11 The design and pricing of bundles: a review of normative guidelines and practical approaches

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Abstract

Bundling, the strategy of marketing products in particular combinations, is growing in significance given the boom in high technology and e-commerce. The seller in these instances typically has to decide which form of bundling to pursue and how to price the bundle and the individual products. We have written this chapter with two main objectives. First, we have sought to draw a set of key guidelines for bundling and pricing from a large body of 'traditional' literature rooted in stylized economic models. Here we have considered factors such as the nature of heterogeneity in consumers' reservation prices, the extent of the underlying correlation in reservation prices, the degree of complementarity or substitutability, and the nature of competition. The key conclusion is that no one form of bundling is always the best. Second, we have attempted to showcase the extant methodologies for bundle design and pricing. The studies that we have considered here have an empirical character and pertain to issues of a 'marketing' nature. In the concluding section, we suggest other avenues for expanding this work.

1. Overview

Bundling – the strategy of marketing two or more products or services as a specially priced package – is a form of nonlinear pricing (Wilson, 1993).[1] The literature identifies three alternative bundling strategies. Under the pure components (or unbundling) strategy, the seller offers the products separately (but not as a bundle);[2] under pure bundling, the seller offers the bundle alone; under mixed bundling, the seller offers the bundle as well as the individual items (see Schmalensee, 1984). The seller's decision involves choosing the particular strategy and the corresponding price(s) that maximize one's objective function. Bundling is significant in both monopolistic and competitive situations, and the guidelines often differ.

Although certain seminal papers on bundling are over four decades old (e.g. Stigler, 1963), the growth in high technology, e-commerce and competition has continually given new meaning to bundling. The rationales for bundling or unbundling (or both!) come from the firm side, demand or consumer side, and the competitor side. The bundles themselves could be of complements (e.g. TV with VCR), substitutes (e.g. a two-ticket combo to successive baseball games) or independently valued products. Indeed, there

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[1] Multipart tariff, another form of nonlinear pricing, is the focus of Chapter 16 in this volume.

[2] Although pure components and unbundling are essentially the same, Venkatesh and Chatterjee (2006, p. 22) note that unbundling represents 'the strategic uncoupling of a composite product (e.g., a news magazine) into its components'. Pure components is then the slight contrast of offering two naturally separate products in their standalone form.

could be bundles of brands (e.g. Diet Coke with NutraSweet) with more than one vested seller for a product.

We have written this chapter with two main objectives. First, we have sought to draw a set of key guidelines for bundling and pricing from a large body of 'traditional' literature rooted in stylized economic models. Second, we have attempted to showcase the work of marketing scholars. This work emphasizes practical approaches to bundle design and pricing, and includes problems of a 'marketing' nature.

The classical work on bundling by economists has predominantly been of a normative nature. Related studies have examined the role of firm-side drivers such as reduced inventory holding costs by restricting product range (e.g. Eppen et al., 1991), lower sorting and processing costs (e.g. Kenney and Klein, 1983), and greater economies of scope (e.g. Baumol et al., 1982). Price discrimination is the most widely recognized demand-side rationale for (mixed) bundling (e.g. Adams and Yellen, 1976; McAfee et al., 1989; Schmalensee, 1984). Other demand-side drivers include buyers' variety-seeking needs (e.g. McAlister, 1982), desire to reduce risk and/or search costs (e.g. Hayes, 1987), and product interrelatedness in terms of substitutability and complementarity (e.g. Lewbel, 1985). Competitor-driven considerations are most notably linked to tie-in sales (see Carbajo et al., 1990), a predatory bundling strategy in which a monopolist in one category leverages that power by bundling a more vulnerable product with it. Table 11.1 provides real-world examples for the above-mentioned rationales.

At one level, the traditional economics literature has provided the primary impetus to bundling research in marketing, and a subset of marketing articles comprises direct extensions of prior work by economists. On the other hand, and as alluded to earlier, bundling research in marketing has proved novel and complementary in the following ways:

- *New methodologies and empirics* While the bundling research in economics is characterized by stylized analytical models, research in marketing has led to an array of specific approaches to aid decision-makers in optimal bundle design and pricing. Representative approaches are conjoint analysis (Goldberg et al., 1984), balance modeling (Farquhar and Rao, 1976), mixed integer linear programming (Hanson and Martin, 1990), probabilistic modeling (Venkatesh and Mahajan, 1993), and combinatorial methods (e.g. Chung and Rao, 2003). There is a much greater emphasis on empirical work in marketing.
- *'Marketing' problems, concepts and issues* Research in marketing has brought qualitatively different problems and concepts within the purview of bundling, an effort boosted by the emergence of e-commerce. Co-branding (Venkatesh and Mahajan, 1997) or the strategy of offering a bundle of two or more brands, product integration as with copier–printer–scanner–fax machine (see Stremersch and Tellis, 2002), and consolidation or bundling of information goods (see Bakos and Brynjolfsson, 2000) are examples of what we see as 'distinctively' marketing-type contexts.

While considering the entire spectrum of bundling research, we cite only a representative subset of articles. We have oriented the chapter toward certain topics only. First, we emphasize demand- and competitor-side determinants and implications of bundling and pricing. The demand-side factors we consider are the pattern of product demand,

Table 11.1 Select firm-, demand- and competitor-side rationales for (un)bundling

	Practical example	Illustrative articles
Firm-side rationales		
Lower inventory holding costs	Dodge's decision to cut down offerings of the Caravan to a few popular 'bundles'	Eppen et al. (1991)
Lower sorting costs	De Beers selling uncut diamonds as a package and not individually	Kenney and Klein (1983)
Greater economies of scope	Microsoft integrating the development of Windows and Internet Explorer apparently to reduce costs and increase quality	Baumol et al. (1982); Gilbert and Katz (2001)
Demand-side rationales		
Price discrimination (also related to correlation of valuations across consumers)	A sports franchise offering higher-priced tickets for individual events and discounted season tickets	Ansari et al. (1996); Schmalensee (1984); Venkatesh and Mahajan (1993)
Balance within a portfolio; variety-seeking	A TV station or network selecting a subset of TV programs from a broader set of options	Bradlow and Rao (2000); Farquhar and Rao (1976); Rao et al. (1991)
Complementarity	Offering ski rentals and ski lessons as a bundle	Lewbel (1985); Telser (1975); Venkatesh and Kamakura (2003)
Competitor-side rationales		
Tie-in sales and entry deterrence	IBM bundling tabulating machines and cards	Carbajo et al. (1990); Whinston (1990)
Aggregation to reduce buyer heterogeneity	A larger aggregator of information goods outbidding a smaller competitor	Bakos and Brynjolfsson (2000)
Enabling competition through unbundling to facilitate market growth	High-end manufacturer de-linking the sales of stereo receivers and speakers	Wilson et al. (1990); Kopalle et al. (1999)

correlation in reservation prices across consumers, and the degree of complementarity or substitutability. On competition, we contrast the implications of a duopoly in all versus a subset of the product categories. On the firm side, we consider the number of product categories on sale and the level of marginal costs. Second, we draw directly on normative work in bundling to provide a series of guidelines on optimal bundling and pricing. Unless otherwise noted, we treat 'optimal' behavior as one that maximizes the seller's profits in a monopoly or represents equilibrium outcome in competitive settings. Third, we review the extant methods for bundle design and bundle pricing. Our intent here is to highlight the purpose and scope of each approach. Fourth, we refrain from technical and

analytical details as much as possible. Finally, we overlook a nascent stream of bundling research in marketing that is motivated by behavioral decision theory.

In Section 2 we discuss the normative bundling guidelines rooted in classical economic theories and axioms. In Section 3 we summarize the key approaches to bundle design and pricing. We conclude with a short chapter summary (Section 4).

2. Normative guidelines on optimal bundling and pricing

By far the largest body of work within the bundling stream is analytical and normative. Articles examining demand-side rationales begin with consumers' valuations for the individual products. The value is often assumed to be deterministic. A consumer's reservation price, an operational measure of value, is simply the maximum price the customer is willing to pay for one unit of a given product (cf. Schmalensee, 1984).[3] The reservation price construct is more nuanced when seen across products for a given consumer, or across consumers. The following two aspects of reservation prices have led to important extensions:

- *Correlation in reservation prices* As price discrimination is a key driver of mixed bundling, the heterogeneity in reservation prices across consumers is of central importance. Reservation prices across consumers for two products could be positively or negatively correlated, or be independent (i.e. uncorrelated). Positive correlation could exist when consumers differ on say their income or importance for quality. Reservation prices for the bundle are the least heterogeneous when component-level reservation prices are perfectly negatively correlated.
- *(Non-)additivity* Additivity means that a consumer's reservation price for a bundle of products is the sum of his or her reservation prices for the individual products. The additivity axiom applies for independently valued products only. For complements (e.g. ski lesson + ski rental), reservation prices are super-additive, i.e. the reservation price for the bundle is greater than the sum of the reservation prices for the individual products. For a bundle of substitutes, the reservation prices are sub-additive, i.e. the bundle reservation price is less than the sum of the product-level reservation prices. Super- or sub-additivity is more generally called non-additivity.

How the component-level reservation prices are stylized has a significant bearing on the bundling and pricing implications. We see four common characterizations and related strengths and weaknesses:

1. *Discrete distributions* (e.g. Adams and Yellen, 1976; Stigler, 1963; Stremersch and Tellis, 2002) Set typically in the two-product case, discrete distributions in bundling represent the reservation prices of two to five potential consumers or segments. The objective of related studies has been to present key conjectures or highlight shortcomings with specific strategies in an anecdotal manner. Comparative statics are irrelevant in these cases and the intent is to be illustrative rather than conclusive.

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[3] A consumer's reservation price for the second, third, or higher unit of a product is central to the stream on quantity discounts – another form of nonlinear pricing. Normative bundling articles have typically focused on a consumer's unit purchase within a category.

2. *Uniform distribution* (e.g. Matutes and Regibeau, 1992; Venkatesh and Kamakura, 2003) This is the analog of the linear demand function. For a two-product case the distribution of bundle-level reservation prices would be triangular (i.e. unimodal) or trapezoidal. This form is analytically quite tractable, can capture complementarity and substitutability, but is not convenient for modeling correlation (except perfect positive/negative correlation).
3. *Normal (i.e. Gaussian) distribution* (e.g. Bakos and Brynjolfsson, 1999; Schmalensee, 1984) The sum of multiple normal random variables is also normally distributed. Thus any number of components can be considered without making the formulation more complicated. The bivariate normal distribution has the ability to capture the underlying correlation through a single parameter, a property leveraged by Schmalensee (1984). The significant downside is that no closed-form solutions are possible for the optimal price(s), thereby requiring numerical analysis.
4. *Double exponential distribution* (e.g. Anderson and Leruth, 1992; Kopalle et al., 1999) The appeal of random utility theory and logit choice models extends to bundling. Several articles on competition in bundling are rooted in this framework and model heterogeneity through the double-exponential distribution. While complementarity or substitutability can be captured in these models, to our knowledge none of the extant articles captures correlation in reservation prices across consumers through the bivariate double-exponential distribution.

The unit variable costs (or, more generally, the marginal costs) and sub-additivity in these costs are two firm-side variables that matter. Cost sub-additivity means that the unit variable cost of the bundle is less than the sum total of those of the individual items. It most often arises from economies of scope. The number of different products making up the bundle is also a relevant variable in some settings (e.g. digital goods where the number could potentially tend to infinity).

While most normative articles on bundling assume a monopolistic setting – a supposition strengthened by the power of bundling to deter competition – the impact of competition on optimal bundling and pricing is another important research avenue.

We shall consider the above variables and state key extant propositions as guidelines.

2.1 The 'simplest' anecdotal cases

As noted earlier, these are based on discrete distributions of reservation prices. The simplest bundling problem in Stigler (1963) in the context of block booking of movies yields the following guideline (keeping aside legal aspects):

G1: *For a monopolist offering two independent products with perfectly negatively correlated reservation prices across consumers, pure bundling is optimal when marginal costs are 'low'.*[4]

Pure bundling works through reduced buyer heterogeneity in bundle reservation prices. This benefit is maximized with perfect negative correlation in reservation prices,

[4] While our guidelines sound definitive, by no means do we rule out exceptions.

Table 11.2 An illustration of the power of pure bundling

Customer	Reservation price ($) for a week's rental of		
	Gone with the Wind (GW)	Getting Gertie's Garter (GGG)	GW+GGG
Theater 1	$8000	$2000	$10 000
Theater 2	$7000	$3000	$10 000

and pure bundling extracts the entire surplus, as illustrated in Table 11.2 with a variation of Stigler's example.

In this example, assuming negligible marginal costs, the seller would have netted $18 000 under pure components by pricing GW at $7000 and GGG at $2000, leaving a surplus of $2000. However, by offering the bundle alone for $10 000, the seller nets $20 000, leaving no surplus behind. Mixed bundling collapses to pure bundling (i.e. component sales are zero). Proposition P2 in Stremersch and Tellis (2002) reinforces this point. Notice that the 'low' marginal cost condition is necessary because if, say, the marginal cost of each extra copy of the movie is $4000, offering GW alone is optimal. A related intuition is discussed below.

Adams and Yellen's (1976) seminal work focuses on both the profit and welfare implications of bundling. Through a number of anecdotal examples the authors show that no one strategy – PC, PB or MB – is always the best from profit and welfare standpoints. The following guideline is significant and could be the reason that pure bundling attracts much legal scrutiny:

G2: *Pure bundling is more prone to over- or undersupply than pure components and mixed bundling.*

In support of the guideline, Adams and Yellen point to the difficulty of adhering to the principle of 'exclusion' with pure bundling in that some individuals whose reservation prices are less than a product's marginal cost may end up buying the product. This oversupply occurs because pure bundling forces the transfer of consumer surplus from one good to another. Undersupply occurs when a consumer who would have bought a subset of the components chooses to forego the bundle as buying it would violate individual rationality.

2.2 Role of marginal costs

Digitized goods and airline seats are examples of products or services with negligible marginal costs. At the other end, electronic equipment and other real hardware have significant marginal costs in relation to consumers' willingness to pay. It would be odd if the bundling and pricing guidelines for such diverse products were the same. Indeed, while it is not uncommon to see marginal costs set to zero for analytical convenience, this section underscores that the level of marginal costs has a profound impact on the attractiveness of alternative bundling strategies.

We assume here that the reservation prices are additive and the correlation coefficient is zero. A commonly used schematic representation of consumers' reservation prices for

the two product case and their choices is shown in Figure 11.1 for the alternative bundling strategies.

The upper bounds of the reservation prices for the individual products can theoretically approach infinity. Moreover, the product and bundle prices under mixed bundling need not be the same as those under pure components and pure bundling strategies respectively. There is no implicit assumption in the diagrams on the density of the bivariate distribution.

Consider the case where unit variable costs are additive:

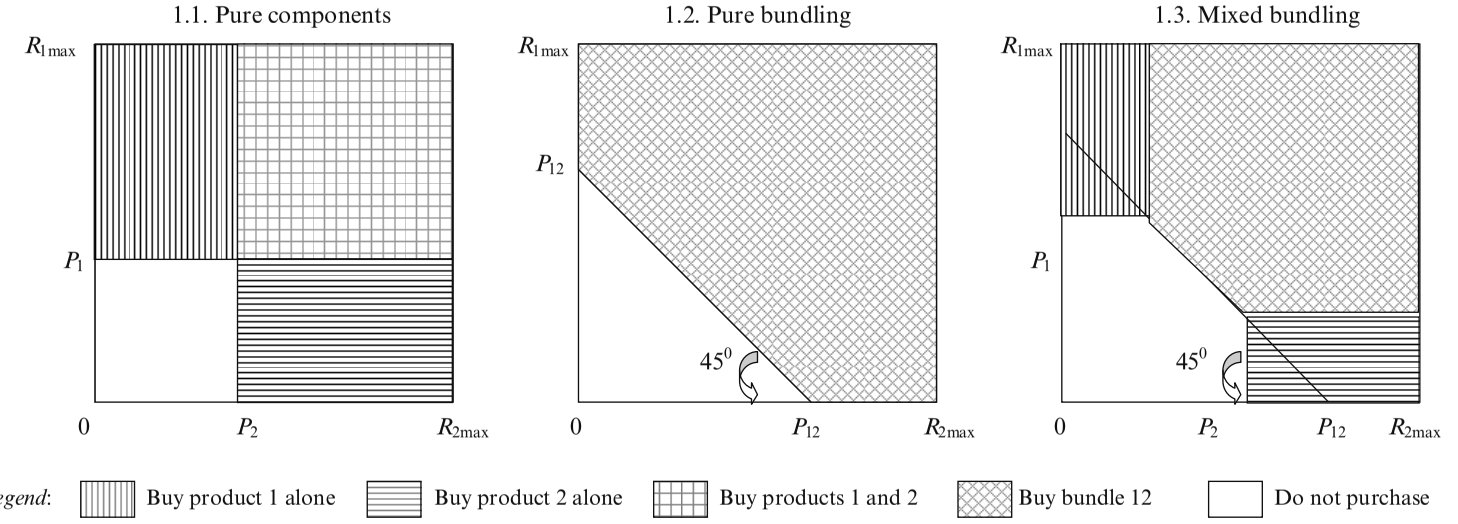
G3: *For a monopolist offering two products with symmetric Gaussian demand and costs:*
- *(a) pure bundling is more profitable than pure components when costs are low relative to mean willingness to pay; otherwise, pure components is more profitable;*
- *(b) as in G2, pure bundling makes the buyers worse off due to over- or undersupply;*
- *(c) mixed bundling is optimal.*

The result comes from Schmalensee (1984). G3(b) is a reinforcement of an earlier guideline. In a sense it drives G3(a): while the seller can effectively force the consumers to buy the bundle without incurring significant marginal costs, the same is not possible when costs are higher. The bundle price would go up significantly to cause severe undersupply; therefore the pure components strategy prevails. On G3(c) – the most significant guideline – Schmalensee (p. S227) points out how mixed bundling is a 'powerful price discrimination device in the Gaussian symmetric case'. This general strategy is able to combine the power of pure bundling to reduce buyer heterogeneity and the ability of pure components to cater to the high-end consumers of one product who care little for the other.

What if the base demand (for a product) is uniform and not Gaussian? Although the uniform and normal distributions can both have low or high standard deviation, given two supports on either side of and equidistant from the mean, the uniform distribution is thicker than the normal near these supports and thinner at the middle. Loosely speaking, the uniform distribution represents greater heterogeneity in reservation prices.

G4: *For a monopolist offering two products with uniform (i.e. linear) demand for each:*
- *(a) mixed bundling is optimal when marginal costs are low to moderate; pure components is optimal when marginal costs are high;*
- *(b) component and bundle prices are both increasing in marginal costs; however, bundle price increases are nonlinear in costs;*
- *(c) when mixed bundling is optimal, the bundle and component prices are weakly greater than under the corresponding pure strategies.*

Supporting evidence comes from Venkatesh and Kamakura (2003, p. 228). When marginal costs are low or negligible, demand-side factors dominate. With mixed bundling, the bundle is targeted at consumers who on average value both products whereas higher-priced components are sold to consumers who value one of the products highly but care little for the other product. As in Schmalensee (1984), mixed bundling can effectively



Notes:
1. Independently valued products are, by definition, neither complements nor substitutes of each other.
2. The bundle and individual product prices under mixed bundling are likely to be higher than those under the corresponding pure strategies.

Notation: R_{1max}, R_{2max} = Maximum reservation price for products 1 and 2 respectively.
P_1, P_2, P_{12} = Optimal prices of product 1, product 2 and bundle 12 respectively.

Figure 11.1 Bundling with two independently valued products: schematic representation of pricing and penetration

price-discriminate. However, compared to G3, notice that the domain of optimality of mixed bundling is somewhat limited. This relates to the earlier point on the difference between uniform and Gaussian demand. Mixed bundling converges to pure components when marginal costs are high. On G4(b), the reason for the (non)linear increase in product (bundle) price is that the underlying demand function for each product is linear whereas that for the bundle has a kink – reservation prices are more concentrated in the middle. Unlike component prices that increase linearly in marginal costs, there is benefit from increasing bundle prices somewhat slowly when faced with higher costs. G4(c) is an important result on product line pricing. A wider product line – consisting of the bundle and the separate components – means that the offerings are weakly closer to consumers' ideal preferences (than under pure components or pure bundling), and the firm can charge a higher price compared to a case when it offers only a subset of these items.

While G3 and G4 are relevant when the seller has a limited portfolio of 'traditional' products with some level of marginal costs, a seller of information goods – which are numerous and practically costless – can draw on the following guideline.

G5: *For a monopolist offering a large number of products with zero marginal costs, pure bundling is optimal.*

The guideline is based on Bakos and Brynjolfsson (1999). The authors draw on the law of large numbers to point out that for a bundle made up of many goods whose valuations are distributed independently and identically, a considerable fraction of consumers has moderate valuations. This fraction approaches unity as the number of goods gets infinitely large. The assumption of zero (or negligible) marginal costs is crucial because the authors also point out that there is a marginal cost level beyond which bundling becomes less profitable.

It is easy to see that when the marginal cost of the bundle is sub-additive in those of the components, the relative attractiveness of pure bundling is likely to increase.

2.3 Role of correlation in valuations

The nature and extent of correlation in reservation prices across consumers for the product offerings significantly impacts the power of bundling as a price discrimination device.

We rely on Schmalensee (1984) for the following guideline:

G6: *For a monopolist offering two products with symmetric Gaussian demand and costs:*

- *(a) the attractiveness of pure bundling increases relative to pure components as the correlation coefficient decreases (i.e. tends to −1); however, reservation prices need not be negatively correlated for pure bundling to be more profitable;*
- *(b) the level of marginal costs in relation to the mean reservation prices of the product and bundle moderate the effectiveness of bundle sales relative to product sales;*
- *(c) as in G3(c), mixed bundling is optimal.*

The effectiveness of pure bundling comes from the reduced heterogeneity in reservation prices for the bundle. G6(a) from Schmalensee (1984) disproves the myth created by

anecdotal examples on bundling that a negative correlation in component-level reservation prices is necessary for reduced bundle-level heterogeneity. With Gaussian demand for the individual products, the benefit of heterogeneity reduction occurs so long as the correlation coefficient is less than +1. Of course, with negative correlation the heterogeneity reduction is greater, and the domain of attractiveness of pure bundling over pure components increases.

A perfectly negative correlation coefficient (of −1) means that the bundle-level reservation prices of all consumers equal the mean value. G6(b) is striking in that even this is not enough to lift pure bundling over pure components. Echoing the point in G1, pure bundling will yield a negative contribution when the marginal cost of the bundle is greater than the mean reservation price. Pure components would prevail.

G6(c) is the succinct generalization from Schmalensee, noted previously in G3. Of course, the share of bundle sales relative to individual product sales depends on the degree of correlation and the level of marginal costs in relation to willingness to pay. When the correlation coefficient approaches +1 (or −1), mixed bundling is expected to converge to pure components (or pure bundling). Of course, the caveat in part (b) will apply.

2.4 Role of complementarity or substitutability

By definition, reservation prices are super- (or sub-) additive for complements (or substitutes). Guiltinan (1987) proposes at least three possible sources of complementarity: (i) search economies, as for oil change performed at the same gas station and at the same time as a filter change; (ii) enhanced customer satisfaction, as for a ski rental accompanied by a lessons package; and (iii) improved total image, as for lawn care services offered with shrub care services (also see Oxenfeldt, 1966). Two products are seen as substitutes when their benefits overlap at least in part (e.g. international business news in the *Financial Times* and *The Wall Street Journal*) or when they compete for similar resources such as a consumer's time. While it may seem at first glance that complements should be bundled and substitutes offered separately, the truth is more nuanced. The normative guidelines that follow are from Venkatesh and Kamakura (2003).

We assume for this subsection that reservation prices across consumers for the two products are uncorrelated. The unit variable costs are additive:

G7: *For a monopolist offering two complements with uniform (i.e. linear) demand for each:*

- *(a) pure bundling is more profitable than pure components only when (i) marginal costs are low or (ii) the products are strong complements;*
- *(b) when all three strategies are available, (i) mixed bundling is optimal for weak complements when the marginal costs are low to moderate; (ii) pure components is optimal for weak complements when marginal costs are high; (iii) pure bundling is optimal for strong complements.*

G7(a) underscores that the pure components strategy actually prevails over pure bundling for a wide range of complements, falling short only for strong complements or when the marginal costs are low relative to the market's mean willingness to pay. In the latter case (with low marginal costs), the seller has more flexibility to offer significant discounts on the bundle and induce joint purchase. It is exactly the upward pressure on prices due

to higher marginal costs that makes pure bundling less profitable than pure components for low to moderate complements.

The significance of G7(b) is that while the power of mixed bundling extends to moderate complements also when marginal costs are low, it is not a dominating strategy. For strong complements, bundling is so attractive that mixed bundling actually converges to pure bundling. On the other hand, when marginal costs are higher, the lowest possible bundle price is so high that mixed bundling converges to the pure components strategy; offering discounts via the bundle to consumers in the 'middle' (i.e. with moderate reservation prices for both products) is suboptimal.

The following guideline applies for substitutes.

G8: *For a monopolist offering two substitutes with uniform (i.e. linear) demand for each:*
- *(a) pure components is optimal for strong substitutes and mixed bundling for weak substitutes;*
- *(b) when marginal costs are higher, the domain of optimality of pure components relative to mixed bundling is enlarged;*
- *(c) pure bundling is suboptimal.*

Part (c) is intuitive yet significant in that enticing consumers with discounts for the bundle under the pure bundling strategy is suboptimal for substitutes. A better alternative is to focus on consumers who care for one product or the other, and let those who have high prices for both products form their own implicit bundles at higher prices. Indeed, discounted bundles are of such limited appeal that mixed bundling converges to pure components for all but the weak substitutes, a trend amplified under higher marginal costs.

The underlying mechanism for the above guidelines is evident from the pricing patterns discussed below.

G9: *For a monopolist offering two complements or substitutes with uniform (i.e. linear) demand for each:*
- *(a) under pure components, optimal prices of complements and most substitutes are weakly higher than those of independently valued products;*
- *(b) under pure bundling, the optimal bundle price is lower for substitutes and higher for complements than that for independently valued goods;*
- *(c) under mixed bundling, the bundle and component prices are weakly greater than under the corresponding pure strategies.*

The obvious part of the above guideline is that prices under both pure components and pure bundling are increasing in the degree of complementarity; after all, stronger complements are more valuable to consumers and higher prices help extract this higher value. The interesting aspect is that the optimal prices under pure components are higher for substitutes than for independently valued products. Relating back to G8, it actually helps not to encourage joint purchase of a suboptimal combination. Because pure bundling lacks this flexibility (i.e. it can only induce joint purchase), it is dominated. To be sure, mixed bundling is still the best for mild substitutes when the marginal costs are low to moderate.

2.5 Role of competition

Besides price discrimination, the rationale most often attributed to bundling is its ability to deter a new entrant or dislodge an incumbent. Kodak's decision to bundle film with processing, IBM's tie-in of tabulating machines and related cards, and the more recent example of Microsoft's integration of Internet Explorer with its Windows/Vista operating systems are prominent examples. We review a set of proposed guidelines on optimal bundling and pricing.

The simplest example of competition is when firm 1 enjoys a monopoly in product category A but competes with firm 2 in a category B. The available products are A_1, B_1 and B_2. If firm 1 follows pure bundling, a consumer who strongly prefers A_1 and B_2 is forced to buy the bundle A_1B_1 and the product B_2, an obvious case of oversupply. When the two product categories are independent of each other, some consumers may buy B_2 alone. However, if the product categories are strict complements – such as TV and DVD player – the power of the tie-in becomes evident. While the Robinson Patman Act prohibits the use of pure bundling in B2B settings, the same is not true for B2C contexts, especially when firm 1 can justify pure bundling as a prerequisite for ensuring overall quality (as Kodak was once able to argue). We first look at the simplest case with independent demand. All articles cited in this subsection assume uncorrelated valuations across consumers for the products in question.

G10: *Given two product categories with independent uniform (i.e. linear) demand, when a monopolist in the first product category faces a competitor in the second category:*

(a) given a Bertrand game in the second category, the monopolist in the first category prefers pure bundling when the marginal cost of the monopoly good is 'large enough' compared to that of the other;

(b) the bundle price of the monopolist in the first category is increasing more rapidly in the marginal cost of the good in the second category;

(c) the competitor's single product price (for the second product) is higher when the monopolist in the first category prefers pure bundling over pure components.

The guideline comes from Carbajo et al. (1990). The authors point out that in equilibrium, the monopolist pursuing pure bundling is able to clear consumers with the highest reservation prices. Of the remaining consumers, the competitor clears those with the higher reservation prices and excludes those with the lowest reservation prices for the second product. Had the monopolist pursued pure components, the equilibrium prices for the competing products in the second category would have been driven down to marginal costs. Thus the tie-in actually makes both manufacturers better off while aggregate welfare typically suffers.

A more general form of competition is when there is a duopoly in both product categories (e.g. Matutes and Regibeau, 1992; henceforth MR). Consumers could potentially buy two products from the same firm (that MR label 'pure systems') or mix between the two firms (i.e. form 'hybrid systems' as per MR). The following guideline applies:

G11: *In a two-product duopoly with linear demand for each product:*

(a) pure components dominates pure bundling when the firms offer compatible products; otherwise, pure bundling prevails;

(b) for compatible products, the choice between pure components and mixed bundling depends on the consumers' valuation of their 'ideal bundle'; when consumers are very particular about their 'ideal bundle', pure components is better.

The guideline comes from MR. Incompatible offerings from the two firms would mean that the consumer has to make the decision at the system (i.e. bundle) level. Pure bundling prevails. However, with compatible offerings from the two firms, the customer's decision is driven by his or her preference intensity for an ideal combination – the pair that the customer finds the most complementary. If the preference intensity for this combination is very high, the firms are better off with pure components, i.e. giving the customer the most flexibility to put together a hybrid system (i.e. a mix of products from the two manufacturers) or a pure system as desired. There is no need to offer a discounted bundle through mixed bundling because when the complementarity from a pure system is strong enough, the customer is self-motivated to buy both products from the same firm.

Anderson and Leruth (1992) look at a variation of the above problem in which the products from different firms are assumed to be compatible but the heterogeneity in valuations of each product is captured by the double-exponential distribution. Broadly echoing MR, Anderson and Leruth find that if firms can commit to a pricing strategy before setting prices, pure components will be the equilibrium strategy for both firms; otherwise, each firm will pursue mixed bundling.

Building on the above, Kopalle et al. (1999) consider the possibility of market expansion (i.e. an unsaturated market). The key conclusion is that the equilibrium strategies of the firms shift from mixed bundling to pure components when there is limited opportunity for market expansion. The rationale is that when the market is less saturated, each firm can entice more customers by offering a wider product line (i.e. offer both the bundle and the individual products). With saturation, the incentive to entice customers with the discounted bundle is removed.

Given a large number of products in the context of the information economy, we have:

G12: *In a duopoly between bundlers of goods with zero marginal costs and i.i.d. reservation prices:*

(a) the firm offering the larger bundle will find it more profitable to add an outside good;

(b) by extension, a firm bundling information goods will be able to deter or dislodge a firm that offers a single information good.

The results are from Bakos and Brynjolfsson (2000), and build on their 1999 study. They invoke the law of large numbers to demonstrate that a firm with a larger bundle of 'costless' information goods is better able to reduce heterogeneity in consumers' valuations. Therefore, in a competition between two firms offering bundles of n_1 versus n_2 goods ($n_1 > n_2$), firm 1 would be better able to extract the consumers' surplus and hence would find it more profitable. The greater power of the larger bundler lets it deter a prospective entrant or dislodge an incumbent firm.

Table 11.3 contains a summary of our above guidelines, the underlying drivers for each guideline, and the articles that provide the supporting evidence.

We see additional linkages such as the following among the above guidelines. Higher

Table 11.3 A summary of normative guidelines on optimal bundling and pricing

Underlying driver(s)	Guidelines	Supporting evidence
Discrete demand (anecdotal cases)	G1: For a monopolist offering two independent products with perfectly negatively correlated reservation prices across consumers, pure bundling is optimal when marginal costs are 'low'.	Stigler (1963) Stremersch and Tellis (2002)
	G2: Pure bundling is more prone to over- or undersupply than pure components and mixed bundling.	Adams and Yellen (1976)
Marginal costs and number of product categories	G3: For a monopolist offering two products with symmetric Gaussian demand and costs: (a) pure bundling is more profitable than pure components when costs are low relative to mean willingness to pay; otherwise, pure components is more profitable; (b) as in G2, pure bundling makes the buyers worse off due to over- or undersupply; (c) mixed bundling is optimal.	Schmalensee (1984)
	G4: For a monopolist offering two products with uniform (i.e. linear) demand for each: (a) mixed bundling is optimal when marginal costs are low to moderate; pure components is optimal when marginal costs are high; (b) component and bundle prices are both increasing in marginal costs; however, bundle price increases are nonlinear in costs; (c) when mixed bundling is optimal, the bundle and component prices are weakly greater than under the corresponding pure strategies.	Venkatesh and Kamakura (2003)
	G5: For a monopolist offering a large number of products with zero marginal costs, pure bundling is optimal.	Bakos and Brynjolfsson (1999)
Correlated valuations	G6: For a monopolist offering two products with symmetric Gaussian demand and costs: (a) the attractiveness of pure bundling increases relative to pure components as the correlation coefficient decreases (i.e. tends to –1); however, reservation prices need not be negatively correlated for pure bundling to be more profitable;	Schmalensee (1984)

Table 11.3 (continued)

Underlying driver(s)	Guidelines	Supporting evidence
	(b) the level of marginal costs in relation to the mean reservation prices of the product and bundle moderate the effectiveness of bundle sales relative to product sales; (c) as in G3(c), mixed bundling is optimal.	
Complements and substitutes	G7: For a monopolist offering two complements with uniform (i.e. linear) demand for each: (a) pure bundling is more profitable than pure components only when (i) marginal costs are low or (ii) the products are strong complements; (b) when all three strategies are available, (i) mixed bundling is optimal for weak complements when the marginal costs are low to moderate; (ii) pure components is optimal for weak complements when marginal costs are high; (iii) pure bundling is optimal for strong complements.	Venkatesh and Kamakura (2003)
	G8: For a monopolist offering two substitutes with uniform (i.e. linear) demand for each: (a) pure components is optimal for strong substitutes and mixed bundling for weak substitutes; (b) when marginal costs are higher, the domain of optimality of pure components relative to mixed bundling is enlarged; (c) pure bundling is suboptimal.	Venkatesh and Kamakura (2003)
	G9: For a monopolist offering two complements or substitutes with uniform (i.e. linear) demand for each: (a) under pure components, optimal prices of complements and most substitutes are weakly higher than those of independently valued products; (b) under pure bundling, the optimal bundle price is the lower for substitutes and higher for complements than that for independently valued goods; (c) under mixed bundling, the bundle and component prices are weakly greater than under the corresponding pure strategies.	Venkatesh and Kamakura (2003)

Competition	G10: Given two product categories with independent uniform (i.e. linear) demand, when a monopolist in the first product category faces a competitor in the second category: (a) given a Bertrand game in the second category, the monopolist in the first category prefers pure bundling when the marginal cost of the monopoly product is 'large enough' compared to that of the other; (b) the bundle price of the monopolist in the first category is increasing more rapidly in the marginal cost of the product in the second category; (c) the competitor's single product price (for the second product) is higher when the monopolist in the first category prefers pure bundling over pure components.	Carbajo et al. (1990)
	G11: In a two-product duopoly with linear demand for each product: (a) pure components dominates pure bundling when the firms offer compatible products; otherwise, pure bundling prevails; (b) for compatible products, the choice between pure components and mixed bundling depends on the consumers' valuation of their 'ideal bundle'; when consumers are very particular about their 'ideal bundle', pure components is better.	Matutes and Regibeau (1992)
	G12: In a duopoly between bundlers of goods with zero marginal costs and i.i.d. reservation prices: (a) the firm offering the larger bundle will find it more profitable to add an outside good; (b) by extension, a firm bundling information goods will be able to deter or dislodge a firm that offers a single information good.	Bakos and Brynjolfsson (2000)

marginal costs appear to increase the significance of the individual components *vis-à-vis* the bundle (and vice versa). This explains why guideline G4(a) on the superiority of pure components over pure bundling for independently valued products with high marginal costs extends even to moderate complements (G7(a)). While the power of pure bundling comes from reduced heterogeneity in the reservation prices for the bundle, guidelines G1 and G6(a) (from Schmalensee, 1984 and Stigler, 1963) together suggest how a negative correlation augments this advantage, a point also made by Salinger (1995, p. 98). The presence of a large number of low-marginal-cost products also aids in reducing buyer heterogeneity for the bundle. Guideline G12 (from Bakos and Brynjolfsson, 2000) points out that an aggregator of a larger number of low-cost products can wield greater power through pure bundling compared to a smaller rival.

3. Approaches for bundle design and pricing

At one level, bundling is a product line decision. Therefore product line design and product line pricing approaches have some relevance to bundling. On the other hand, bundling is different from a product line problem because the latter involves a set of 'similar' or substitute products, such as the line of Toyota cars. The products that make up a bundle could have a broader array of interrelationships such as substitutability, independence or complementarity, and positively or negatively correlated reservation prices. Farquhar and Rao (1976) point to the need for 'balance' among products that make up a bundle. McAlister (1982) links consumers' evaluations of bundles to their variety-seeking needs and proposes the concept of attribute satiation as a driver of portfolio choice. While product line approaches are complicated, approaches to bundling are arguably even more challenging (and cumbersome).

Methodological approaches to bundling come in one of two broad types. Design-oriented approaches (e.g. Bradlow and Rao, 2000; Chung and Rao, 2003; Farquhar and Rao, 1976; Goldberg et al., 1984) help identify which among a feasible set of 'products' should go into the bundle (e.g. the composition of a professional basketball team) or what the levels of specific attributes should be (e.g. designing the make-up of a hotel in terms of the type of room, lounge etc.). Pricing-oriented approaches (e.g. Ansari et al., 1996; Hanson and Martin, 1990; Venkatesh and Mahajan, 1993) typically assume a product portfolio and propose the prices at which the individual items and/or bundles should be offered.

There is of course a design element to pricing-oriented approaches in the sense that if the proposed price of a product is 'too high', it essentially means withdrawing the product from the final set of offerings. However, the design focus is lacking in the sense that if a new component (not in the original portfolio) is added, the model has to be re-estimated (see Chung and Rao, 2003, p. 115). Likewise, while a typical design-oriented approach, say of Chung and Rao, answers certain pricing questions, its pricing focus is typically limited to a subset of strategies – pure bundling in Chung and Rao. By contrast, a component level approach, say Hanson and Martin (1990), provides optimal prices for all three alternative bundling strategies. Thus the distinction between a design versus a pricing emphasis in the extant approaches broadly holds.

Based on Chung and Rao's classification, design-oriented approaches are more likely to be attribute-level approaches (e.g. Bradlow and Rao, 2000) that model the complementarity among product attributes to capture bundle-level valuation. Pricing-oriented approaches are typically component level methodologies (e.g. Hanson and Martin, 1990);

that is, they treat 'components of a bundle as the ultimate unit of analysis in describing the utility of the bundle' (Chung and Rao, 2003, p. 115).

A key input for most pricing-oriented approaches is the consumers' reservation prices for the individual products and the bundle. Indeed, significant bias and/or measurement error in eliciting reservation prices could severely affect the appropriateness of the proposed optimal prices. Several recent studies such as Jedidi et al. (2003), Jedidi and Zhang (2002), Wang et al. (2007), Wertenbroch and Skiera (2002), and Wuebker and Mahajan (1999) propose interesting and effective ways of measuring reservation prices. The reader is referred to Chapter 2 in this book by Jedidi and Jagpal on estimating or eliciting reservation prices.

We now discuss representative design- and pricing-oriented approaches to bundling.

3.1 Design-oriented approaches to bundling

The diversity in the bundles to be designed has led to several types of design-oriented approaches. Our review focuses on the following routes summarized in Table 11.4:

- Hybrid categorical conjoint analysis (Goldberg et al., 1984)
- Balance model (Farquhar and Rao, 1976) and its later adaptations (e.g. Bradlow and Rao, 2000; Chung and Rao, 2003) (Rao and colleagues, hereafter)
- Co-branding approach (Venkatesh and Mahajan, 1997).

Table 11.4 contains the inputs to and outputs from each approach, and its key strengths and weaknesses. We devote this subsection to a discussion of the underpinnings of each approach.

(Hybrid categorical) conjoint approach Conjoint analysis is a well-established methodology in marketing for evaluating consumers' preferences for multi-attribute items and, in turn, as a product development tool. Goldberg et al.'s (1984, GGW) hybrid categorical conjoint approach is an improvement over basic conjoint in that it can deal with correlated attributes (e.g. hotel room price is typically correlated with room size) and provide bundle combinations and price premiums (i.e. express 'the price premiums for each amenity and also for competing bundles of amenities', GGW, p. S112). The GGW approach is preferable especially when a large number of attributes (40+ in their hotel context) and attribute levels (100+) are involved.

The 'hybrid' aspect of GGW's approach comes from simplifying the data collection task while still accounting for certain individual differences. Each respondent evaluates 'the levels of each attribute (one at a time) on some type of desirability scale' (Wind et al., 1989). The respondent is then exposed to a subset of the universal set of profiles so that only the main effects and select interactions are estimated. The 'categorical' element connotes that unlike with 'ordinal' approaches such as LINMAP, the dependent variable capturing preference need not be ordered. GGW's approach is implemented with 'dummy variable canonical correlation'.

The balance modeling approach The original balance model and its variants by Rao and colleagues have two core premises: one, that the selection of products that go into a bundle should consider the interactions among the attributes that define the

Table 11.4 Comparison of alternative approaches to optimal bundle design

Framework and representative articles	Inputs (what the approach needs)	Output (what the approach provides)	Strengths	Limitations
Conjoint analysis • Goldberg et al. (1984) (GGW)	• Respondents' choices at an attribute level, preference importance of attributes, and the likelihood of choosing specific bundles: collected in three phases	• The bundle of amenities and add-ons to be offered, and associated prices (or premiums) • Attribute importance and part-worths	• Extends conjoint analysis to the case of correlated attributes (as in bundling contexts) • A large number of attributes and levels can be handled with categorical hybrid conjoint	• As with traditional conjoint studies, cost of the offerings is not factored in; profit implications of bundle design are unavailable
Balance model • Bradlow and Rao (2000) • Farquhar and Rao (1976)	• Respondents' assessments on which product(s) from a feasible set balances a given (pair of) product(s); pairwise comparisons	• Identification of the best balanced product combinations • Classification of attributes as balancing, non-balancing, or non-essential	• 'Balance', a fundamental driver of consumers' bundle-choice decisions, is captured • Models bundle-level decision as a multi-attribute problem, helps clarify sources of interdependencies	• Pricing is not the focus; determining the makeup of the bundle is • Number of products making up a bundle is exogenous (to keep data collection manageable)
Comparability-based balance model • Chung and Rao (2003)	• Consumers' self-explicated bundle choices in a series of choice tasks, and reservation prices for their 'best' bundle • Consumers' ratings of the products on importance and comparability	• Identification of market segments for candidate bundles • Estimation of consumers' bundle-level reservation prices • Optimal bundle prices	• Integrates the key elements of conjoint analysis and balance model • Considering assortments across product categories improves upon prior balance modeling articles	• Mixed bundling strategy is not considered • Classification of attributes based on their balancing character could overlook perceived differences across consumers

Co-branding approach • Venkatesh and Mahajan (1997)	• Consumers' reservation prices for alternative co-branded offerings, and allocation of preference intensities between brands within each offering	• Best alliance partners and product combinations • Optimal prices, profits and (asymmetric) benefits for the respective partners	• By modeling the enrichment or suppression among brands, clarifies the asymmetric returns to alliance partners • General parametric distribution used to capture heterogeneity in valuations and (dis-synergies)	• Model is implemented for a product with two component brands only

products; and two, the bundle so chosen should be one that provides the best balance of features.

Balance represents the 'general harmony [among] the parts of anything, springing from the observance of just proportion and relation' (*Oxford English Dictionary*). Balance, as Rao and colleagues note, could come from homogeneity on some attributes and heterogeneity on others. Setting aside 'non-essential' attributes, the balance approach seeks to classify the remaining essential attributes as balancing and non-balancing. Balancing attributes can be equibalancing or counterbalancing; consumers seek heterogeneity on counterbalancing attributes (e.g. color, as in the assortment of shirts that consumers might like to own) and homogeneity on equibalancing attributes. Non-balancing attributes are those on which consumers wish to maximize (or minimize) aggregate scores as with quality (or costs).

The seminal paper in the stream by Farquhar and Rao (1976) – implemented in the context of scheduling TV programs – takes consumers' self-explicated measures on a series of 'balance'-related questions (see Table 11.3) and uses linear programming to classify attributes and select the most balanced bundle(s) from the possible alternatives.

The extension proposed by Bradlow and Rao (2000) relies on a hierarchical Bayesian model to implement the balance framework at the level of individual consumers as in their magazine or video purchasing behavior. The approach can help managers identify the best prospects for pre-existing product assortments as well as identify the specific bundle that would be appealing to the highest number of customers.

While the above two articles deal with bundle selection in 'homogeneous' categories (e.g. among television programs), the recent article by Chung and Rao (2003) proposes how a bundle of items from across categories could be identified. The approach tackles the possible non-comparability among attributes – a problematic issue for the traditional balance model. The proposed approach gets consumers' input to trifurcate attributes as comparable, partially comparable and non-comparable. Comparable attributes essentially become system-level attributes with possible interaction. Also, while computing sums and dispersion scores, the approach weights the components differently depending on their importance. The authors apply their approach to the context of personal computer systems.

Co-branding approach Bundles of co-branded products, such as 'Lenovo PCs with Intel Inside', represent an emerging class of product combinations. Such bundles arise out of firms' motivation to emphasize their core competencies and forge alliances with synergistic partners. Unlike the other examples discussed in this subsection, co-branded bundles represent a coming together of two or more firms. The Venkatesh and Mahajan (1997, VM) approach is suitable for partner selection and pricing in co-branded bundles.

VM note that it would not suffice to consider only the aggregate payoffs from the co-branded bundles. Rather, the payoffs attributable to either partner should be distinguished because the benefit or cost from forming the brand alliance could be asymmetric depending on the prior reputation of the two brands and the nature of spillover. The approach defines a positive spillover to a brand as 'enrichment' and a negative spillover as 'suppression'. The heterogeneity in consumers' valuations for the base bundles (those between a branded offering and a generic) and in the perceived spillover effects are used to identify the best partners, the asymmetric benefits to the partners, the optimal prices and

premiums for the baseline and co-branded bundles, and the corresponding payoffs. These decisions and outcomes are clarified in the context of the personal computer category and involving Compaq and Intel.

3.2 Approaches to bundle pricing

We devote this subsection to a discussion of the following three significant and diverse approaches to bundle pricing. These are summarized in Table 11.5:

- Mixed integer linear programming (Hanson and Martin, 1990)
- Probabilistic approach (Ansari et al., 1996; Venkatesh and Mahajan, 1993)
- Choice experiment-based hierarchical Bayesian approach (Jedidi et al., 2003)

While each approach's inputs and outputs, and the key strengths and weaknesses, are shown in Table 11.5, our discussion below focuses on the underpinnings and the key empirical findings.

Mixed integer linear programming approach Bundle pricing is a particularly complicated problem when the number of products is three or higher. With n distinct products, the number of possible offerings – consisting of all standalone products and bundles – is 2^{n-1}. Hanson and Martin's (1990) mixed integer linear programming approach is appropriate for a monopolist seeking to set the optimal prices for such a large-scale problem, given the right inputs.

The approach requires consumers' (or their segments') reservation prices and the seller's unit variable costs for all the possible offerings. In the limit, a segment could be made up of a single consumer. Making a reasonable set of assumptions, the article first establishes that a profit-maximizing vector of prices exists provided that each customer will purchase exactly one product or bundle or neither. A disjunctive approach that reduces computational times is used to determine the optimal solution. The approach is implemented with survey data on consumers' preferences for home services such as apartment cleaning.

Probabilistic approach While bundling articles typically assume that the key constraint at the consumer level is the willingness to pay, the probabilistic approach of Venkatesh and Mahajan (1993) and Ansari et al. (1996) is relevant for products such as entertainment or sports events for which other constraints such as available time are also significant in consumers' decision-making. While Venkatesh and Mahajan's approach is aimed at a profit-maximizing monopolist, Ansari et al. extend it to non-profits such as certain symphonies and museums. The components in these instances are the individual events or games, and the bundle is the package of such events. The single and season ticket prices are optimized.

The two studies, based on the same dataset and similar consumer choice processes, are probabilistic in the sense that they recognize potential consumers' uncertainty with finding the time for temporally dispersed events, even when they may have strong tastes for the events in question. The modeling approach translates the dispersion in consumers' reservation prices for the individual events and the heterogeneity in their time-related uncertainty to the bundle level, and provides the optimal single and season ticket prices.

Table 11.5 Comparison of alternative approaches to optimal bundle pricing

Framework and representative articles	Inputs (what the approach needs)	Output (what the approach provides)	Strengths	Limitations
Mixed integer linear programming framework • Hanson and Martin (1990)	• Consumers' reservation prices for components and bundles • Marginal costs of components and bundles	• Optimal prices of the bundle and components • Consumers' choices and surpluses	• Superior to alternatives when a large number of components and bundles is involved • Programming tool developed by authors has interactive, decision support capability	• Focus is on setting actual prices, not on providing strategic insights • Framework is not at the attribute level and hence sensitivity of results to product additions is hard to assess
Probabilistic framework • Ansari et al. (1996) • Venkatesh and Mahajan (1993)	• Distributions of consumers' resources and preferences (e.g. heterogeneity in available time and willingness to pay) • Fixed and variable costs of the bundle/components	• Optimal prices of the bundle and/or components under pure components, pure bundling and mixed bundling • Associated profits and, hence, the optimal bundling strategy	• Integrates consumers' preference intensities (e.g. reservation prices) and constraining resources (e.g. available time) • Suited for time-variant consumption (e.g. concerts) • For-profit and non-profit contexts compared (Ansari et al.)	• Makeup of the bundle is exogenous (i.e. components that go into the bundle are predetermined) • Underlying heterogeneity on any dimension is assumed to be unimodal
Choice experiment/ hierarchical Bayesian framework • Jedidi et al. (2003)	• Consumers' reservation prices inferred through choice experiment • Fixed and variable costs of the bundle/components	• Joint distribution of reservation prices for the individual products and bundle; approach accommodates non-additivity and correlated valuations • Optimal prices, profits and the optimal bundling strategy	• Model is rooted in utility theory and allows for interrelationships among product offerings • No-purchase option captures price expectations and reference effects	• Makeup of the bundle is exogenous, as above • Assuming normal (Gaussian) heterogeneity in component-level valuations is moot for a practical methodology

In the empirical context of a series of entertainment events, Venkatesh and Mahajan find that while mixed bundling is more profitable, the single and season ticket prices have to be optimized simultaneously. That is, starting with the optimal price from pure bundling (say) and sequentially determining the component prices is likely to be suboptimal. Also, ignoring the heterogeneity in available time is likely to bias the prices significantly upward. Ansari et al. find that a non-profit is likely to offer more events and set lower prices. As increasing total attendance is more important for non-profits, pure bundling becomes more attractive than pure components.

Choice experiment-based hierarchical Bayesian approach The above two types of approaches assume that consumers' reservation prices are available, through the use of other approaches. Jedidi et al.'s (2003) choice experiment-based hierarchical Bayesian approach is apt when the seller wishes to arrive at the multivariate distribution of reservation prices for the bundle(s) and the component products, and then apply a built-in algorithmic procedure to arrive at product line prices.

The estimation of the multivariate reservation prices consists of two steps. A (hybrid) choice-based experiment makes up the first step to infer respondents' reservation prices. This part includes a no-purchase option which helps capture competitive and reference price effects, and obtain 'dollarmetric reservation prices' (Jedidi et al., 2003, p. 111). With the choice information and the corresponding price points from the first step, and with the assumption that the true distribution of reservation prices for the offerings is multivariate normal, a hierarchical Bayesian framework is used to estimate the parameters of the joint posterior distribution. Any non-additivity in bundle-level valuations is captured under this approach. The optimization algorithm to obtain the optimal prices of the product line is routine, and requires as input the marginal costs of the various offerings.

The above study by Jedidi et al. yields the following empirical results: charging high prices for the bundle(s) and the individual products is profit maximizing only when there is considerable heterogeneity in the valuations of these offerings. Otherwise, specific products/bundle(s) have to be priced low.

4. Conclusion

Consumers often purchase baskets of products from across product categories. Even when they plan to buy integrated products such as a car, they evaluate its components and how these interact. It is this issue of interrelationships among products that lends meaning and power to the strategy of bundling. Of course, the seller's own desire to reduce costs, increase efficiencies and challenge competition gives added meaning to bundling.

Our objective in this chapter has been to review and synthesize the extant literature on the design and pricing of product bundles. We have looked at the normative guidelines for bundling and pricing as well as the empirical approaches to actually design or price product bundles. Our conclusion from a normative angle is that mixed bundling does not always trump pure bundling and pure components. Indeed, depending on factors such as marginal costs, correlation in reservation prices, complementarity or substitutability, and competition, it may be appealing to the seller to pursue pure components or pure bundling. On the practical approaches, the seller has to be clear about the issues s/he is facing because different approaches apply depending on whether the focus is on design or pricing. Other deciding factors are the number of products in the portfolio, whether

these products are predetermined or have to be identified, type of data that are available or can be collected, and so on.

Space constraints have forced us to leave out several other exciting domains of bundling research. Among them are behavioral approaches to bundling that draw on behavioral decision theory and experimental evidence to argue that the assumptions of classical economics may not always hold. For example, Soman and Gourville (2001) show that for bundles of temporally dispersed events (e.g. a four-day ski pass), consumers' likelihood of attending later events (e.g. skiing on the fourth day) is lower than that for earlier events. The authors draw on the sunk cost literature to propose 'transaction decoupling' as the underlying theoretical rationale. Soman and Gourville's findings point to a research opportunity for modelers to propose an approach for overselling and pricing later events in a series. Separately, on the topic of price framing, Yadav and Monroe (1993) find that consumers separate the savings from a bundle into two parts – savings on the individual items if purchased separately, and the additional savings from buying the bundle. An implication is that even when pure bundling is the optimal strategy, a seller should consider offering the individual components as decoys that make the bundle more attractive than what rational behavior might suggest. Analytical research would benefit by recognizing these perspectives.

While we have drawn on some bundling articles motivated by e-commerce, there are several other relevant contributions to bundling (e.g. Rusmevichientong et al., 2006; Venkatesh and Chatterjee, 2006). Indeed, real-world developments in e-commerce and technology offer exciting opportunities for future work on bundling. We urge a closer look at these research avenues.

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