat and Rivkin 2006) derived from the marginal value depictions in Brandenburger and Stuart (1996). The value bar plots value creation as the difference between a firm's cost of production and a customer's willingness to pay for the firm's offer. It shows added value as the difference across firms' levels of value creation. We can use the model to generate value bars for firms and explicitly identify added value, as illustrated in Figure 3. The height of the bars shows willingness to pay (WTP_{ij}), which varies across segments (due to differences in their taste for quality) and varies across firms (due to differences in their choice of quality level d_i). Red shows cost per customer c_i, which depends on d_i and varies across firms but not segments. Blue shows value creation, $WTP_{ij} - c_i$, for a customer in a segment. Black shows added value (profit), which is the difference between value creation (the two blue bars) for a given market segment.

Central to modern value-based analysis is the focus on the next best alternative, as this is a critical determinant of a firm's added value. In Figure 3, the next best alternative is the offer of the other firm, though this is not always the case. There is another alternative, which is for the customer not to buy. This no-purchase alternative becomes relevant when there is only one firm creating value in a segment. The cost leader, positioned to optimize value for the low-end

[7] Note that if there were n segments, each with a distinct taste for quality a_j, the equilibrium with technology M would involve n specialists, each with a distinct position.

Figure 3 **(Color online) Value-Based Analysis of Industry Competition with a Cost Leader and Differentiator with** $m=1$, $a_H=2.25$, $a_L=1.5$ **and Hence a Moderate Level of Demand Heterogeneity** ($h=1.5$)



segment, always creates some value in the high-end segment: If low-end customers have a WTP higher than the marginal cost, then certainly this will be true for high-end customers. The same is not true for the differentiator in the low-end segment. If its quality is too high, then its cost can exceed the WTP of low-end customers. Formally, this happens when $a_L\sqrt{d_H^*}-d_H^*<0$. Using the fact that the differentiator's quality d_H^* is an increasing function of the taste for quality in its target segment a_H, some straightforward algebra yields that the differentiator ceases to create value in the low-end segment when $a_H \geq 2a_L$. Recall that h is defined as the taste for quality in the high-end segment relative to the low-end (a_H/a_L). Hence the critical threshold is $h=2$. Figure 3, for which $h=1.5$, shows the case where firms are competing with each other in both segments.[8]

Our model shows that it is useful to be explicit about demand heterogeneity: with heterogeneous customers we can explain the sustainable coexistence of different generic strategies. Unlike current textbook treatments, we can conduct a formal value-based analysis of competitive advantage of these strategies without evoking a "standard competitor," which could not in fact exist in equilibrium, and which is therefore of questionable relevance for an analysis of competitive advantage.

To this point, our model captures the classic depiction of positioning with generic strategies. We now consider when this equilibrium breaks down, such that generalist firms serving markets from "the middle" can outcompete specialists.

4. When Can Generalists Dominate from the Middle?

We have shown that firms following the specialist strategies of cost leadership and differentiation, choosing positions at d_H^* and d_L^*, can outcompete firms positioned anywhere else on the frontier, rendering these rivals "stuck in the middle." This is necessarily true when the available technology is M. This is consistent with the numerous examples of firms that successfully achieve competitive advantage through strategies of cost leadership (e.g., RyanAir, Aldi, Dollar Store) or differentiation (e.g., Emirates Airline; Whole Foods; Neiman Marcus).

However, there is also widespread recognition that many successful firms break the cost-differentiation trade-off. For example, as Grant (2010) notes in his popular textbook, "In most industries, market leadership is held by a firm that maximizes customer appeal by reconciling effective differentiation with low cost—Toyota in cars, McDonald's in fast food, Nike in athletic shoes" (p. 202). The existence of successful generalists has been held out as disconfirming evidence for the universality of the stuck-in-the-middle claim.

We now identify conditions under which a firm can profitably enter an industry by simultaneously serving both segments from a single position, and outcompeting the specialists. That is, we identify the conditions under which a generalist dominating from the middle is a winning generic strategy.

From Proposition 3.1, we know this cannot happen with technology M. Suppose firms now also have access to the fixed-cost technology F. Recall that—in contrast to technology M—with technology F, a fraction of the costs associated with differentiation are fixed. Note too, that fixed costs are nonrecoverable, and hence these are sunk costs in the second stage of the game. For technology F, marginal costs are given by $c_i=(1-f)d_i$ and fixed costs are given by $F_i=fKd_i$ where $f\in[0,1]$ determines the sensitivity of average costs to production volumes, and therefore parameterizes the scalability of the technology.

An example of differentiation with low scalability is adding leather to a car's interior, which increases the production cost for each car. An example of differentiation with high scalability is adding a fuel cell engine to a car. The R&D investment is a fixed cost that does not increase with production volumes, but

[8] One could extend the model so that the cost leader would sometimes fail to create value in the high-end segment. In particular, if the WTP of the high-end segment were shifted down by a constant, then for sufficiently low-quality levels, the costs would exceed the WTP of high-end customers. The interpretation would then be that the high-end segment has an aversion to low-quality products. We thank an anonymous referee for this observation.

does shift marginal production costs (e.g., of sensors and the costs of producing individual fuel cells) as reflected in parameter f. The parameter K reflects the effectiveness of the fixed investments in fuel cells in raising quality and WTP relative to the effectiveness of marginal cost investments (such as in the car's interior).

4.1. Possible Equilibria with Technology F

In our model, it does not make sense to use technology F if a firm expects to serve only one segment. The cost of any quality level d_i with technology F when serving one segment is $TC_i^F(d_i) = (1-f)md_i + fKd_i$. Because $K > m$, this is greater than the cost $TC_i^M(d_i) = md_i$ that occurs with a choice of technology M. Hence, any firm choosing to use technology F must be targeting both segments and, as such, pursuing a generalist strategy.[9]

A generalist will still seek to maximize its value creation by trading off increased WTP against the costs. However, now it is not sufficient to consider maximizing the marginal value creation for a customer in one target segment as we did for the cost leader or differentiator. Rather, we must consider the total WTP across both segments as well as the fixed and marginal costs. Formally, a generalist chooses its quality to maximize the following total value creation expression:

$$\max_{d_i} \left[ma_L\sqrt{d_i} + ma_H\sqrt{d_i} - ((1-f)d_i 2m + fKd_i)\right].$$

The optimal position is then

$$d_G^* = \frac{1}{4}\left(\frac{a_L + a_H}{2}\right)^2 \left(\frac{1}{1-f+fK/(2m)}\right)^2.$$

This is our formal definition of the generalist strategy. Note that the position depends on the average taste for quality across the two segments $(a_L + a_H)/2$ and the scalability of technology F as given by f and by the importance of fixed costs relative to the total market size $K/(2m)$.

Because technology F can only be used in equilibrium if the generalist is serving both segments, it is not possible for the generalist to coexist with specialists. Hence we have the following proposition.

Proposition 4.1. *Suppose firms have access to both technology F and M. There are at most two possible equilibria—a Specialist equilibrium where there is a cost leader and a differentiator both using technology M and a Generalist equilibrium with a single firm at d_G^* serving both segments using technology F.*

[9] Conversely, the difference between the cost of serving both segments with technology F and the cost with technology M is $2m(d_i(1-f) + d_i fK) - 2md_i = d_i f(K-2m) < 0$ as $K < 2m$. Hence, a firm targeting both segments will minimize its costs by using technology F, while a firm targeting only one segment will minimize its costs using technology M.

Thus, there are only two possible equilibria, one with specialists using technology M and one with a generalist using technology F.

4.2. Shifting the Value Frontier

Figure 4 shows the value frontiers for technology F (solid lines) relative to the previous frontiers for technology M (dashed lines). The generalist's offer appears on two frontiers with the same average cost but with two distinct levels of WTP. As a single product firm, the generalist has a single average cost level (determined by its choice of quality d_G^*) and hence a single average cost position on the x-axis.

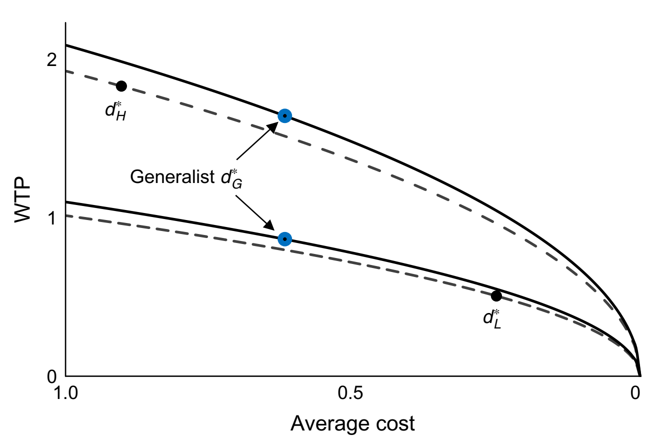
Because technology F involves fixed costs, the average cost in the frontier depends on the volume of output. In the figure, the average cost is calculated assuming that the firm using technology F is serving both segments for a total output of $2m$. The expression for average cost for a given quality d_i is then

$$AC_G^F = (1-f)d_i + f\frac{K}{2m}d_i,$$

and the average cost with technology M is just d_i. The assumption that $K < 2m$ implies that any given d_i—and hence any level of WTP—can be supplied at a lower cost using technology F. This is reflected in the outward shift in the frontiers relative to technology M.

Does the outward shift in frontiers mean that technology F inevitably dominates? Not necessarily: To get the scale economies the firm has to standardize its product. Thus, the generalist cannot choose its position independently across the two frontiers. As we saw in the expression for d_G^*, the optimal quality level for the generalist responds to the *average* ability to pay across the segments it is serving. In contrast, technology M supports specialist firms offering products tailored to each segment.

Figure 4 (Color online) The Value Frontiers for Technology M (Dashed Curves) and Technology F (Solid Curves) for a Low-End Segment with $a_L = 1$ and a High-End Segment with $a_H = 1.9$ for $f = 0.5$, $K = 1.4$, and $m = 1$



Our discussion of the Specialist equilibrium in Section 3 highlighted the important role of demand heterogeneity in our model. In this section, we see how the potential to leverage economies of scale can potentially overwhelm the effect of demand heterogeneity and desegment an industry. We now consider how these two factors interact to govern the boundary conditions for the existence of the different generic strategies.

4.3. Boundary Conditions

Thus far we have identified two distinct possible equilibria that can exist in the market: a Specialist equilibrium with a cost leader serving the low-end segment and a differentiator serving the high-end segment; and a Generalist equilibrium with a single generalist serving both market segments from a single position. We now consider the conditions under which these equilibria exist. Formally, we consider each of the two possible equilibria in turn and check whether any firm has a profitable deviation so that the equilibrium breaks down. This identifies boundary conditions for the Specialist and Generalist equilibria with respect to f and h. We then consider the implications for the uniqueness and multiplicity of the equilibria.

We start with the Specialist equilibrium. Define critical levels of demand heterogeneity h_S and of scalability f_S as follows:

$$h_S = \frac{1+\sqrt{1-(K/m-1)^2}}{K/m-1},$$

$$f_S = \frac{1}{2-K/m}\ \frac{(h-1)^2}{h^2+1}.$$

These thresholds mark the level of demand heterogeneity (h_S) above which the Specialist equilibrium always exists and the level of scalability (f_S) above which the Specialist equilibrium necessarily breaks down. Note that $K/m > 1$ implies that the critical value $h_S > 1$. We have the following characterization of existence:

Proposition 4.2. (i) *When demand heterogeneity is sufficiently high ($h \geq h_S$), a Specialist equilibrium exists regardless of the level of scalability f of technology F.* (ii) *For heterogeneity below the critical threshold ($h < h_S$), the Specialist equilibrium breaks down if and only if technology F is sufficiently scalable ($f > f_S$).* (iii) *The scalability threshold f_S is increasing in h and K/m.*

On the demand side, the Specialist equilibrium is associated with higher levels of demand heterogeneity (h). On the supply side, the Specialist equilibrium is associated with lower levels of scalability f and higher fixed costs relative to market size (K/m).

Turning now to the Generalist equilibrium, we again define a critical level of demand heterogeneity h_G:

$$h_G = \frac{1}{\sqrt{K/m}-1},$$

and a critical level of scalability f_G. The expression is more complicated than for the Specialist equilibrium:

$$\begin{aligned} f_G &= \max\{f_{G1}, f_{G2}\},\\ f_{G1} &= \frac{1}{2-K/m}\left(1-\frac{2}{h^2}-\frac{1}{h^2}\right),\\ f_{G2} &= \frac{1}{2(2-K/m)^2}\\ &\quad \big[(h+1)^2-2(2-K/m)(h-1)\\ &\quad -(h+1)\sqrt{(h+1)^2-4(h-1)(2-K/m)}\big]. \end{aligned}$$

The expression f_{G1} arises from the need to rule out a generalist preferring a deviation to a differentiation strategy using technology M. The expression f_{G2} arises from the need to rule out a firm profitably entering to compete with the generalist with a cost leadership strategy using technology M.

Proposition 4.3. (i) *When demand heterogeneity is sufficiently high ($h > h_G$), the Generalist equilibrium does not exist for any level of scalability f of technology F.* (ii) *For heterogeneity below the critical threshold ($h < h_G$), the Generalist equilibrium exists if and only if technology F is sufficiently scalable ($f \geq f_G$).* (iii) *The scalability threshold f_G is increasing in h and K/m.*

Proposition 4.3 has exactly the same structure as Proposition 4.2 except the effects are inverted. On the demand side, the Generalist equilibrium is associated with lower levels of demand heterogeneity (h). On the supply side, it is associated with higher levels of scalability f and lower fixed costs relative to market size (K/m).

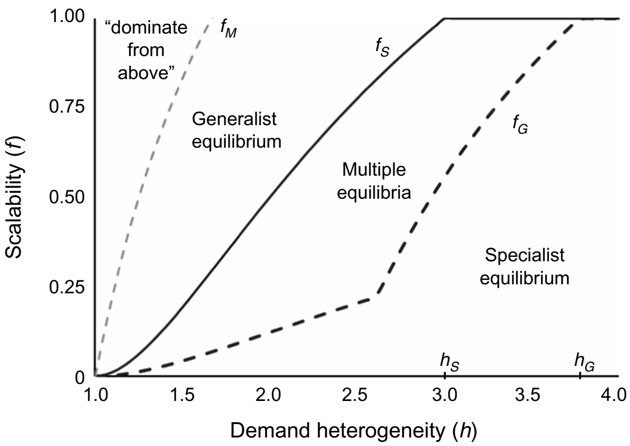
What about existence and multiplicity of these equilibria? Note that $h_G < h_S$ and hence the following corollary obtains.

Corollary 4.4. *For any level of demand heterogeneity for which the Generalist equilibrium can exist ($h < h_G$), there is a range of scalability where both the Specialist and Generalist equilibria exist ($f_G \leq f \leq f_S$). For all values of $h > 1$ and $f \in (0, 1)$ at least one of the two equilibria exists.*

Figure 5 illustrates our results on the equilibrium boundaries.

For sufficiently low levels of demand heterogeneity and sufficiently high levels of scalability, the Generalist equilibrium is unique. This occurs in the upper left-hand side of the figure where $f > f_S$. Conversely, for high levels of demand heterogeneity and low levels of scalability the Specialist equilibrium is unique.

Figure 5 Equilibrium Boundary Conditions for $K = 1.6$ and $m = 1$



This occurs in the lower-right-hand side of the figure where $f < f_G$. The kink in the f_G line occurs because of its two components.[10] Strikingly, we find considerable scope for multiplicity. In particular, whenever heterogeneity is low enough for the Generalist equilibrium to exist ($h < h_G$), there is a range of f where the Generalist and Specialist equilibria co-exist.

4.4. Generalists: Dominating from the Middle or Above?

In Figure 4 the generalist is positioned in the middle, with a quality level between that of a cost leader and a differentiator (i.e., $d_L^* < d_G^* < d_H^*$). The alternative possibility is that the generalist is positioned at a quality level that is above that of the differentiator (i.e., $d_G^* > d_H^*$). Because d_G^* is increasing in scalability f, whether d_G^* is below or above d_H^* depends on f. In particular, setting $d_G^* = d_H^*$ yields the following critical level of scalability:

$$f_M = \frac{1 - 1/h}{2 - K/m},$$

which is increasing in demand heterogeneity h.

Whether a generalist is located in the middle depends on the level of scalability of its technology. For lower levels of scalability ($f < f_M$), the generalist locates "in the middle" and offers a compromise product. For a sufficiently high level of scalability ($f > f_M$), its cost of increasing quality is so low that the generalist's optimal quality level exceeds that of a differentiator. An example of a generalist leveraging high fixed costs to target the mass of the market is Barnes & Noble book superstores, which offered higher performance (e.g., wider selection, knowledgeable staff, and in store cafe) than the differentiated independent booksellers that had dominated the high-end of the market prior to its entry.

Where is the dominate-from-above boundary relative to the equilibrium boundary conditions from Section 4.3? For the parameters in Figure 5, we see that the dominate-from-above threshold f_M is high, even greater than f_S. This ordering holds in general:

$$f_M - f_S = \frac{1}{2 - K/m} \frac{h^2 - 1}{h^3 + h} > 0.$$

Thus, the whole region with multiplicity has the generalist in the middle, as well as some of the region where the Generalist is the unique equilibrium. Hence we have established the following result:

Proposition 4.5. *A generalist can either "dominate from the middle" ($d_L^* < d_G^* < d_H^*$) or "dominate from above" ($d_G^* > d_H^* > d_L^*$) depending the level of scalability. The generalist dominates from above if and only if technology F is highly scalable such that $f > f_M$ where $f_M > f_S > f_G$. The region where the generalist dominates from above is shrinking in demand heterogeneity h.*

Note that the generalist never locates below the cost leader, and hence it is not possible in our model for the generalist to "dominate from below." The reason is that the generalist always has more incentive to invest in quality than does the cost leader. Specifically, the incentive to invest in quality depends on the average ability to pay across targeted market segments, which is higher for a generalist than a cost leader, relative to the cost of quality, which is lower for a generalist using technology F than for a specialist using technology M.

4.5. Link to Value-Based Strategy: Sunk Costs, Fixed Cost Allocations, and Sources of Multiplicity

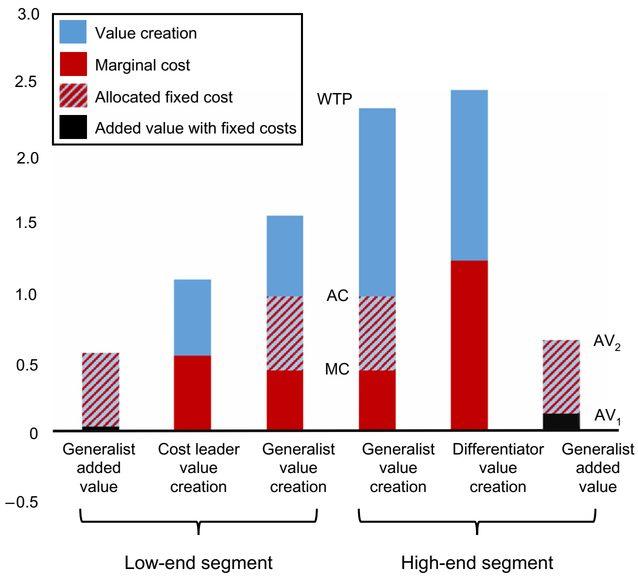
In this section we provide a value-based analysis of the generalist position. Specifically, we analyze the added value of a generalist that is competing with a cost leader and a differentiator, which allows us to clarify the determinants of equilibrium boundaries. The value analysis clarifies two distinct effects. The first is the impact of fixed costs on competitive advantage. The second is the critical role of the fact that these fixed costs are sunk in giving rise to multiple equilibria.

Formally, we consider when the generalist is able to profitably enter and disrupt the Specialist equilibrium (impact on f_S), as well as when the Generalist can deter entry by specialists (impact on f_G). As seen in Section 4.3, these give rise to distinct boundary conditions.

For specialists using technology M, the only relevant costs are marginal costs. In contrast, the generalist using technology F has both marginal costs $(1 - f)d_G^*$

[10] For lower values of h, the binding constraint is f_{G2} required to assure there is no profitable entry by a specialist. For higher values of h, the binding constraint is f_{G1} to assure that the generalist does not prefer to switch to a differentiation strategy.

Figure 6 **(Color online) Value-Based Analysis of Industry Competition with a Generalist, Cost Leader, and Differentiator with** $K = 1.6$, $f = 0.6$, $m = 1$, $a_H = 2.25$, $a_L = 1.5$ **and Hence a Moderate Level of Demand Heterogeneity** ($h = 1.5$)



and fixed costs fKd_G^*. Whereas marginal costs are, by definition, associated with serving individual consumers, fixed investments raise the question of cost allocation. Following the approach from the value frontier, we suppose the generalist spreads the fixed costs over $2m$ buyers. Then the average cost is

$$AC_G = (1-f)d_G^* + f\frac{K}{2m}d_G^*.$$

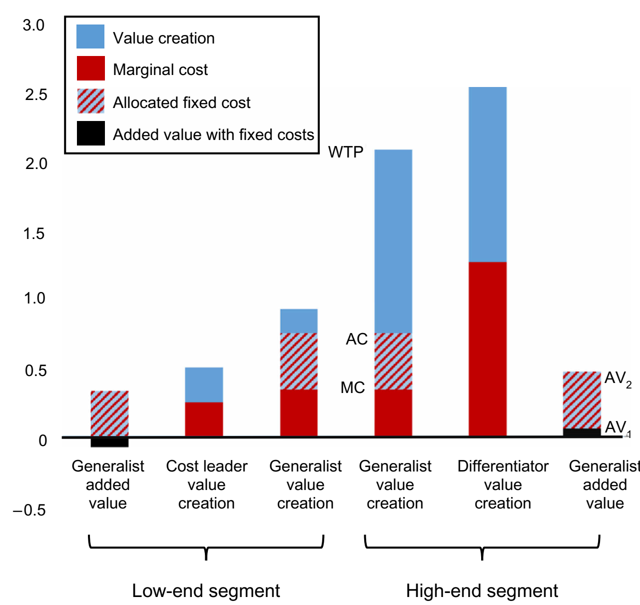
Figure 6 considers value-based competition among the three generic strategies for an intermediate level of heterogeneity ($h = 1.5$). The value bars for the specialists, as before, show marginal costs and WTP. The value bars for the generalist show its WTP as well as the average cost, which is the sum of the marginal costs (in red) and the allocated fixed costs (dashed). From Figure 5 (where $K = 1.6$ as well) we know there is a unique Generalist equilibrium for $h = 1.5$ when scalability is $f = 0.6$. Figure 6 clarifies why this is the case.

First, consider the Specialist equilibrium where the cost leader and differentiator are expected to enter. Can a generalist profitably enter and disrupt the equilibrium? The black bars show the added value of the generalist in each segment (AV_1) based on its average costs including both marginal and fixed costs. This is the right quantity given that the fixed costs are not yet incurred when the generalist decides whether to enter. Note that, for the parameters in Figure 6, added value is positive in both segments, and hence the total added value is positive as well. Consequently, the Generalist can profitably enter and, as such, the Specialist equilibrium is not supportable. (Later in this section we will come back to the fact that the generalist's added value is greater in the high end than the low end.)

Now consider the decision by a specialist to enter to disrupt the Generalist equilibrium. Do either of the specialists have added value if the generalist is expected to enter? When price competition occurs, the generalist should optimally treat its fixed investment in quality as sunk, and hence its pricing will be given by its marginal costs. In this case, the relevant added value of the generalist is the higher quantity AV_2, which is given by AV_1 (in black) plus AC_G (hashed). This illustrates the general result that it is easier to sustain the Generalist equilibrium than it is to disrupt the Specialist equilibrium, which we now see to be clearly linked to the impact of sunk costs.

Now consider what happens with an increase in demand heterogeneity. Figure 7 shows the case of a shift to $h = 2.25$. From Figure 5, we know that for these parameters, there are multiple equilibria. When including the allocated fixed costs, the generalist has a loss (negative added value AV_1) in the low-end segment that exceeds its profits in the high-end segment. Hence, because a generalist would not enter if it expects the specialists to enter as well, the Specialist equilibrium now exists. Conversely, now suppose the generalist is expected to enter. Then the relevant added value for the specialists is AV_2, which does not include the allocated costs. In this case, the added value of the generalist is still strongly positive in each segment and hence the Generalist equilibrium exists as well. This highlights that expectations and

Figure 7 **(Color online) Value-Based Analysis of Industry Competition with a Generalist, Cost Leader, and Differentiator with** $K = 1.6$, $f = 0.6$, $m = 1$, $a_H = 2.25$, $a_L = 1$ **and Hence a High Level of Demand Heterogeneity** ($h = 2.25$)



path dependence can sometimes be important determinants of whether specialists or generalists will be observed in an industry.

To formally characterize the importance of sunk costs, suppose the generalist was to price based on its average costs. That is, suppose the generalist is unwilling to reduce price in a given segment below AC_G in the face of competition. This makes the generalist less aggressive and hence will increase the profitability of entry by specialists, shrinking the region in which the Generalist equilibrium exits. How is the existence of the Generalist equilibrium impacted by the allocation of sunk costs? We now have the following critical levels of heterogeneity and scalability:

$$h'_G = 1 + 2\sqrt{1 - K/(2m)},$$
$$f'_G = \frac{1}{2}\frac{(h-1)^2}{2 - K/m}.$$

Proposition 4.6. *Suppose the generalist competes on average costs rather than marginal costs.* (i) *For heterogeneity below the critical threshold ($h < h'_G$), the Generalist equilibrium exists if and only if technology F is sufficiently scalable ($f \geq f'_G$).* (ii) *These conditions are more restrictive than those for the Specialist equilibrium: $h'_G < h_S$ and $f'_G > f_S$. For $h > 2$, it is even the case that $f'_G > f_M$.*

We find that sunk costs and cost allocations have a substantial impact on outcomes. The Generalist equilibrium ceases to exist in the entire region where there had been multiplicity (between f_G and f_S). Recall that the value f_S is where the Specialist equilibrium breaks down precisely because the generalist can cover its fixed costs and hence its entry becomes profitable. If the generalist is pricing to cover its fixed costs (even though they are sunk) then this will also allow specialists to enter up to this same level, and the difference between the two conditions is eliminated. The result clarifies that the existence of multiplicity in the model arises precisely from the fact that once the generalist enters, it competes based on its marginal costs and this intense rivalry deters further entry; however, when the generalist is considering entry to disrupt the Specialist equilibrium, the fixed investments are not sunk and do factor into its decision.

Interestingly, conditions for the existence of the Generalist equilibrium shift up even beyond f_S; and for $h < 2$, the conditions shift even beyond f_M. This is due to the uniform allocation of the fixed costs implicit in the formula for AC_G. In Figures 6 and 7, note that the allocated fixed costs are the same for both market segments, even though it is WTP in the high-end segment that is benefiting more from the increases in quality. As a result, the profits in the low end are smaller than those in the high end, which provides extra scope for entry by the cost leader. In Figure 7 the added value of the generalist after the allocated fixed costs AV_1 is negative, which means that the added value of the cost leader is positive and entry is profitable. Hence, this example illustrates a case where the Specialist equilibrium breaks down with a generalist that enters based on a positive total added value across both segments, but where the Generalist equilibrium would break down with pricing based on a uniform allocation of fixed costs.

Our model connects to the managerial accounting field where the allocation of fixed costs is a central concern. The approach of activity-based costing highlights the dangers of arbitrary allocations of fixed costs to businesses (e.g., Cooper and Kaplan 1991). One danger is that these allocations can make a business look unprofitable even though eliminating that business would not actually reduce fixed costs, and hence would actually lower total profits. Our model can capture this tension: With a level of $h = 2.2$, if a generalist is competing with specialists, the profits of the generalist are 0.09 in the high end and -0.06 in the low end, for a net positive. However, if the firm were to exit the low end (because of the negative accounting profit in the segment), all of the fixed costs would fall on the high end and the total profit would become strongly negative.[11]

5. Performance Implications

We now consider the implications of our theory for firm performance. We are interested in the impact of demand heterogeneity and scalability on the profits of individual firms, as well as on the overall industry attractiveness. There are two effects: shifts in profits within a given strategy equilibrium, and a possible shift in the equilibrium regime.

In a Specialist equilibrium, it is straightforward to show that the profit of the differentiator in the high-end segment is

$$\Pi_H = \frac{m}{4}(a_H - a_L)^2.$$

Differentiator profits are increasing in the size of the high-end segment m and the difference in the taste for quality across the two segments, because this reduces rivalry as the firms position farther apart.

For the cost leader, the profits in the low end depend on whether the differentiator creates value in the low end, and hence on whether $h \leq 2$:

$$\Pi_L = \begin{cases} \dfrac{m}{4}(a_H - a_L)^2 & \text{if } h \leq 2, \\ \dfrac{m}{4}a_L^2 & \text{otherwise.} \end{cases}$$

[11] Note that this activity-based costing example is the one place in the paper where we have deviated from an equilibrium perspective in that the generalist and specialists do not coexist in the market in the equilibrium of our model.

When demand heterogeneity is below the critical threshold, the differentiator's offer creates (inferior) value in the low-end segment, and therefore the cost leader's profits are determined by its relative value creation. Profits then depend on the difference in the taste for quality across the two segments, with a greater difference reducing rivalry and increasing profits. As such, somewhat counterintuitively, the cost leader's profits are actually falling in a_L, the taste for quality in the low-end segment. In contrast, when the high-end segment's taste for quality is sufficiently above that of the low-end segment, positioning to optimally serve the high-end segment results in the differentiator's cost of delivering quality level d_H^* exceeding the low-end segment's WTP. At this level of quality, the differentiator creates no value in the low end, and the cost leader's profits are its absolute level of value creation, which is increasing in a_L.

We define industry profits in the Specialist equilibrium as $\Pi_S = \Pi_L + \Pi_H$. For the Generalist equilibrium, profits are

$$\Pi_G = \frac{m}{4}\frac{(a_H + a_L)^2}{2(1-f) + fK/m},$$

which is the same as the industry profits as there is only one active firm in this case.

Proposition 5.1. *With either the Specialist or Generalist equilibrium we have the following comparative statics*: (i) *increases in the taste for quality in the high-end segment* (a_H) *increase the profit of the generalist*, *differentiator*, *and cost leader*; (ii) *increases in the taste for quality in the low-end segment* (a_L) *increase the profit of the generalist*, *decrease the profits of the differentiator, and have a nonmonotonic effect on the profits of the cost leader*; (iii) *increases in scalability* (f) *increase the profits of the generalist and do not impact the profits of the specialists*.

Figures 8–10 plots firm and industry profits for the Specialist and Generalist equilibria. We continue to focus on the parameters of $K = 1.6$, $m = 1$.

Figure 8 shows how the profits vary with scalability (f) when $a_H = 2$ and $a_L = 1$. Note that between $f_S = 0.14$ and $f_G = 0.5$ both equilibria exist. In the region of multiplicity, generalist profits (Π_G) are represented with a dashed line. Industry profits are significantly lower in the Specialist equilibrium due to impact of rivalry. Because the specialists use technology M, their profits are unaffected by changes in f.

Figures 9 and 10 consider the effect of changes in demand heterogeneity through shifts in a_L and a_H respectively when $f = 0.3$. For graphical simplicity, we show the specialist profits whenever that equilibrium exists, and the generalist values are shown when that equilibrium is unique.

In Figure 9, we take $a_L = 1$ and show the impact of increasing a_H from 1 to 2.5. At first, heterogeneity is sufficiently low that only the Generalist equilibrium exists. As a_H initially increases, the generalist's profits rise with the taste for quality in the high-end segment. Eventually ($a_H = 1.67$) heterogeneity is great enough that the scale advantage of technology F can be challenged by specialists using technology M such that the uniqueness of the Generalist equilibrium breaks down. As a_H further increases to $h = 2$ profits increase for both the differentiator (who benefits from increasing taste for quality in the high end) as well as for the cost leader (who benefits from the decreasing competitiveness of the differentiator's offer in the low end). As a_H further increases to drive heterogeneity beyond the $h = 2$ threshold, the differentiator's profits continue to increase with rising WTP in the high end. Because the differentiator ceases to create value for the low end beyond this threshold, the cost leader's profits reach a permanent plateau. It is this divergence

Figure 8 Impact of Scalability on the Profits of a Generalist, Cost Leader, and Differentiator when $K = 1.6$, $m = 1$, $a_L = 1$, and $a_H = 2$

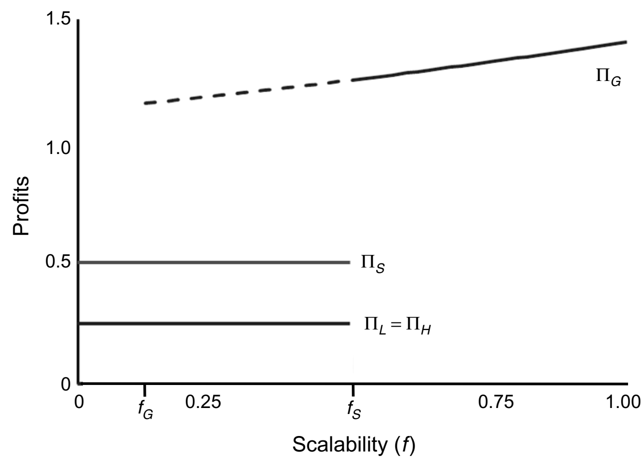


Figure 9 Impact of a_H on the Profits of a Generalist, Cost Leader, and Differentiator When $K = 1.6$, $m = 1$, and $a_L = 1$

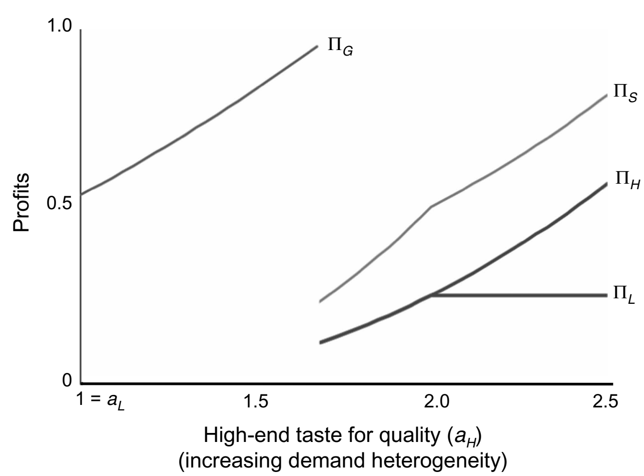
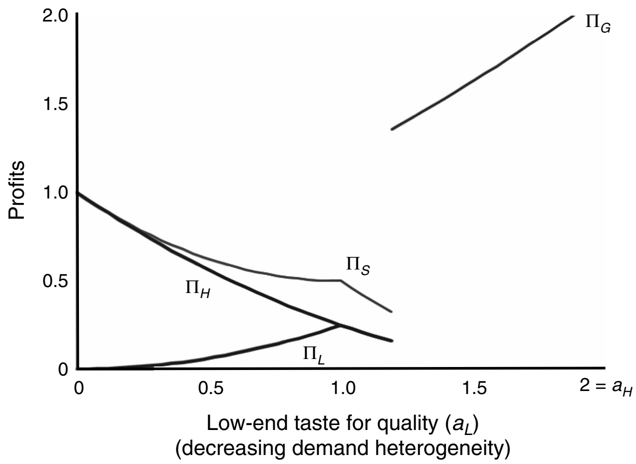


Figure 10 **Impact of a_L on the Profits of a Generalist, Cost Leader, and Differentiator When $K = 1.6$, $m = 1$, and $a_H = 2$**



in profit trajectories that gives rise to the kink in total industry profits at $h = 2$.

In Figure 10, we set $a_H = 2$ and show the impact of increasing a_L from 0 to 2 so that heterogeneity is falling along the x-axis. Here the specialists initially experience opposing profit shifts: The cost leader benefits from increased taste for quality in the low end. The differentiator suffers as the increasing quality of the cost leader's offer reduces the differentiator's added value in the high end. At the industry level, total profits decrease as the increased profit of the cost leader is more than offset by the fall in profit of the differentiator. When a_L increases past 1, demand heterogeneity crosses the critical threshold ($h = 2$) such that the differentiator's offer begins to create value in the low end. From here, the cost leader's profits decrease with further increases in a_L, which corresponds to the nonmonotonicity in part (ii) of Proposition 5.1. With further increases in a_L, demand heterogeneity falls to the point that the Specialist equilibrium breaks down and the Generalist equilibrium becomes the unique outcome. For the generalist, increases in a_L have an unambiguously positive effect on profits.

5.1. The Impact of Equilibrium Shifts on Value Creation and Value Capture

For the parameters used in Figures 8–10, the breakdown of the Specialist equilibrium and the shift to the Generalist equilibrium leads to an increase in industry profits. We now consider whether this is true in general. In addition, we consider the impact of a shift of equilibrium on social welfare.

Social welfare is the total value creation. For the Specialist equilibrium this is

$$V_S = \frac{m}{4}(a_H^2 + a_L^2),$$

which is greater than industry profits as competition allows consumers to capture some surplus.[12] For the Generalist equilibrium, there is no competition, and hence the firm captures all of the value creation and $V_G = \Pi_G$.

Note that $V_G = \Pi_G$ is increasing in f, while V_S and Π_S are independent of f. Define the critical value f_V such that the Generalist equilibrium has higher value creation for $f > f_V$. Similarly define f_Π such that the Generalist equilibrium has higher industry value capture for $f > f_\Pi$. We have the following strict ordering of critical values:

Proposition 5.2. *The critical scalability thresholds have the following ordering $f_V = f_S > f_G > f_\Pi$.*

Consider a shift of equilibrium in the region of multiplicity where $f_S \geq f \geq f_G$. Note that unless this happens at $f = f_S$ the emergence of a generalist reduces total value creation because the two specialists create more total value. Since $f_G > f_\Pi$, industry profit always increases with the shift from specialists to generalists due to the strong impact of eliminating competition. In summary, in the region $f_S > f > f_G$ society is better off with specialists but profits are higher with a generalist. Once $f > f_S$, then not only are profits higher with the generalist, but total value creation is higher as well due to the greater scale economies of the generalist.

6. Extension: Asymmetric Market Sizes

We now relax the simplifying assumption that the high- and low-end segments are the same size. One objective is to verify the robustness of the key results. The other is to explicitly understand the impact of segment sizes on the choice of competitive positions.

Let $m_L > 0$ be the number of consumers in the low-end segment and $m_H > 0$ be the number of consumers in the high-end segment. Hence the total market size is $m_H + m_L$ rather than the $2m$ in the base model. To assure that there is a nontrivial choice of technology, we assume that $\max(m_H, m_L) < K < m_H + m_L$, which is a generalization of the analogous condition in the base model that $m < K < 2m$. All other elements of the model are as before.

It is straightforward to show that Lemma 2.1 generalizes to the case of asymmetric market sizes so that firm profits are still proportional to added value.

[12] Although our model does not give consumers bargaining power, they still capture value when there is competition. The expression for V_S is derived from $V_S = m(a_L\sqrt{d_L^*} - d_L^*) + m(a_H\sqrt{d_H^*} - d_H^*)$, the willingness to pay in each segment less the marginal production cost times the number of consumers in each segment.

6.1. Optimal Positions

Consider the optimal positioning of specialists and generalists. The optimal position of specialists using technology M does not depend on segment sizes. Hence, the expressions d_L^* and d_H^* are unchanged. The optimal position of a generalist targeting both segments using technology F does depend on segment sizes. The earlier expression for d_G^* generalizes to

$$\hat{d}_G^* = \frac{1}{4}\left(\frac{m_L}{m_L+m_H}a_L + \frac{m_H}{m_L+m_H}a_H\right)^2 \cdot \left(\frac{1}{1-f+fK/(m_L+m_H)}\right)^2.$$

The earlier term $K/(2m)$ in d_G^* becomes $K/(m_L+m_H)$ and what matters is still K relative the total market size. Before, d_G^* depended on the average of a_L and a_H, the position $\hat{d}_G^*$ now depends on the average ability to pay weighted by segment size.

The generalist chooses a middle position between the cost leader and differentiator as long as $\hat{d}_G^* < d_H^*$, which is equivalent to the condition $f < \hat{f}_M$ where

$$\hat{f}_M = \frac{m_L(1-1/h)}{m_L+m_H-K}.$$

Thus, whether the generalist is positioned in the middle now depends in part on the relative segment sizes. The more customers in the low-end segment, the more likely is the generalist to locate in the middle (i.e., $\partial \hat{f}_M/\partial m_L > 0$); while the more customers in the high-end segment, the more likely the generalist is to position above the differentiator (i.e., $\partial \hat{f}_M/\partial m_H < 0$).

6.2. Boundary Conditions

We now show that the key results of the paper in Propositions 4.1–4.3 generalize to the case of asymmetric segment sizes. For the Specialist equilibrium, the critical thresholds governing existence generalize nicely to

$$\hat{f}_S = \frac{(h-1)^2}{(1/m_H+(1/m_L)h^2)(m_H+m_L-K)}$$

and

$$\hat{h}_S = \frac{m_L}{K-m_H}\left(1+\sqrt{1-(K/m_L-1)(K/m_H-1)}\right),$$

while the analogous expressions for the Generalist equilibrium are considerably more complex.[13]

[13] As in the base model, the boundary conditions for the Generalist equilibrium arises from ruling out a profitable deviation by the generalist to just focus on the high-end segment and a profitable deviation by an inactive firm to enter the high-end segment. Not only do these expressions become more complicated with asymmetric market sizes, but there is an additional possibly binding constraint arising from the need to rule out entry by an inactive firm in the low-end segment. See proof for details.

Proposition 6.1. *Suppose the market segments vary in size.*

(i) *There are at most two possible equilibria—a Specialist equilibrium where there is a cost leader at d_L^* and a differentiator at d_H^*, both using technology M; and a Generalist equilibrium with a single firm at $\hat{d}_G^*$ serving both segments using technology F.*

(ii) *A Specialist equilibrium exists unless heterogeneity h is below a critical threshold $\hat{h}_S$ and the scalability of technology F is greater than a critical level $\hat{f}_S$ that is increasing in h and K/m. It holds that $\hat{f}_S < \hat{f}_M$.*

(iii) *The Generalist equilibrium exists if heterogeneity is below a critical threshold and the scalability of technology F is greater than a critical level $\hat{f}_G$, where $\hat{f}_G < \hat{f}_S$.*

To explore how relative segment sizes impact the use of specialist and generalist strategies, we focus on the expression for $\hat{f}_S$ as it is much more tractable that $\hat{f}_G$. We shift the relative size of the high-end segment while keeping the total number of buyers fixed at T.

Corollary 6.2. *Suppose the total market size is fixed so that $m_H+m_L=T$. If $m_L > hm_H$ so that the low-end segment is sufficiently larger than the high-end segment, then the upper-bound on the existence of the Specialist equilibrium $\hat{f}_S$ is increasing in m_H. If $m_L < hm_H$, then $\hat{f}_S$ is decreasing in m_H.*

There are two forces at play. On the one hand, an increase in the size of the high-end segment increases the average WTP for quality in the market, and hence increases the relative value creation of the generalist strategy because technology F gives the generalist a lower cost of supplying quality. On the other hand, when the low-end segment is larger than the high end segment ($m_H < m_L$), then an increase in m_H increases the effective heterogeneity in the market, which benefits the use of specialist strategies. Recall that $h = a_H/a_L$, the parameter of heterogeneity, is always greater than one. When the low-end segment is sufficiently large (i.e., $hm_H < m_L$), then the second effect dominates. Otherwise, an increase in the size of the high-end segment favors the use of technology F and undercuts the existence of the Specialist equilibrium.

It is straightforward to generalize the value bar analysis from Sections 3.4 and 4.5. One should just make the width of the value bars for each segment proportional to the segment size. Then the value creation and added value quantities are represented by areas rather than by the heights.

7. Discussion

We revisit the classic debate regarding the relative attractiveness of specialist and generalist strategies.

We ground these strategies in explicit cost-quality positions, which allows us to connect them to Porter's influential but incomplete ideas around generic strategies and the "stuck-in-the-middle" claim. We formally model how positioning choices depend on the nature of the available technologies and on the heterogeneity of consumer market segments. We take a value-based approach by mapping cost-quality positions onto value frontiers that explicitly incorporate the willingness-to-pay of consumer segments.

Endogenous segmentation plays a central role in our theory of positioning. We characterize whether the underlying consumer segments give rise to distinct specialist positions that segment the market, or whether a generalist is able to serve multiple customer types, thus de-segmenting the market. Thus, our theory elucidates whether demand heterogeneity manifests itself in strategic heterogeneity.

We focus on the interaction between the extent of demand heterogeneity and the extent of economies of scale in the available production technologies. While greater demand heterogeneity favors specialists tailoring their offers to individual segments, greater economies of scale favor generalists who are aggregating demand across segments at the expense of a less tailored offering.

We use our model to identify the optimal positions for competitors along the cost-quality productivity frontier, and show how they translate to positions along the cost-WTP value frontier. With this approach we identify the boundary condition under which a generalist is able to outcompete specialists optimally positioned as a cost leader and a differentiator. We characterize how demand heterogeneity and technology scalability affect not only optimal positioning, but also firm and industry level profitability. Further, we show how positioning choices link to the value-bar framework that is increasingly common in strategy teaching. We formalize this relationship, and show how different production technologies, and different cost allocation choices, affect the representation, logic, and outcomes of competitive interactions.

Our analysis shows the usefulness of equilibrium thinking for strategy research when one needs to identify contingency logics. We show how the validity of Porter's stuck-in-the-middle claim need not be a matter of truth or falsehood, but rather a matter of boundary conditions. Indeed, we accommodate both the stuck-in-the-middle and dominate-from-the-middle outcomes within a single logically coherent framework.

By explicitly incorporating firm technology choice, our analytic framework not only speaks to positioning choices but also to whether and how new technologies impact a market. A prominent question in technology strategy is whether or not a particular new technology will disrupt the existing positions of incumbent firms in an industry (e.g., Christensen 1997). For example, there was considerable debate about the impact of massive open online course (MOOC) technology on competitive outcomes in different segments of the higher education industry, with many analysts captivated by the scalability of online learning (e.g., Friedman 2013). In general, digital technologies tend to increase scalability (f in our model) by reducing the importance of variable costs relative to fixed costs. Our analysis confirms the importance of the scalability of new technologies whether they are MOOCs, recorded entertainment, or chain restaurants. At the same time, subsequent discussions of online education highlight that variable costs (c_i), such as for the employment of course moderators and teaching assistants, are also important for high quality solutions. That is, online education has turned out to have greater requirements on variable costs (i.e., lower f) and greater relative effectiveness of variable inputs (i.e., higher K) than the values suggested by early advocates. Our analysis of boundary conditions (cf. Figure 5) shows that sufficiently high demand heterogeneity (h) can deter the adoption of a scalable technology. Thus, our model further suggests that assessments of the impact of online education need to also consider the heterogeneity in the demand for education and what is lost in aggregating the different segments into massive courses.

8. Conclusion

This study provides foundations for a comprehensive approach to competitive positioning that combines technology choice and consumer segmentation with value creation and competition. Integrating these elements is necessary if the field is to develop a deeper understanding of positioning, which lies at the heart of competitive strategy. There is ample potential for further theoretical development building from this general structure.

On the technology side, it would be interesting to consider more than two possible technologies. For example, one could extend our model to allow for a set of n possible technologies each with its own value of (f, K). This would relax the assumption that specialists only have a pure marginal cost technology. It could also be interesting to add entry costs that vary across technologies. It could be fruitful as well to extend the analysis to multiproduct firms. The general questions would remain, namely which technologies would deliver competitive advantage in equilibrium, and how technology adoption maps to consumer segments.

On the demand side, extending the analysis to consider more than two segments would move the analysis beyond the simple cost leader/differentiator dichotomy and open up a richer set of specialist strategies. This would also allow for partial desegmentation of the market by one or more generalists, which would then face competition in equilibrium. Finally, one could extend the model to allow for horizontal differentiation to create an even richer value landscape on which firms can position.

In addition to generalizing the current analysis, we note some additional areas for exploration. While our analysis focuses on fixed investments in differentiation, one could also consider interactions between demand heterogeneity and investments in cost reduction (cf. Adner and Levinthal 2001, Stuart 2016). Finally, it is important to better link value-based positioning to the internal firm activities that underlie the external market positions (e.g., Porter 1996; Siggelkow 2001, 2002). In particular, there is a need to understand explicitly how the cost-quality trade-off in the configuration of each activity, especially in multiproduct settings, gives rise to the overall positioning of the firm.

Our goal in this paper has been to help develop a strategy-based perspective on positioning that goes beyond traditional IO models of competition. To do this we have focused our theorizing on the distinct questions and constructs that arise in strategy research and teaching. Given the richness of the phenomena of interest, there is great scope for further structured analysis, which would serve to strengthen the strategy field.

Acknowledgments
The authors thank the seminar audiences at Fuqua and Wharton as well as the reviewers and the Editor for valuable comments.

Appendix

Proof of Lemma 2.1. Let $v_{ij} = w_{ij} - c_i$ be the marginal value created if firm i serves a customer in segment j. The value created with all firms and all customers is then

$$V(N) = m\max_i v_{iL} + m\max_i v_{iH},$$

while the value created without firm i is

$$V(N\backslash i) = m\max_{k\neq i} v_{kL} + m\max_{k\neq i} v_{kH}.$$

Let $I_{ij} = 1$ if firm i increases value creation in segment j (i.e., $v_{iL} > \max_{k\neq i} v_{jL}$) and $I_{ij} = 0$ otherwise. The added value of firm i is then the increase in marginal value creation made possible in each segment:

$$V(N) - V(N\backslash i) = mI_{iL}\Big(v_{iL} - \max_{k\neq i} v_{kL}\Big) + mI_{iH}\Big(v_{iH} - \max_{k\neq i} v_{kH}\Big).$$

We now characterize firm profits under Bertrand price competition in each segment. Let p_{ij} be the price of firm i in segment j. Buyers purchase from the firm that gives them the maximum consumer surplus defined as $w_{ij} - p_{ij}$. Firms that the customer does not choose in equilibrium, are willing to price at their marginal cost $p_{ij} = c_i$ and thus are willing to offer customers a surplus of v_{ij}. Hence, the firm that does serve the segment has to give at least this much surplus to the customer. In equilibrium, this implies that if firm i serves the segment, its price satisfies

$$w_{ij} - p_{ij} = \max_{k\neq i} v_{kj}$$

and hence the profit is given by

$$\begin{aligned}\Pi_i &= mI_{iL}(p_{iL} - c_i) + mI_{iH}(p_{iH} - c_i) - F_i\\ &= mI_{iL}\Big(v_{iL} - \max_{k\neq i} v_{kL}\Big) + mI_{iH}\Big(v_{iH} - \max_{k\neq i} v_{kH}\Big) - F_i\\ &= V(N) - V(N\backslash i) - F_i. \quad \square\end{aligned}$$

Proof of Proposition 3.1. Firm profits are given by Π_i from Lemma 2.1. Note that at most one firm can have added value in a segment. Hence with two segments there can be at most two firms that profitably enter.

We start by showing that two firms entering, one at d_L^* and one at d_H^*, is a subgame perfect equilibrium. The value creation terms $v_{ij} = w_{ij} - c_i = a_j d_i^{1/2} - d_i$ are convex functions with a single peak at the maximum d_j^*. Given that d_L^* is the position that maximizes value creation for the low-end customers, while d_H^* does not, the firm positioned at d_L^* has value added for the low-end segment and $\Pi_L > 0$. Similarly, the firm at d_H^* has added value for buyers in the high-end segment and hence $\Pi_H > 0$. Moreover, a third firm cannot enter and have added value for either segment. Hence, two firms at d_L^* and d_H^* constitutes an equilibrium.

We now establish that there is no other possible equilibrium. This would require that there is a firm that enters with a position $\hat{d}$ not equal to d_L^* and d_H^* and has positive profits, which implies that either d_L^* and d_H^* is unoccupied. However, there would then be a profitable deviation from the equilibrium involving a firm entering at either d_L^* or d_H^*. This contradicts the claim that the position $\hat{d}$ is selected in equilibrium. $\square$

Proof of Proposition 4.1. Recall from Lemma 2.1 that firm profits are given by

$$\Pi_i = mI_{iL}\Big(v_{iL} - \max_{k\neq i} v_{kL}\Big) + mI_{iH}\Big(v_{iH} - \max_{k\neq i} v_{kH}\Big) - F_i. \quad (1)$$

If firm i enters it must expect to either serve both segments ($I_{iL} = I_{iH} = 1$) or one segment ($I_{iL} = 1 - I_{iH}$).

Suppose a firm expects to serve one of the two segments with a quality d_i. Then it will choose the technology that minimizes its costs as willingness to pay in the segment $w_{ij} = a_j d_i$ is determined by d_i not the choice of technology. Its costs if it uses technology M are md_i, while if it uses technology F, costs are $m(1-f)d_i + fKd_i$. Because $m < K$, technology M always has a lower cost for a firm that expects to serve one segment. Hence the firm must optimally use technology M and its optimal position is then $d_i = d_L^*$ if it expects to serve the low-end segment, and $d_i = d_H^*$ if it expects to serve the high-end segment.

If a firm expects to serve both segments with a quality d_i then the cost of using technology M is $2md_i$, and the cost to using technology F is $2m(1-f)d_i + fKd_i$. Because $2m > K$, technology F always has a lower cost. The optimal position is then $d_i = d_G^*$.

At most two firms can enter and have positive profits given that there are only two segments. If two firms enter in equilibrium, they must then each choose technology M and target different segments. We define this as a Specialist equilibrium. If one firm enters, it must choose technology F and target both segments. We define this as a Generalist equilibrium. □

Proof of Proposition 4.2. We consider the conditions under which a Specialist equilibrium exits such firm $i = 1$ enters as a cost leader with $d_1 = d_L^*$, firm $i = 2$ enters as a differentiator with $d_2 = d_H^*$, and the remaining firm $i = 3$ stays out of the industry. From the proof of Proposition 4.1, we know that the cost leader and differentiator are using technology M.

Equilibrium existence requires that no firm has a profitable deviation. In particular, the two specialized firms (i) must have positive profits so that they prefer entry to staying out; (ii) cannot increase profits by shifting to another quality level using technology M; and (iii) cannot increase profits by using technology F. In addition, we need the third firm to be willing to stay out, which means that it cannot have positive profits by (iv) entering with technology M or (v) entering with technology F.

Consider first the profits of the specialized firms in equilibrium. The profits of Firm 2, which is pursuing a strategy of differentiation at d_H^* are given by taking the general expression for firm profit (1) with $I_{2L} = 0$, $I_{2H} = 1$ and $F_2 = 0$. For the high-end segment, the value creation for the Differentiator is $v_{2H} = a_H\sqrt{d_H^*} - d_H^* = a_H^2/4$; value creation for the Cost Leader is $v_{1H} = a_H\sqrt{d_L^*} - d_L^* = a_L(2a_H - a_L)/4$; and value creation for the third firm is $v_{3H} = 0$ as it is out of the market. This yields the following equilibrium profit for the differentiator:

$$\Pi_H^* = m\frac{(a_H - a_L)^2}{4}$$

Now consider the profits of the cost leader, for whom $I_{1L} = 1$, $I_{1H} = 0$, $F_1 = 0$ and $v_{1L} = a_L\sqrt{d_L^*} - d_L^* = a_L^2/4$. The marginal value creation of the differentiator for a low-end customer is $v_{2L} = a_L\sqrt{d_H^*} - d_H^* = a_H(2a_L - a_H)/4$, which is positive only if $a_H < 2a_L$. Hence, equilibrium profits for the cost leader are

$$\Pi_L^* = \begin{cases} m(a_H - a_L)^2/4 & \text{if } a_H \le 2a_L, \\ ma_L^2/4 & \text{otherwise.} \end{cases}$$

Note that $\Pi_H^* > 0$ and $\Pi_L^* > 0$, and hence equilibrium condition (i) is always satisfied. Moreover, as shown in Proposition 3.1 by construction d_L^* and d_H^* are the profit maximizing positions for each using technology M given the position of the other firm. Hence, condition (ii) always holds. Finally, Firm 3 cannot profitably enter using technology M given that d_L^* and d_H^* are already occupied, satisfying condition (iv).

The remaining conditions (iii) and (v) involve one of the firms using technology F. From Proposition 4.1, it must be that the firm deviating to technology F expects to serve both segments ($I_{iL} = I_{iH} = 1$), and hence must optimally set $d_i = d_G^*$. Let Π_G^* be the profit of a firm using technology F at position d_G^* if it faces no competition. Then

$$\begin{aligned}\Pi_G^* &= m\big(a_H\sqrt{d_G^*} - d_G^*\big) + m\big(a_L\sqrt{d_G^*} - d_G^*\big) - (1-f)2md_G^* - fKd_G^* \\ &= \frac{m}{4}\frac{(a_H + a_L)^2}{2(1-f) + fK/m}\end{aligned}$$

The profit of a deviating firm is then given by Π_G^* less the maximum value creation in each segment of firms using technology M.

Condition (v), that there is no profitable entry using technology F for Firm 3, requires that

$$\Pi_G^* - \frac{m}{4}a_L^2 - \frac{m}{4}a_H^2 \le 0 \tag{2}$$

as $v_{1L} = a_L^2/4$ and $v_{2H} = a_H^2/4$. Condition (iii), for the differentiator not switching to technology F, requires that

$$\Pi_G^* - \frac{m}{4}a_L^2 - \frac{m}{4}a_L(2a_H - a_L) \le \Pi_H^* \tag{3}$$

as $v_{1L} = a_L^2/4$ and $v_{1H} = a_L(2a_H - a_L)/4$. Substituting for Π_H^* and simplifying, one obtains that condition (3) is equivalent to condition (2).

Condition (iii), for the cost leader not switching to technology F, depends on h. If $h \ge 2$, then the differentiator does not create value in the low end and the condition is

$$\Pi_G^* - \frac{m}{4}a_H^2 \le \Pi_L^*, \tag{4}$$

which is equivalent to condition (2) as $\Pi_L^* = (m/4)a_L^2$ for $h \ge 2$. If $h < 2$ then

$$\Pi_G^* - \frac{m}{4}a_H(2a_L - a_H) - \frac{m}{4}a_H^2 \le \Pi_L^* \tag{5}$$

and substituting $\Pi_L^* = (m/4)(a_H - a_L)^2$ as $h < 2$ one obtains that condition (5) is also equivalent to (2).

We conclude that condition (2) is necessary and sufficient for the existence of the Specialist equilibrium. We can rewrite (2) as

$$f \le \frac{1}{2 - K/m}\,\frac{(h-1)^2}{h^2 + 1} = f_S.$$

Note that f_S is increasing in h and equal to 1 for $h = h_S$. □

Proof of Proposition 4.3. We consider the conditions under which a Generalist equilibrium exists such that firm $i = 1$ enters as a generalist using technology F with $d_1 = d_G^*$ and the other two firms stay out.

Equilibrium existence requires that no firm has a profitable deviation. Consider first the generalist. By definition of d_G^*, it is not possible to have higher profits at another position using technology F. Suppose that Firm 1 uses technology M instead with some position $d > 0$. Suppose that position d creates value in both segments. However, by definition, technology F has a lower cost when serving both segments for any given d. Hence, Firm 1's deviation cannot be profitable. As a result, the only way for a deviation to technology M can be profitable is if the firm only serves one market segment; this can only occur when the firm targets the high end. (When targeting the low end, the firm always creates value in the high end and hence would be serving two segments.) When targeting the high end with technology M, the optimal position is d_H^*. Note that it must then be that $h > 2$ as otherwise the firm would create value in the low end as well. The deviation is not profitable under the following condition

$$\Pi_G^* \geq \frac{m}{4} a_H^2,$$

which with some manipulation can be shown to be equivalent to

$$f \geq f_{G1} = \frac{1}{2 - K/m}\left(1 - \frac{2}{h^2} - \frac{1}{h^2}\right).$$

Note that f_{G1} is increasing in h and $f_{G1} \geq 0$ if and only if $h \geq 1 + \sqrt{2}$.

Consider now the firms that stay out in the Generalist equilibrium. They cannot enter profitably with technology F targeting both segments given that the generalist has already occupied the value maximizing position when targeting both segments. Targeting one segment with technology F will be dominated by a deviation using technology M, which has lower costs for serving a single segment.

To rule out entry using technology M it must be that the *marginal* value creation of the generalist is higher than that of the entrant. It is sufficient to show that the generalist has greater marginal value creation than either the cost leader or the differentiator. That is, for $j \in \{L, H\}$, this requires that

$$a_j\sqrt{d_G^*} - (1-f)d_G^* \geq a_j\sqrt{d_j^*} - d_j^*.$$

Some algebra yields that this inequality is equivalent to

$$\frac{a_j}{2}\left(\frac{ma_L + ma_H}{2m(1-f)+fK}\right) - \frac{1-f}{4}\left(\frac{ma_L + ma_H}{2m(1-f)+fK}\right)^2 \geq \frac{a_j^2}{4}. \quad (6)$$

We now analyze under what conditions this inequality is satisfied. We start with $j = L$ and then turn to $j = H$.

For $j = L$, expression (6) can be rewritten as

$$m^2 f(1+h)^2 - (m(h-1) + f(2m-K))^2 \geq 0.$$

Define

$$G_1(f) = m^2 f(1+h)^2 - (m(h-1) + f(2m-K))^2.$$

We proceed to give conditions such that $G_1(f) \geq 0$, where $G_1(\cdot)$ is a strictly concave function (since $d^2G_1(f)/df^2 = -2(2m-K)^2 < 0$). The concavity of $G_1(\cdot)$, coupled with the fact that

$$\begin{aligned} G_1(0) &= -m^2(h-1)^2 < 0 < K(m(2h-1)+m) \\ &< K(2mh + 2m - K) \\ &= G_1(1), \end{aligned}$$

yields that $G_1(f) \geq 0$ if and only if $f \geq f_{G2}$, where $f_{G2} \in (0,1)$ uniquely solves $G_1(f) = 0$, so

$$\begin{aligned} f_{G2} &= \big[(h+1)^2 - 2(2-K/m)(h-1) - (h+1) \\ &\quad \cdot \sqrt{(h+1)^2 - 4(h-1)(2-K/m)}\big] \cdot \big[2(2-K/m)^2\big]^{-1}. \end{aligned}$$

One can show that f_{G2} grows with h. Indeed, by the implicit function theorem,

$$\frac{df_{G2}}{dh} = -\frac{\partial G_1/\partial h}{\partial G_1/\partial f}\bigg|_{f=f_{G2}}.$$

Because $\partial G_1/\partial f|_{f=f_{G2}} > 0$, it follows that the sign of df_{G2}/dh is the opposite to that of

$$\frac{\partial G_1}{\partial h}\bigg|_{f=f_{G2}} = 2m[mf_{G2}(1+h) - m(h-1) - f_{G2}(2m-K)].$$

Note that $\partial G_1/\partial h|_{f=f_{G2}}$ is negative if and only if $f_{G2} < m(h-1)/(m(1+h) - (2m-K))$. This is always true, since

$$G_1\left(\frac{m(h-1)}{m(1+h)-(2m-K)}\right) = \frac{m^3(h-1)(1+h)^2K}{(m(1+h)-(2m-K))^2} > 0,$$

which can only happen if $f_{G2} < m(h-1)/(m(1+h) - (2m-K))$ given that $G_1(f_{G2}) = 0$ and $G_1(\cdot)$ is increasing for $f \in (0,1)$. As a result, we have shown that f_{G2} increases with h, with $f_{G2} \in (0,1)$. In fact, note that $f_{G2} \to 0$ as $h \to 1$ and $f_{G2} \to 1$ as $h \to \infty$.

We have therefore shown that satisfaction of condition (6) for $j = L$ requires that $f \geq f_{G2}$, where f_{G2} increases with h and $\lim_{h\to 1} f_{G2} = 0 < 1 = \lim_{h\to\infty} f_{G2}$. We now examine the conditions under which (6) holds for $j = H$. Such an expression can be written after some algebra as follows:

$$m^2 f(1+h)^2 - (m(h-1) - fh(2m-K))^2 \geq 0.$$

Defining

$$G_2(f) = m^2 f(1+h)^2 - (m(h-1) - fh(2m-K))^2,$$

note that

$$G_2(f) - G_1(f) = f(2m-K)[2m(1-f) + fK](h^2-1) > 0,$$

so it follows that (6) is more stringent when $j = L$ than when $j = H$: hence, $f \geq f_{G2}$ ensures that both conditions hold. We have now shown that the Generalist equilibrium exists if and only if $f \geq \max\{f_{G1}, f_{G2}\}$. □

Proof of Corollary 4.4. Letting $Z = 2 - K/m$, recall that

$$f_S = \frac{1}{Z}\frac{(h-1)^2}{h^2+1}$$

and $f_G = \max\{f_{G1}, f_{G2}\}$, where

$$f_{G1} = \frac{1}{Z}\frac{h^2 - 2h - 1}{h^2}$$

and f_{G2} is the unique root in $(0,1)$ to $G_1(f) = 0$, where

$$G_1(f) = m^2 f(1+h)^2 - (m(h-1) + f(2m-K))^2$$

is increasing in f. Note that $1/Z = 1/(2 - K/m) > 1$, which implies that

$$\begin{aligned} G_1(f_S) &= m^2(h-1)^2\left[\frac{1}{Z}\frac{(1+h)^2}{h^2+1} - \left(1 + \frac{h-1}{h^2+1}\right)^2\right] \\ &> \left(\frac{m(h-1)(h+1)}{h^2+1}\right)^2 > 0, \end{aligned}$$

so the increasingness of $G_1(\cdot)$ yields that $f_S > f_{G2}$. Because we also have that

$$f_S - f_{G1} = \frac{(1+h)^2}{h^2(1+h^2)Z} > 0,$$

it indeed holds that $f_S > f_G$, as claimed. □

Proof of Proposition 4.6. We simply need to rule out that one of the firms that remains out can choose technology M and generate more value than the generalist in segment $j \in \{L, H\}$ by choosing d_j^*. Therefore, the following should hold

$$a_j\sqrt{d_G^*} - (1-f)d_G^* - \frac{fKd_G^*}{2m} \geq a_j\sqrt{d_j^*} - d_j^*$$

for all $j \in \{L, H\}$, that is,

$$a_j^2 \leq \frac{4a_j(a_L + a_H) - (a_L + a_H)^2}{2[2(1-f) + fK/m]} \quad \text{for all } j \in \{L, H\}.$$

If $j = L$, then we should have

$$f \geq f_L' = \frac{(h-1)^2}{2(2-K/m)}.$$

If instead $j = H$, then it should hold that

$$f \geq f_H' = \frac{(1-1/h)^2}{2(2-K/m)}.$$

Now let $f_G' = \max\{f_L', f_H'\}$. Because $h > 1$ implies that $f_H' < f_L'$, we have that $f_G' = f_L'$. It always holds that f_G' is increasing in h, with $\lim_{h\to 1} f_G' = 0 < 1 < \lim_{h\to\infty} f_G'$. In particular, $f_G' < 1$ if and only if

$$h < h_G' = 1 + \sqrt{2(2-K/m)}.$$

To conclude the proof, note that

$$f_G' = \frac{(h-1)^2}{2(2-K/m)} > \frac{1}{2-K/m}\frac{(h-1)^2}{h^2+1} = f_S$$

and

$$h_G' = 1 + \sqrt{2(2-K/m)} < \frac{1+\sqrt{1-(K/m-1)^2}}{K/m-1} = h_S$$

for $1 < K/m < 2$, with

$$f_G' = \frac{(h-1)^2}{2(2-K/m)} > \frac{(h-1)^2}{h(h-1)(2-K/m)} = f_M.$$

whenever $h > 2$. □

Proof of Proposition 5.1. It follows by inspection that

$$\Pi_G = \frac{m}{4}\frac{(a_H + a_L)^2}{2 - f(2-K/m)}$$

is increasing in a_H, a_L and f (since $2 > K/m$). Similarly,

$$\Pi_H = \frac{m}{4}(a_H - a_L)^2$$

and

$$\Pi_L = \begin{cases} \dfrac{m}{4}(a_H - a_L)^2 & \text{if } h \leq 2, \\ \dfrac{m}{4}a_L^2 & \text{otherwise,} \end{cases}$$

increase with a_H and do not vary with f. Inspection also shows that Π_H falls with a_L, as does Π_L when $h \leq 2$; when $h > 2$, Π_L grows with a_L. □

Proof of Proposition 5.2. Taking into account that

$$V_S = \frac{m}{4}(a_H^2 + a_L^2)$$

and

$$V_G = \frac{m}{4}\frac{(a_H + a_L)^2}{2(1-f) + fK/m},$$

it follows from straightforward manipulations that $V_G > V_S$ if and only if

$$f > \frac{1}{2-K/m}\frac{(h-1)^2}{h^2+1} = f_V,$$

which shows that $f_V = f_S$.

Since it always holds that $f_S > f_G$, it remains to show that $f_G > f_\Pi$ to conclude the proof. Recall that

$$\Pi_G = \frac{m}{4}\frac{(a_H + a_L)^2}{2(1-f) + fK/m},$$

$$\Pi_H = \frac{m}{4}(a_H - a_L)^2,$$

and

$$\Pi_L = \begin{cases} \dfrac{m}{4}(a_H - a_L)^2 & \text{if } h \leq 2, \\ \dfrac{m}{4}a_L^2 & \text{otherwise.} \end{cases}$$

Letting $Z = 2 - K/m$, straightforward manipulations yield that the Generalist equilibrium has higher industry value capture if and only if $f \geq f_\Pi$, where

$$f_\Pi = \begin{cases} \dfrac{1}{Z}\left(2 - \dfrac{(1+h)^2}{2(h-1)^2}\right) & \text{if } h < 2, \\ \dfrac{1}{Z}\left(2 - \dfrac{(1+h)^2}{1+(h-1)^2}\right) & \text{if } h \geq 2. \end{cases}$$

Since

$$f_{G1} = \frac{1}{Z}\frac{h^2 - 2h - 1}{h^2} = \frac{1}{Z}\left(2 - \frac{(1+h)^2}{h^2}\right),$$

it is easy to show that $f_\Pi < f_{G1}$ regardless of whether $h \in (1, 2)$ or $h \geq 2$, so we have $f_\Pi < f_{G1} \leq \max\{f_{G1}, f_{G2}\} = f_G$, which completes the proof. □

Proof of Proposition 6.1.

Proof. The proof of (i) is similar to the cases in which the sizes of the two market segments coincide.

Regarding (ii), let us try to sustain an equilibrium in which Firm 1 chooses $d_1 = d_L^*$, Firm 2 chooses $d_2 = d_L^*$, and Firm 3 chooses to remain inactive. The active firms must clearly choose M, since $K > \max(m_H, m_L)$. Several conditions need to be met at the same time in order for a Specialist equilibrium to exist: (a) any specialist firm should have no incentive to become inactive; (b) none of them should have an incentive to use technology M and produce another differentiation level; (c) none of them should have an incentive to switch to technology F; (d) the inactive firm should have no incentive to enter with technology M; and (e) it should have no incentive to enter with technology F.

The differentiator always earns $m_H(a_H - a_L)^2/4 \geq 0$. If $h \geq 2$ (i.e., the high-end firm creates no value in the low-end segment), the cost leader earns $m_L a_L^2/4 \geq 0$, whereas the cost leader earns $m_L(a_H - a_L)^2/4 \geq 0$ otherwise. As a result, condition (a) always holds. Condition (b) also holds by construction, as does (d). Clearly, using technology F makes sense for any firm only if both segments are to be served, in which case it is optimal to choose differentiation level $\hat{d}_G^*$.

We first focus on the implications of satisficing condition (c) for each specialist, since we shall later show that satisfaction of such a condition automatically implies (e).

We begin by considering the conditions that ensure that the differentiator has no incentive to enter with technology F and choose differentiation level $d=\hat{d}_G^*$. The fact that $a_H\sqrt{d_L^*}-d_L^*=a_L(2a_H-a_L)/4$ is always positive (i.e., the cost leader always creates value for high-end consumers) implies that the differentiator has no incentive to deviate if and only if the following holds:

$$\begin{aligned}&m_H\big(d_L^*+a_H\sqrt{d_H^*}-a_H\sqrt{d_L^*}-d_H^*\big)\\&\quad\ge m_H\big(d_L^*+a_H\sqrt{\hat{d}_G^*}-a_H\sqrt{d_L^*}-(1-f)\hat{d}_G^*\big)\\&\qquad+m_L\big(d_L^*+a_L\sqrt{\hat{d}_G^*}-a_L\sqrt{d_L^*}-(1-f)\hat{d}_G^*\big)-fK\hat{d}_G^*.\end{aligned}$$

Equivalently, the differentiator has no incentive to deviate if and only if

$$f\le\hat{f}_S=\frac{m_H(h-1)^2}{(1+(m_H/m_L)h^2)(m_H+m_L-K)}. \tag{7}$$

Let us now consider the conditions that ensure that the cost leader has no incentive to choose differentiation level $d=\hat{d}_G^*$ by entering with technology F. On the one hand, if it holds that $a_L\sqrt{d_H^*}-d_H^*=a_H(2a_L-a_H)/4>0$ (i.e., the differentiator creates some value in the low-end segment), then the following should be fulfilled:

$$\begin{aligned}&m_L\big(d_H^*+a_L\sqrt{d_L^*}-a_L\sqrt{d_H^*}-d_L^*\big)\\&\quad\ge m_H\big(d_H^*+a_H\sqrt{\hat{d}_G^*}-a_H\sqrt{d_H^*}-(1-f)d_G^*\big)\\&\qquad+m_L\big(d_H^*+a_L\sqrt{\hat{d}_G^*}-a_L\sqrt{d_H^*}-(1-f)\hat{d}_G^*\big)-fK\hat{d}_G^*.\end{aligned}$$

This condition can be easily shown to be equivalent to that in (7). On the other hand, if it holds that $a_L\sqrt{d_H^*}-d_H^*=a_H(2a_L-a_H)/4\le 0$ (i.e., the differentiator creates no value in the low-end segment), then the following should be fulfilled:

$$\begin{aligned}&m_L\big(a_L\sqrt{d_L^*}-d_L^*\big)\\&\quad\ge m_H\big(d_H^*+a_H\sqrt{\hat{d}_G^*}-a_H\sqrt{d_H^*}-(1-f)\hat{d}_G^*\big)\\&\qquad+m_L\big(a_L\sqrt{\hat{d}_G^*}-(1-f)\hat{d}_G^*\big)-fK\hat{d}_G^*.\end{aligned}$$

Again, this condition can be easily shown to be equivalent to that in (7).

We conclude by considering condition (e), that is,

$$\begin{aligned}&m_H\big(d_H^*+a_H\sqrt{\hat{d}_G^*}-a_H\sqrt{d_H^*}-(1-f)\hat{d}_G^*\big)\\&\quad+m_L\big(d_L^*+a_L\sqrt{\hat{d}_G^*}-a_L\sqrt{d_L^*}-(1-f)\hat{d}_G^*\big)-fK\hat{d}_G^*\le 0.\end{aligned}$$

This condition is equivalent to

$$\frac{(m_La_L+m_Ha_H)^2}{4((1-f)(m_L+m_H)+fK)}-\frac{m_Ha_H^2+m_La_L^2}{4}\le 0,$$

which holds if and only if $f\le\hat{f}_S$, so satisficing condition (c) automatically implies that (e) is met. Note that $\hat{f}_M/\hat{f}_S=(h^2+m_L/m_H)/(h^2-h)$, so it always holds that $\hat{f}_M/\hat{f}_S>1$. It is straightforward to prove the other claims in (ii).

Finally, we turn to the proof of the claims in (iii), so let us try to sustain an equilibrium in which Firm 1 chooses $d_1=\hat{d}_G^*$, and Firms 2 and 3 choose to remain inactive. The generalist will be alone and hence will charge the monopoly price to both high- and low-end customers given the differentiation it delivers. Given that technology F is preferred over M if both segments are to be targeted, it should hold that profits for the generalist be nonnegative in equilibrium:

$$(m_Ha_H+m_La_L)\sqrt{\hat{d}_G^*}-((m_H+m_L)(1-f)+fK)\hat{d}_G^*\ge 0.$$

This means that the following inequality should hold:

$$\frac{(m_Ha_H+m_La_L)^2}{4(fK+(1-f)(m_H+m_L))}\ge 0, \tag{8}$$

which is always satisfied.

The generalist should have no incentive to deviate to technology M so as to target one of the market segments. Choosing such a technology with $d_1=d_L^*$ would effectively allow Firm 1 to target both segments (since value is created for high-end customers when $d_1=d_L^*$), but in such a case we know that technology F with $d_1=\hat{d}_G^*$ is better because $K<m_H+m_L$. Similarly, technology M with $d_1=d_H^*$ leads to lower profitability than technology F with $d_1=\hat{d}_G^*$ if $h\le 2$, since Firm 1 would create value in both segments in such a case. Therefore, let $h>2$ and consider the profit that Firm 1 would make if it chose technology M with $d_1=d_H^*$: $m_Ha_H^2/4$. We need Firm 1 to perform better if it chooses technology F with $d_1=\hat{d}_G^*$, that is,

$$\frac{(m_Ha_H+m_La_L)^2}{4(fK+(1-f)(m_H+m_L))}\ge\frac{m_Ha_H^2}{4},$$

which holds if and only if

$$f>\hat{f}_{G1}=\frac{m_Hm_L(1-2/h)-(m_L/h)^2}{m_H(m_H+m_L-K)}. \tag{9}$$

Having examined the conditions when the generalist has no incentive to become a specialist, we turn to the analysis of the conditions under which any inactive firm has no incentive to enter either the high or low end of the market. To this end, we need to show that the generalist creates more value in segment $j\in\{H,L\}$ than a firm specialized in such a segment, that is,

$$a_j\sqrt{\hat{d}_G^*}-(1-f)\hat{d}_G^*\ge a_j\sqrt{d_j^*}-d_j^*.$$

Some algebra yields that this inequality is equivalent to

$$\begin{aligned}&\frac{a_j}{2}\,\frac{m_La_L+m_Ha_H}{(1-f)(m_L+m_H)+fK}\\&\quad-\frac{1-f}{4}\left(\frac{m_La_L+m_Ha_H}{(1-f)(m_L+m_H)+fK}\right)^2\ge\frac{a_j^2}{4}.\end{aligned} \tag{10}$$

We now analyze under what conditions this inequality can be satisfied. We start with $j=L$ and then turn to $j=H$.

For $j=L$, expression (10) can be rewritten as

$$f(m_L+hm_H)^2-(m_H(h-1)+f(m_L+m_H-K))^2\ge 0.$$

Defining

$$G_1(f)\equiv f(m_L+hm_H)^2-(m_H(h-1)+f(m_L+m_H-K))^2,$$

we proceed to give conditions such that $G_1(f) \geq 0$, where $G_1(\cdot)$ is a strictly concave function (since $d^2G_1(f)/df^2 = -2(m_L + m_H - K)^2 < 0$). The concavity of $G_1(\cdot)$, coupled with

$$G_1(0) = -m_H^2(h-1)^2 < 0 < K(m_H(2h-1)+m_L) < K(2m_H h - K + 2m_L) = G_1(1),$$

yields $G_1(f) \geq 0$ if and only if $f \geq \hat{f}_{G2}$, where $\hat{f}_{G2} \in (0,1)$ uniquely solves $G_1(f) = 0$.

One can show that $\hat{f}_{G2}$ grows with h. Indeed, by the implicit function theorem,

$$\frac{d\hat{f}_{G2}}{dh} = -\frac{\partial G_1/\partial h}{\partial G_1/\partial f}\bigg|_{f=\hat{f}_{G2}}.$$

Because $\partial G_1/\partial f|_{f=\hat{f}_{G2}} > 0$, it follows that the sign of $d\hat{f}_{G2}/dh$ is the opposite to that of

$$\frac{\partial G_1}{\partial h}\bigg|_{f=\hat{f}_{G2}} = 2m_H[\hat{f}_{G2}(m_L+hm_H) - m_H(h-1) - \hat{f}_{G2}(m_H+m_L-K)].$$

Note that $\partial G_1/\partial h|_{f=\hat{f}_{G2}}$ is negative if and only if

$$\hat{f}_{G2} < \frac{m_H(h-1)}{(m_L+hm_H)-(m_H+m_L-K)}.$$

This is always true, since

$$G_1\left(\frac{m_H(h-1)}{(m_L+hm_H)-(m_H+m_L-K)}\right) = \frac{m_H(h-1)(m_L+hm_H)^2K}{((m_L+hm_H)-(m_H+m_L-K))^2} > 0,$$

which can only happen if $\hat{f}_{G2} < (m_H(a_H/a_L - 1)/(m_L + m_H(a_H/a_L)) - (m_H + m_L - K))$ given that $G_1(\hat{f}_{G2}) = 0$ and $G_1(\cdot)$ is increasing for $f \in (0,1)$. As a result, we have shown that $\hat{f}_{G2}$ increases with h, with $\hat{f}_{G2} \in (0,1)$. In fact, note that $\hat{f}_{G2} \to 0$ as $h \to 1$ and $\hat{f}_{G2} \to 1$ as $h \to \infty$.

We have therefore shown that satisfaction of condition (10) for $j = L$ requires that $f \geq \hat{f}_{G2}$, where $\hat{f}_{G2}$ increases with h and $\lim_{h\to 1}\hat{f}_{G2} = 0 < 1 = \lim_{h\to\infty}\hat{f}_{G2}$. We now examine the conditions under which (10) holds for $j = H$. Such an expression can be written after some algebra as follows:

$$f(m_L+m_H h)^2 - \big(m_L(h-1) - fh(m_L+m_H-K)\big)^2 \geq 0.$$

Defining

$$G_2(f) \equiv f(m_L+m_H h)^2 - \big(m_L(h-1) - fh(m_L+m_H-K)\big)^2,$$

note that $G_2(f)$ is strictly concave, with $dG_2(f)/df|_{f=0} > 0$ and $dG_2(f)/df|_{f=1} > 0$.[14] It follows that $G_2(f)$ is increasing for $f \in (0,1)$. Taking into account that $G_2(0) = -m_L^2(h-1)^2$ is always negative, it follows that there must exist a unique value $\hat{f}_{G3} > 0$ that solves $G_2(f) = 0$. Defining $\hat{f}_G = \max_{k=1,2,3}\hat{f}_{Gk}$, it follows from our previous arguments that a Generalist equilibrium exists if and only if $f \geq \hat{f}_G$.[15]

To conclude the proof, note that

$$\hat{f}_S - \hat{f}_{G1} = \frac{(1+(m_H/m_L)h)^2}{(m_H/m_L+1-K/m_L)(m_H/m_L)h^2(1+(m_H/m_L)h^2)} > 0,$$

whereas $m_H < K < m_H + m_L$ implies that $G_1(\hat{f}_S) > 0$, so $\hat{f}_S > \hat{f}_{G2}$. Because $m_L < K < m_H + m_L$ implies that $G_2(\hat{f}_S) > 0$, it also holds that $\hat{f}_S > \hat{f}_{G3}$, so we have shown that $\hat{f}_S > \hat{f}_G$, as desired.

Proof of Corollary 6.2. Suppose $m_L = T - m_H$. Then

$$\hat{f}_S = \frac{(h-1)^2}{T-K}\frac{1}{1/m_H + h^2/(T-m_H)},$$

and

$$\frac{\partial \hat{f}_S}{\partial m_H} = \frac{(h-1)^2}{T-K}\frac{m_L+hm_H}{(m_L+h^2m_H)^2}(m_L - hm_H),$$

which is positive if $m_L > hm_H$ and negative if $m_L < hm_H$. □

[14] To prove this, note that

$$\frac{dG_2(f)}{df}\bigg|_{f=1} = (m_L+hm_H)^2 + 2m_L h(m_L+m_H-K)(h-1) - 2h^2(m_L+m_H-K)^2.$$

Letting

$$\mu(K) \equiv (m_L+hm_H)^2 + 2m_L h(m_L+m_H-K)(h-1) - 2h^2(m_L+m_H-K)^2,$$

it holds that $\mu(K) > 0$ for all $\max(m_L, m_H) < K < m_L + m_H$ (since $\mu(\max(m_L, m_H)) > 0$, $\mu(m_L+m_H) > 0$ and $d^2\mu(K)/dK^2 = -h^2 < 0$). The result that $dG_2(f)/df|_{f=1} > 0$ follows.

[15] Note that it might be possible that $\hat{f}_{G3} > 1$, in which case expression (10) cannot hold. In such a case, $\hat{f}_G > 1$, so it is impossible that $f \geq \hat{f}_G$ and the desired result would follow. We therefore need not be concerned about whether $\hat{f}_{G3}$ is less than one.

References

Adner R (2002) When are technologies disruptive: A demand-based view of the emergence of competition. *Strategic Management J.* 23(8):667–688.
Adner R, Levinthal D (2001) Demand heterogeneity and technology evolution: Implications for product and process innovation. *Management Sci.* 47(5):611–628.
Adner R, Zemsky P (2005) Disruptive technology and the emergence of competition. *Rand J. Econom.* 36(2):229–254.
Adner R, Zemsky P (2006) A demand-based perspective on sustainable competitive advantage. *Strategic Management J.* 27(3):215–239.
Adner R, Zemsky P (2016) Diversification and performance: Linking relatedness, market structure, and the decision to diversify. *Strategy Sci.* 1(1):32–55.
Adner R, Csaszar FA, Zemsky PB (2014) Positioning on a multiattribute landscape. *Management Sci.* 60(11):2794–2815.
Barney J (1997) *Gaining and Sustaining Competitive Advantage* (Addison-Wesley, Reading, MA).
Besanko D, David D, Mark S (2000) *Economics of Strategy*, 2nd ed. (John Wiley, New York).
Brandenburger A, Stuart HW (1996) Value-based business strategy. *J. Econom. Management Strategy* 5(1):5–24.
Brandenburger A, Stuart H (2007) Biform games. *Management Sci.* 53(4):537–549.
Campbell-Hunt C (2000) What have we learned about generic competitive strategy? A meta-analysis. *Strategic Management J.* 21(2):127–154.
Chatain O, Zemsky P (2007). The horizontal scope of the firm: Organizational tradeoffs vs. buyer-supplier relationships. *Management Sci.* 53(4):550–565.
Christensen CM (1997) *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Harvard Business School Press, Boston).
Cohen WM, Klepper S (1996) Firm size and the nature of innovation within industries: The case of process and product R&D. *Rev. Econom. Statist.* 78(2):232–243.

Cooper R, Kaplan RS (1991) Profit priorities from activity-based costing. *Harvard Bus. Rev.* 69(3):130–135.
Cronshaw M, Davis E, Kay J (1994) On being stuck in the middle or good food costs less at Sainsbury's. *British J. Management* 5(1):19–32.
Friedman T (2013) Revolution hits the universities. *New York Times* (13 January) SR1.
Grant RM (2010) *Contemporary Strategy Analysis* (John Wiley, New York).
Ghemawat P, Rivkin J (2006) Creating competitive advantage. Harvard Business School Background Note 9–798—062, Cambridge, MA.
Hannan MT, Freeman J (1993) *Organizational Ecology* (Harvard University Press, Cambridge, MA).
Kim C, Mauborgne R (2005). *Blue Ocean Strategy* (Harvard Business School Press, Cambridge, MA).
Karnani A (1984) Generic competitive strategies—An analytical approach. *Strategic Management J.* 5(4):367–380.
Levinthal DA (1997) Adaptation on rugged landscapes. *Management Sci.* 43(7):934–950.
MacDonald G, Ryall MD (2004) How do value creation and competition determine whether a firm appropriates value? *Management Sci.* 50(10):1319–1333.
Milgrom P, Roberts J (1990) The economics of modern manufacturing: Technology, strategy, and organization. *Amer. Econom. Rev.* 80(3):511–528.
Miller A, Dess GG (1993) Assessing Porter's (1980) model in terms of generalizability, accuracy, and simplicity. *J. Management Stud.* 30(4):553–585.
Porter ME (1980) *Competitive Strategy* (The Free Press, New York).
Porter ME (1985) *Competitive Advantage* (The Free Press, New York).
Porter ME (1990) *The Competitive Advantage of Nations* (Free Press, New York).
Porter ME (1996) What is strategy? *Harvard Bus. Rev.* 74(6):61–79.
Saloner G, Shepard A, Podolny J (2001) *Strategic Management* (John Wiley, New York).
Shaked A, Sutton J (1982) Relaxing price competition through product differentiation. *Rev. Econom. Stud.* 49(1):3–13.
Siggelkow N (2001) Change in the presence of fit: The rise, the fall, and the renaissance of Liz Claiborne. *Acad. Management J.* 44(4):838–857.
Siggelkow N (2002) Evolution toward fit. *Admin. Sci. Quart.* 47(1):125–159.
Siggelkow N, Wibbens PD (2015) A ladder of competitive advantage. Working paper, Wharton School, University of Pennsylvania, Philadelphia.
Stuart HW Jr (2004) Efficient spatial competition. *Games Econom. Behav.* 49(2):345–362.
Stuart HW Jr (2016) Value gaps and profitability. *Strategy Sci.* 1(1):56–70.
Sutton J (1991) *Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration* (MIT Press, Cambridge, MA).
Sutton J (1998) *Technology and Market Structure* (MIT Press, Cambridge, MA).
Thornhill S, White R (2007) Strategic purity: A multi-industry evaluation of pure vs. hybrid business strategies. *Strategic Management J.* 28(5):553–561.

Ron Adner is the David T. McLaughlin D'54, T'55 Chaired Professor, and professor of strategy and entrepreneurship at the Tuck School of Business at Dartmouth College. He received his Ph.D. from the Wharton School of Business at the University of Pennsylvania. His research explores the intersection of strategy and innovation.

Francisco Ruiz-Aliseda is an assistant professor of business economics at Pontificia Universidad Católica de Chile. He received his Ph.D. in managerial economics and strategy from the Kellogg School of Management. His research centers around high-tech industries, competitive dynamics, and formalizations of competitive strategy.

Peter Zemsky is the Eli Lilly Chaired professor of strategy and innovation and deputy dean of INSEAD. He received his Ph.D. from the Stanford Graduate School of Business. His research explores core issues in competitive strategy, with a particular focus on developing a value-based approach to the field.