

Operations Management and Business Pricing

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Abstract

The field of revenue management originated within the operations research community and is concerned with demand management and related pricing decisions. Pricing has not traditionally been one of the mainstream operations management (OM) concerns, but revenue management is attracting a substantial amount of OM research. While revenue management has had significant impact on the management of demand and pricing for *consumer* services, the management of *business* pricing decisions has received comparably much less attention within this community. This paper reviews fundamental differences between business and consumer commerce, discusses current business pricing practice, brings to light gaps between this practice and revenue management based pricing research, and identifies future trends for research and applications in the area of business pricing that might benefit from OM research.

1 Introduction

The field of revenue management originated within the operations research community and, quoting Talluri and van Ryzin (2004, p. 2), “is concerned with *demand-management* decisions and the methodology and systems required to make them.” Talluri and van Ryzin (2004, p. 6) define revenue management as follows:

The process of managing demand decisions with science and technology – implemented with disciplined processes and systems, and overseen by human analysts (a sort of “industrialization” of the entire demand-management process) – defines modern RM [revenue management].

Revenue management was born in the airline industry from the observation that an empty seat after departure constitutes lost revenue, because seats cannot be stored after a plane takes off. It has enjoyed tremendous success in practice during the past twenty years, with major applications in the airline and travel and hospitality industries (Smith et al. 1992, Geraghty and Johnson 1997, Boyd and Bilegan 2003) and, more recently, in retailing (Elmaghraby and Keskinocak 2003). Revenue management has now become a respected and

active area of research. While pricing has not traditionally been one of the mainstream operations management (OM) concerns, as explained in §4, revenue management is now attracting substantial attention within the OM research community (Geoffrion 2002, Buhman et al. 2005, Kouvelis et al. 2005). Thus, with important exceptions (see, e.g., Petruzzzi and Dada 1999, Van Mieghem and Dada 1999, Chod and Rudi 2005), pricing research in this community significantly overlaps with revenue management research.

Revenue management practice and research have had significant impact and made important contributions, respectively, to the management of demand for *consumer* services, but this community has given considerably less attention to the management of *business* pricing decisions. Business pricing in this paper is interpreted in a broad sense and will also be referred to as pricing in business markets. In particular, business markets include both *digital* markets where transactions are executed via the Internet, and markets where commerce is not exclusively executed through the Internet. While it is true that the Internet has brought business-to-business (B2B) commerce to the forefront, both in practice and research, and it is difficult to imagine a business market that is completely separated from the Internet, an exclusive focus on B2B digital markets seems too restrictive for the purposes of this paper.

There is a stream of *practice* based work dealing with pricing in business markets. Kasilingam (1996) and Billings et al. (2003) deal with the application of revenue management in the air cargo industry. Secomandi et al. (2002) discuss a structured conceptual methodology for revenue management business development and its application to the broadcasting, health care, and natural gas pipeline industries. Bichler et al. (2002) illustrate potential flexible-pricing applications in B2B e-commerce. Bollapragada et al. (2002) and Born et al. (2004) discuss implementations of decision support systems in the broadcasting and health care industries, respectively. Elmaghraby (2004) and Harvey et al. (2004) present case studies dealing with dynamic pricing in B2B e-commerce and the petroleum industry, respectively. Talluri and van Ryzin (2004, Chapter 10) illustrate some potential B2B domains for application of revenue management ideas. Phillips (2005, Chapter 11) discusses simple pricing models with B2B applicability.

Nevertheless, the OM *research* literature has not given sufficient attention to business pricing and, hence, does not seem to have substantially affected the practice of pricing in business markets. Moreover, this literature does not include (1) an account of the current pricing practice landscape in business markets, (2) an analysis of the gaps between theory and practice, and (3) a discussion of future trends that could both stimulate and benefit

from OM research in the area of pricing in business markets. This paper contributes to this literature by addressing each of these three dimensions.

This paper contrasts business and consumer commerce (§2), reviews current business pricing practice (§3), and briefly discusses the revenue management approach to pricing and its relevance to OM (§4). After arguing that there exist significant gaps between this theory and current business pricing, mainly due to the predominant B2C and operational focus of revenue management (§5), this paper discusses futures trends in the area of business pricing from an OM angle, that is, by emphasizing the role that OM can play in this area of research and applications (§6). It concludes with a discussion that summarizes the relevance of OM research to business pricing, points out implications for OM researchers, and emphasizes the pricing of business services as an application area with high potential practical impact (§7).

2 Business Versus Consumer Commerce

The terms B2B and business-to-consumer (B2C) commerce are different names for what used to be called industrial and consumer commerce in the pre-Internet era. Their “e-” versions, i.e., the terms B2B and B2C e-commerce, came about with the widespread usage of the Internet to conduct commerce. However, since the acronyms B2B and B2C are so widespread in the literature, they will be employed in this paper to refer both to Internet-based and non-Internet-based commerce. Given this clarification, it is not surprising that the literature contains excellent descriptions of the differences between B2B and B2C commerce under the more traditional headings. Table 1, adapted from Karmarkar (1996, p. 131), summarizes some of these basic differences (see also Hutt and Speh 1998 and Anderson and Narus 2004).

The most apparent difference between B2C and B2B commerce is that the B2B customer is not an individual, as in the B2C case, but a firm. Hence, the economic model of B2B customer is quite distinct from the B2C customer model. Instead of maximization of an individual’s utility subject to a budget constraint (as in B2C), an appropriate B2B model is the maximization of profit, subject to capacity constraints in the short term. In other words, while B2C demand is linked to an individual’s utility or value function, B2B demand is associated with a firm’s production function (broadly interpreted to encompass both the manufacturing of goods and the provision of services). This means that B2B demand is derived or, in Karmarkar’s words (1996, p. 130), B2B “*demand functions are imputed from*

Table 1: Basic differences between B2C and B2B commerce (adapted from Karmarkar 1996).

Topic	B2C	B2B
(1) Customer	Individual	Firm
(2) Model of customer	Utility or value function	Production function
(3) Product valuation	Taste and preference	Value to firm, profitability
(4) Source of value	Consumption	Productivity, competition
(5) Attributes valued	Perceived product characteristics	Impact on time, cost, quality, flexibility, revenue
(6) Decision makers	Consumer	Agents (employees) of the firm
(7) Buying-decision process	Introspection	Management process (hierarchies, teams)
(8) Size of market	Many customers	Few customers
(9) Typical transaction	Arm's length, price-quantity market mechanism	Bilateral contracting, multi-issue negotiation
(10) Monetary value of typical transaction	Small	Large
(11) Data availability	Large	Small
(12) Customer analysis	Statistical	Subjective
(13) Knowledge of individual customers	Limited	Substantial

production functions and not [directly] from consumption behavior.” These considerations immediately imply that the valuation of a product by a B2B customer is driven by the additional value or profitability that a firm derives from purchasing a product. For a B2C customer, this valuation is instead driven by factors such as individual taste and preferences, i.e., the determinants of an individual’s utility function. In economic terms, the source of value to a B2C customer is the consumption of the product, while a B2B customer obtains value by improving its productivity or its competitive stature within its particular industry. It follows naturally that the product attributes valued by a B2C customer relate to the product characteristics as perceived by the individual, while product attributes have relevance to a B2B customer in terms of their impact on its operations as measured by time, cost, quality, flexibility, and revenue.

From a decision-making perspective, a B2C decision maker is typically a single individual who makes a purchasing decision based on introspection, even though this decision may also be made by a small group of consumers, as in the case of a family making a joint purchasing decision for a durable product such as a car. In contrast, in the B2B case the decision makers customarily consist of a group of employees who act as agents of the firm, whose

buying decision is driven by managerial processes such as team dynamics and organizational hierarchies.

Another fundamental difference is the number of customers, which is large in the B2C case but small in the B2B case. Hence, a firm selling to individuals interacts with many different customers through arm's length transactions, characterized by prices set by a price-quantity market mechanism. In contrast, a firm selling to other firms typically deals with a small number of customers by negotiating bilateral contracts where price is only one of a variety of issues being bargained. The monetary values of these contracts are also much larger than those of typical B2C transactions. The contractual nature of most B2B transactions is well recognized in the academic and technology literatures (see, e.g., Lucking-Reiley and Spulber 2001, Bichler et al. 2002). In particular, Boyd and Bilegan (2003, p. 1382) report that according to *The Economist* (2000), 80-90% of B2B trade is based on extended-term contracts. While B2C transactions can also be thought of as contractual agreements (e.g., magazine subscriptions and contracts for cellular phones, access to the Internet, and apartment leases), the key element that sets them apart from B2B transactions is their dramatically simpler commercial structures, with purchases executed with little or no negotiation. B2B agreements tend to have complex structures and inevitably entail a fairly pronounced negotiation process, carried out through bilateral trades, auctions or requests for proposal/quote.

An important implication of these differences is that in the B2B case fewer customer and fewer transactions translate into lower availability of data than in consumer markets, that is, there are simply fewer historical data points. Indeed, the wealth of data in the B2C case, combined with the availability of computerized reservation systems, has been one of the fundamental enablers of revenue management in the airline industry (Boyd and Bilegan 2003). In contrast, lack of data has long been identified as one of the main explanations for the limited number of management science applications in industrial marketing (Webster 1978). This means that while statistical analysis of customer purchasing behavior is a well established method of analysis in the B2C case, in the B2B case such analysis is necessarily more subjective in nature. Nevertheless, it is important to recognize the positive impact on data availability of the following communication and information technologies: computerized enterprise-resource-planning/customer-relationship-management (ERP/CRM) systems and B2B e-commerce, which, according to Lucking-Reiley and Spulber (2001), "refers to the substitution of computer data processing and Internet communications for labor services in the production of economic transactions." It is also important to emphasize that while it

is true that data availability is lower in B2B than in B2C, the knowledge that companies have about their *individual* customers is substantial in B2B and limited in B2C. This does not contradict the previous statement, it only states that, typically, in B2B firms have a better understanding of who their individual customers are and of their *aggregate* purchasing behaviors.

3 Current Practice

This section reviews current business pricing practice. After a very brief discussion of what still appears to be the most widespread business pricing approach, cost-plus pricing, it illustrates a business pricing approach and a tool, value pricing and the price margin waterfall, respectively, which have made significant inroads in practice. It reviews more quantitative business pricing applications, one based on data driven price adjustments and two based on operations research methods, which are distinct from the previous approaches in terms of the analytical sophistication of their models. Finally, it briefly discusses the real option pricing approach, with an emphasis on commodity markets.

Cost-plus pricing. Cost-plus pricing sets a product price by marking-up its unit cost. Nagle and Hogan (2006, pp. 2-3) note that “[c]ost-plus pricing is, historically, the most common pricing procedure” employed in practice, but they also point out the following basic limitation of this approach, which follows from the assumption that a product unit cost does not change with its volume: its application requires one to allocate the product fixed costs based on sale volume, which itself depends on the price being charged. This circularity undermines the validity of this approach.

Value pricing. Value pricing is an approach to pricing popularized by Nagle and Hogan (2006), and is sometimes referred to as strategic pricing. In contrast to cost-plus pricing, the philosophy of value pricing is to charge customers according to the value that they obtain by using a company’s products. Cost considerations remain obviously important, because one does not want to sell unprofitable products, but the emphasis of this approach is on creating value for customers and charging in relationship to this value. Value pricing has gained some acceptance both in practice and in MBA education at some institutions.

Parker Hannifin Corp. manufactures various industrial components, such as pumps, tubing systems, micrometering devices, and power units. This company has embraced value pricing with significant success: this approach boosted operating income by \$200 million

since 2002, when this company started adopting value pricing, and its return on investment has also risen from 7% in 2002 to 21% in 2006 (Aeppel 2007). The application of value pricing at this manufacturer was based on segmenting the more than 800,000 products that this company produces into five categories, and adjusting the existing prices by -3% to more than 25% depending on the category (Aeppel 2007). This company also integrated value pricing into its new product development and innovation processes, focusing on developing products that offer the greatest potential for commanding price premia in the marketplace.

While value pricing is also relevant in B2C settings, it seems a natural pricing approach for B2B applications. In light of the discussion in §2 regarding the model of customer demand, this statement follows from the fact that in B2B it may be easier to estimate the value that a customer derives from using a company's product, since this estimation can be based, at least in principle, on tangible elements, that is, how it affects the customer's operations.

The pocket margin waterfall. The pocket margin waterfall is a data analysis and reporting tool, covered thoroughly by Marn et al. (2004), which firms can employ to consider the full impact of their pricing decisions. This tool accounts for all transaction specific and off-invoice elements that impact the profitability of a transaction. Examples of these off-invoice items include annual volume bonuses, end user rebates, consignment costs, and market development funds. While the pocket margin waterfall does not suggest a specific price to charge for a given product, it does provide a full picture of the status quo regarding the pricing of this product that conveys important information for making subsequent price adjustments.

Data driven price management. A number of companies have moved beyond simple data analysis in making their business pricing decisions. An approach that is rapidly gaining momentum in this area is data driven price management. (Vendavo is a provider of such solutions to customers in several industries, including chemicals, industrial manufacturing, high technology, and distribution.) A data driven price management model seeks to identify pricing opportunities by quantifying two key metrics: pricing *power* and *risk*. Pricing power is a predictor of a company's ability to shape price in a customer segment. Its computation leverages data such as deal win percentage, price variance across deals, number of deals requiring management review, and number of deals eventually approved by management. It does not typically involve the concept of price elasticity. Pricing risk is a measure of the business at risk and is quantified by using deal attributes such as revenue, margin, volume, and the skewness of the historical price distribution.

Once power and risk scores are quantified, an appropriate pricing objective can be assigned to each customer segment based on a set of rules that use these scores. These rules can be determined based on mathematical analysis, but empowering business managers to set them makes the results more likely to be implemented and used. Pricing objectives include the following: maintain price levels, moderate or aggressive price increase, and increase sales force scrutiny. For example, an aggressive price increase could be applied to segments with a power score greater than 70 and a risk score below 25. The output of the model is a set of deal guidance parameters, e.g., a target price, various management approval thresholds, and a hard floor, determined according to the pricing objectives. For instance, setting the pricing objective to increase sales force scrutiny will raise the management approval thresholds requiring management intervention for more deals.

The advantage of the data driven price management approach is that its users are in control of how the model determines the deal guidance parameters. On the other side, the challenges in using this approach are linking the dimensions of pricing power and risk to specific business factors, and developing appropriate rules.

Operations research based business pricing. The NBC (Bollapragada et al. 2002) and TCH (Born et al. 2004) implementations are two examples of the use of operations research methods to support business pricing decisions. NBC is “in the business of delivering eyeballs (audiences) to advertisers” largely through its television network (Bollapragada et al. 2002, p. 47). At the beginning of May of each year, NBC faces the problem of selling advertising slots for the next broadcast year that starts in September. Most inventory is sold in the up-front market during two or three weeks in late May. Left over inventory is sold in the scatter (spot) market during the remainder of the year. In preparing for the up-front market, NBC develops a detailed sales plan that account executives use to negotiate deals with advertising agencies, which correspond to a customer base of about 250 customers. Bollapragada et al. (2002) report that NBC developed a suite of models to forecast demand for air slots, optimize the generation of the sales plan, and aid the deal negotiation process.

TCH is a provider of health care services for children. TCH delivers these services to individual patients, but the revenue associated with their provision is essentially driven by large contracts with insurers (or payors) rather than payments by individuals. Therefore, TCH faces the problem of negotiating contractual agreements with payors. TCH manages a portfolio of contracts that, at any point in time, may consist of 50 to 200 active contracts. Most of these agreements never expire but are periodically renegotiated. Born et al. (2004)

report that the system developed at TCH forecasts patient encounters (demand) under a given contract and optimizes the contract prices to minimize the total variance of margin risk subject to a target expected margin constraint. A distinguishing feature of this system is its ability to forecast demand at the disaggregate level of patient encounters by modeling the hierarchical relationship between contracts and their associated patient encounters through Bayesian hierarchical forecasting techniques.

These brief summaries highlight important parallels between the features that distinguish B2B and B2C commerce (Table 1 in §2) and the NBC and TCH business problems. At the contractual level, these companies deal with a limited number of customers by bilaterally negotiating contracts, each characterized by a large monetary value, according to specific management processes. For example, NBC account executives negotiate directly with customers, and each deal is reviewed by sales management to ensure that it meets all of NBC's requirements. This process is hierarchical in nature. In addition, contract valuation by NBC/TCH customers is driven by considerations related to gains in profitability, productivity, or competitive stature. For example, Born et al. (2004, p. 55) state that the "complex collection of services offered [by TCH] and the myriad ways to package and price them provide many opportunities for structuring highly productive contracts."

The solutions developed at NBC and TCH differ in terms of methods, but these differences are not fundamental when seen in terms of their decision support functionalities. In both cases, the developed systems employ forecasting models to project the demand for perishable inventory, optimize the pricing of such inventory, and support the negotiation of contracts for the provision of services. In particular, Bollapragada et al. (2002, p. 58) report that the developed system allows NBC to forecast demand by show and by week, inform the pricing of this inventory, minimize the amount of premium inventory used to satisfy a client requirements during contract negotiation, and use this information to target profitable customers. Born et al. (2004, pp. 54-55) point out that the developed system enables TCH to forecast demand at the level of patient encounters, and to incorporate this information in an optimization model that offers TCH opportunities to negotiate contractual terms to which insurers may not be sensitive. In both cases, the ability to forecast demand at a disaggregate level (individual shows at NBC, patient encounters at TCH) provides contract managers/negotiators with the ability to individuate opportunities for customer targeting (at NBC) and for renegotiation of underperforming contracts (at TCH). In summary, the systems developed at NBC and TCH support decisions related to (1) profitable targeting

of customers and (2) negotiation (and periodic renegotiation) of contractual agreements for the provision of services by (3) leveraging in a fundamental manner the ability to forecast demand at a low level of detail, and to exploit this disaggregate forecast to determine how demand is likely to exert pressure on the firm's available inventory in the future.

Real option pricing. Real option pricing is significantly different from the previously discussed approaches, and has a financial economics origin (Trigeorgis 1996). Applied to real assets, e.g., a natural gas pipeline, this approach values (prices) the asset cash flows by dynamically constructing portfolios of futures contracts that replicate them. ("A forward contract on a commodity is a contract to purchase or sell a specific amount of the commodity at a specific price and at a specific time in the future" and a futures contract is a standardized forward contract; Luenberger 1998, pp. 264-265.) Since futures prices can be observed in the marketplace, the current price of the financial portfolio is also that of the real asset. This approach is widely applied in the energy and commodity industries (Smith and McCardle 1999), which feature vibrant futures markets, such as the Chicago and the New York Mercantile Exchanges. In this approach, the main focus is on modeling the evolution of commodity prices, typically as stochastic processes, since these prices enter the real asset cash flow definition. For example, the value of the capacity of a natural gas pipeline that connects two geographical markets clearly depends on the difference between the prices in these two markets. Real option pricing can also be applied in the absence of futures contracts, e.g., in noncommodity industries, based on equilibrium arguments (see, e.g., Smith 2005).

4 OM and Pricing: Revenue Management

As pointed out in §1, OM-based pricing research significantly overlaps with revenue management, whose main tenets are now reviewed. This section does not attempt to provide a detailed review of revenue management models and applications since there already exist several up to date reviews of both revenue management research (Caldentey and Bitran 2003, Elmaghraby and Keskinocak 2003) and practice (Boyd and Bilegan 2003); the reader is also referred to Talluri and van Ryzin (2004) for a comprehensive introduction to this field. The discussion here is focused on highlighting specific aspects of the revenue management approach to demand management and pricing, and their relevance to OM.

Following Talluri and van Ryzin (2004), it is useful to distinguish between quantity-based

and price-based revenue management decisions, with the former including capacity control and overbooking and the latter dynamic pricing and auctions. The basic revenue management approach is to employ demand forecasting and optimization models to generate control parameters, such as capacity allocations, overbooking levels, and prices, which are then used to support the management of demand given a firm's available capacity (in quantity-based revenue management) or jointly with the management of production/inventory decisions (in some price-based revenue management models).

Demand forecasting models are statistical in nature, with the most recent models aimed at modeling consumer choice behavior. Price-based models usually model demand for products using demand functions based on the notion of price elasticity. Since demand management and pricing decisions are made over time, the optimization models are based on the dynamic programming formalism. However, their solution approach combines math programming (in particular linear programming) and stochastic optimization in an approximate dynamic programming fashion, which is needed to efficiently deal with the large scale of the resulting optimization models.

The OM community has recently recognized the importance of revenue management as a set of tools to match supply and demand when the supply exhibits inflexibility. In other words, what makes revenue management relevant to OM is its coupling of demand management and pricing decisions with the consideration of the firm's capacity availability or production/inventory management. Bitran and Caldentey (2003, p. 203) state that it "is our strong belief that pricing policies are [...] a fundamental component of the daily operations of manufacturing and service companies" and that they are "a tool that helps to regulate inventory and production pressures." Geoffrion (2002), Swaminathan and Tayur (2003), and Kouvelis et al. (2005) share similar views. This explains why revenue management has now entered the OM curriculum (see for example the textbooks by Chopra and Meindl 2004, Cachon and Terwiesch 2006, and Van Mieghem 2008). Incidentally, this is also what distinguishes revenue management from marketing.

5 Gaps Between Theory and Practice

It is useful to compare the current business pricing practice reviewed in §3 with the revenue management approach to support demand management and pricing decisions, with the goal of identifying gaps between the two. The most striking gap is that revenue management

predominantly deals with B2C applications, where the demand being managed originates directly from consumers. For example, Boyd and Bilegan (2003) review two classical revenue management applications in the airline and hotel industries, and Elmaghraby and Keskinocak (2003) discuss dynamic pricing practices in retailing. This B2C orientation continues to characterize more recent applications. For example, Smith et al. (2007) discuss how Travelocity became a more effective travel retailer. While most of the models employed in this work appear different from those employed in traditional revenue management practice and research, the focus of this application is fundamentally of the B2C type.

To be fair, as briefly pointed out in §1, not all revenue management applications have a B2C focus. For example, cargo revenue management (Kasilingam 1996, Billings et al. 2003) is a *bona fide* business application of classical revenue management models that support the demand management decisions of providers of transportation services to industrial shippers and forwarders. However, this seems to be more the exception than the norm. One could label the NBC (Bollapragada et al. 2002) and TCH (Born et al. 2004) implementations reviewed in §3 as examples of the use of revenue management *principles* in B2B environments, but their models have very little in common with typical revenue management models.

Moreover, not all revenue management research, as opposed to practice, has an exclusive B2C focus. Those models that integrate capacity management and inventory/production planning decisions with pricing could well be interpreted as having a B2B orientation. These models show a strong parallel with some OM models that deal with due date and capacity/order management in a manufacturing setting (see, e.g., Keskinocak and Tayur 2004, Kapuscinski and Tayur 2007). However, those models dealing with price setting decisions typically employ demand functions based on the concept of price elasticity. While it is clear that business, as opposed to consumer, demand is still price sensitive, the demand functions employed in these models strongly resemble those that one obtains when modeling consumer utility maximizing behavior. These comments do not apply to those models that do not make price decisions. However, these models represent demand in a fairly simplistic manner that does not capture the richness of business demand discussed in §2.

Another important gap relates to the hierarchical level of the types of decisions supported by revenue management, both in practice and research, relative to the full range of business pricing decisions made in practice. Section 3 shows that business pricing decisions span multiple hierarchical levels: economic valuation of (new) products at the strategic level, setting of list prices at the tactical and planning levels, and negotiation of discounts at the

operational level. As discussed in §4, revenue management essentially deals with operational pricing decisions, and the OM community sees it as a regulator to optimize capacity utilization or inventory replenishment and production planning decisions. In this OM view, pricing becomes a support tool for managing operational processes.

Notice that Talluri and van Ryzin (2004, pp. 2-3) categorize demand management decisions as being of the structural, price, and quantity type. Structural decisions encompass choices on the selling format, segmentation, terms of trade, and product bundling. Price decisions address the problem of how to set prices in the context of a given configuration of structural choices. Given a set of structural and price decisions, quantity decisions include the choice of when inventory/capacity should be sold, or how it should be allocated to different products/customers or channels of distribution. While these decisions can be also categorized as strategic, tactical, and operational, revenue management has predominantly dealt with operational demand management decisions.

Finally, revenue management appears to have very little in common with the real option pricing approach in commodity industries. The former is employed in settings where the seller can actively manage the demand that it serves or the prices that it charges, while in the latter prices are determined by market clearing conditions. Thus, it is not obvious that revenue management ideas could be usefully integrated, especially in applications in commodity industries, even though Anderson et al. (2004) combine revenue management and real option techniques in the car rental industry (a B2C setting with some commodity-like features), and Secomandi (2007) shows how revenue management and real option methods can be integrated to value natural gas pipeline capacity (a B2B setting in a commodity industry).

To summarize, the existing body of revenue management practice and research is inadequate to deal with business pricing issues because of its predominant B2C orientation, its price elasticity approach to model demand (in price-based revenue management models), the otherwise mostly crude modeling of demand in those models that integrate demand management and capacity and inventory/production control, and its substantial operational orientation. In particular, with their focus on operational demand management, existing revenue management models do not address the strategic valuation issues that are instead important in business pricing. Moreover, there is very little work dealing with the integration of revenue management and real option ideas. Yet, the revenue management principles of forecasting demand and superimposing it on the firm's resource availability during dif-

ferent time frames through optimization models remain relevant to inform business pricing decisions, as exemplified in the NBC and TCH applications (see §3).

6 Future Trends

In outlining future trends for OM based research in the area of business pricing, it is useful to briefly present the different types of strategies that a firm can adopt, as well as the different hierarchical levels of pricing decisions that a firm needs to make. In the former case, the Delta Model is a strategic framework proposed by Hax and Wilde II (2001) that seems particularly relevant in this respect. In the latter case, the industry strategy, product/market strategy, and transaction distinction discussed by Marn et al. (2001, Chapters 3-5) is pertinent.

As explained in detail by Hax and Wilde II (2001), the Delta Model unifies and extends both Porter's Competitive Strategy model and the Resource-Based View of the firm. The starting point in the Delta Model is the triangle that summarizes three possible strategic options: best product (BP), total customer solutions (TCS), and system lock-in (SLI). In the BP strategy, a firm attracts its customers based on specific aspects of its products, due to low cost, which commands a price advantage to the customer, or to differentiation, which provides uniqueness of features that customers value and are willing to pay for in excess of what charged by the firm competitors. The firm focus in this case is on its own supply chain and its competitors. In the TCS, a firm develops a profound understanding of its individual customers, and customized value propositions and relationships with each of them yield strong bonding between them and the firm. Instead of the inward focus typical of the BP strategy, in the TCS case the firm has an outward focus that emphasizes its own and its customers' supply chains, while it deemphasizes the role played by the competition. In the SLI case, individual customers continue to play an important role, but the firm now is also concerned with the role played by the complementors, which are firms whose own offerings make customers value more the firm's products. In this case, the firm focus is the widest possible, since, relative to the TCS case, it also includes bonding with its complementors.

At the industry strategy level, the pricing decisions made by a firm relate to studying and predicting the long-term dynamics of price, which in turns require studying the same dynamics for demand and supply. At the product/market strategy level, the firm pricing decisions involve segmenting its customers, valuing its products from their perspectives, and structuring contracts with them. At the market tactical level, the firm sets medium-term

Table 2: Future trends on operations and business pricing.

Hierarchical Level	Strategic Option		
	BP	TCS	SLI
Industry (Strategic)	Long-term industry price dynamics	Long-term industry/multi-industry price dynamics	
Market (Strategic)	Product valuation for a generic customer (market) and contract structuring	Product bundle valuation for specific customers	Product bundle valuation for specific customers with complementors
Market (Tactical)	List price setting	Customer value splitting	Customer value splitting with complementor effects
Transaction (Operational)	Discount price negotiation	Real-time adjustment to customer value splitting	Real-time adjustment to customer value splitting with complementor effects

prices for its products, which would typically be customized at the customer level. (The product/market strategy level includes both strategic and tactical decisions.) Transaction is the lowest level, where the firm pricing decisions involve pricing each individual transaction relative to the medium-term prices. It is clear that the three levels of pricing decisions are related in a hierarchical fashion. Also, the product/market strategy label is not completely satisfactory for the purposes of the ensuing discussion, since it overly emphasizes product without mentioning customers. Hence, this label is simplified to market in the remainder of this paper.

Table 2 displays future trends in the business pricing area that can benefit from OM research. These trends are organized according to the types of strategic option and levels of pricing decisions presented above. Each of these trends is now discussed in detail. The order of presentation is by type of strategy and, within each strategic option, by hierarchical level of the pricing decision. We give more emphasis to the BP strategy case, because, according to Hax and Wilde II (2001), this is the strategic option adopted by most companies. This also sets the stage for the discussion of the TCS and SLI cases, where we only highlight additional aspects that are specific to these strategies.

6.1 BP Strategy

Industry (strategic) level. At the utmost level, a firm adopting the BP strategy is interested in predicting the long-term evolution of its product prices. Such prediction cannot be made separately from the modeling of capacity investment at the industry level, i.e., the modeling of the “industry operations.” Industry equilibrium models can be useful in this respect. These models solve for the equilibrium capacity investment and resulting price paths for specific products. Examples of such models are the econometric and math programming models used in the energy and commodity industries (see, e.g., Murphy and Shaw 1995, Hogan 2002). In noncommodity industries, oligopoly, as opposed to perfect competition, models are more relevant (see, e.g., Corbett and Karmarkar 2001, Bernstein and Federgruen 2004, Carr and Karmarkar 2005, Corbett and Deo 2006). It is clear that such long-term capacity related decisions are within the OM scope of attention, but usage of industry equilibrium models in OM applications has so far been limited. One important exception is Mudrageda et al. (2004), but OM based work in this area is still limited. One challenge in using these strategic models is linking their analysis to those related to firm specific models and decisions, both at the strategic and lower hierarchical levels. This area of research appears to be largely untouched.

Market (strategic) level. At the firm strategic level, the firm needs to assess how its customers value its products. This could be done by developing economic valuation models of the firm products. The real option literature offers a rich set of tools in this regard (Trigeorgis 1996), which can also be applied in noncommodity industries (Birge 2000, Smith 2005). Smit and Trigeorgis (2004) have recently advanced the possibility of merging oligopoly and real option models to support strategic capacity investment decisions. By modeling how customers use its products over time, the firm can estimate the economic value that they derive from them. One aspect that is particularly relevant to OM research is that these models can benefit from accurate modeling of the role played by the firm’s products within its customers’ operations. One difficulty here is that within the scope of the BP strategy, the firm may not have specific knowledge of its customers’ operations, and these valuation models may have to be set up at the market (generic customer) level. It is also important to stress that industry level models are not unique to business settings, but the inputs required to apply them in a business environment do reflect the basic differences between business and consumer markets discussed in §2, e.g., the fact that business demand is derived from

consumer demand.

Recall from §2 that in business settings firms bilaterally negotiate contracts with their customers. The choice of how to structure these contracts is important because it can affect the value a company can create by transacting with a customer. For example, the potential inefficiency of wholesale price contracts in supply chain management are well known (Cachon 2003). Several other types of business contracts exist. They may depend on the variability of the customer product-margins and/or demand in a way that enables the seller to dynamically shape demand. Thus, the seller obtains better utilization of capacity and can offer better service to those customers who are willing to pay more for purchasing capacity when they need it. In addition, such contracts may include minimum/maximum quantities, options on additional output/capacity, cancellation penalties, and financial hedging clauses (such as price escalation clauses).

The extensive literature on industrial organization and contract theory (see, e.g., Tirole 1988, Bolton and Dewatripont 2005) is relevant to support contract structuring choices. Its application to supply chain contracting and information sharing (see Cachon 2003 and Chen 2003 for reviews, respectively) provide important insights that could be used to support these decisions, e.g., the forecast of the flow of products associated with a buy back contract would be structurally different from the forecast of the demand stream associated with a wholesale price contract. However, a limitation of this literature is its focus on manufacturing rather than services (see §7). Empirical research is also needed to investigate the effectiveness of theoretically optimal contracts in practice and the relative performance of suboptimal contracts used in practice. The paper by Gopal et al. (2003), dealing with the empirical analysis of contracts in offshore software development, is an example of this line of research.

Both theoretical and empirical research is valuable because, while theoretical work can provide valuable insights, it makes little sense to put in place contractual structures that are fundamentally flawed, have been shown empirically to have a negative impact on the firm's performance, or are simply impractical. Hence, a practice based research stream, based on surveys and/or case studies, is also needed to build institutional knowledge on how business contract structuring decisions are made within specific organizations, and to document differences and similarities among firms, in the same industry and across industries. An example of this type of research, whose focus is however not on contract structuring, is Chapter 10 in Talluri and van Ryzin (2004), which provides profiles of several industries from the standpoint of actual or potential revenue management decision support.

Market (tactical) level. Once the firm has made capacity and contract structuring strategic decisions, perhaps informed by a model of the economic value that the market places on its products, the next level in the hierarchy of pricing decisions is the tactical setting of product list prices in the medium term. (This statement assumes that the firm employs contracts that include a list price, e.g., a wholesale contract, an assumption that continues to hold in the ensuing discussion within the context of the BP strategy.) List price setting is where price-based revenue management models can prove useful, since at this level the firm is interested in setting medium-term prices given its capacity choice. List price optimization can be approached from the standpoint of network pricing models, as those described by Talluri and van Ryzin (2004, Chapter 5), augmented with relevant variable costs. The generic revenue management principle of determining prices based on coupling a firm's capacity with the demand for its products remains valid in this setting, but the model of demand would be different in a business, as opposed to a consumer, setting.

While it is plausible that a firm's demand for its products would decrease when the firm charges higher prices, how demand would do so depends on the role played by the firm's products in the operations of those businesses that purchase them. OM based research can play an important role in supporting demand modeling at this level, because (at least part of) the demand faced by a company in a business setting reflects the *procurement* decisions of those firms in a downstream position in the supply chain. The demand model could consist of a simplified representation of the role played by the firm's products within its customers' operations. Such a model would enable the seller to evaluate the impact of its product availability on its customers' operations with respect to the status quo, both in terms of volume and profit change, hence providing key information to estimate demand, both in terms of quantity and willingness to pay.

Transaction (operational) level. At the operational level, the firm adjusts its list prices to reflect short-term and real-time variations both in its operations, i.e., capacity or supply availability, and in its customers' operations, which in turn might be related to variations in their own demand. List price adjustments are negotiated, and typically they take the form of discounts for specific products. While these could be upward, rather than downward, adjustments, it may be difficult for a firm to command an increase above its list price, and these price adjustments will be assumed to be discounts in the remainder of this paper. This is the level where existing revenue management models might prove to be most relevant. However, there are two aspects that are not addressed in the current literature and

that future research will need to account for.

As in the determination of list prices, one aspect is related to the derived nature of business demand, which will have to be reflected in the demand forecasting models. The TCH application points to the importance, for improved forecasting accuracy, of understanding the relationship between aggregate demand (at the tactical level) and disaggregate demand (at the operational level), and modeling the hierarchical relationship that exists between them, possibly through Bayesian forecasting techniques. The main challenge is hierarchically relating this data to that available at the tactical and strategic levels, possibly by blending it with the more subjective knowledge available to managers at these higher levels.

The other aspect has to do with the negotiated nature of business transactions. The literature on bargaining is relevant here. Raiffa et al. (2003) present the negotiation-analytic approach to negotiated decision-making, which draws on decision analysis, behavioral decision theory, and game theory. The goal of negotiation analysis is to give useful advice to negotiators based on prescriptive analysis, in the sense of “how real people could behave more advantageously with some systematic reflection” (Raiffa et al. 2003, p. 1). Hence, this approach tries to give advice to negotiators to perform as well as they can, given the imperfections and actual behaviors of others. In other words, this approach has an asymmetrically *prescriptive/descriptive* orientation, whereby the negotiation analyst prescriptively supports one party in the negotiation process by employing a descriptive representation of the other party’s decision-making behavior. In a commercial negotiation context, this approach might be well suited to model important human interaction effects, which may include personal relations, the length of the business relationship, mutual trust, and commitment. The challenge here is obtaining an accurate descriptive model of customer behavior. A perhaps less ambitious endeavor, which is however more heroic in its assumptions, is to employ the normative, game-theoretic approach to bargaining (see, e.g., Myerson 1991, Chapters 8 and 10, and Cachon and Netessine 2004, §4) in an asymmetric *prescriptive/normative* sense. While normative models may not always accurately describe how customers make decisions in bargaining settings, they may still prove to be useful for decision support purposes.

Regardless of how one might model customer price negotiation decisions, the revenue management and negotiation-analytic and/or game-theoretic literatures can complement each other. The latter contain models that can be used to model the outcome of a negotiation given that the value of the best alternative to a negotiated agreement (or BATNA value for short) for each party is known (the BATNA value for the two negotiating parties are their

respective values of walking away from the bargaining table with no deal made between them). The former provides models that can be modified to compute these BATNA values. Bhandari and Secomandi (2007) make a first attempt at this integration by developing a dynamic revenue management model with negotiated prices.

The transition between the tactical and operational levels requires consideration of the issue of how to properly incentivize the salesforce to adopt the firm's pricing decisions/guidelines set at the tactical level. The discussion in Nagle and Hogan (2006, pp. 119-20) is pertinent here. Even if tactical prices were set to maximize profit, motivating the salesforce based on revenue would largely negate the potential effectiveness of these prices. As stated by Nagle and Hogan (2006, p. 119), "giving salespeople revenue-based incentives and empowering them to negotiate prices is a toxic combination that poisons the motivation to sell value." The key point here is to link salesforce compensation to profitability. Nagle and Hogan (2006, Exhibit 6-6, p. 120) discuss a simple, and apparently effective, practical method, but more research is needed in this area.

6.2 TCS Strategy

Industry (strategic) level. The bonding between a firm and its customers plays a unique role in the TCS strategy and its related future trends. At the strategic level, industry equilibrium models continue to be relevant, but these models are better described as multiindustry models. This is due to the strong relationship between a firm and its customers, and the fact that the latter may operate in different industries than the firm's one. Hax and Wilde II (2001, pp. 57-62) provide an insightful discussion of this situation in their description of the TCS strategic option for Codelco, in the copper industry, and Alcoa, in the aluminum industry. Under the TCS strategy, these companies, both operating in commodity industries, looked beyond their own specific industries to the industries where their customers operate, e.g., the electricity and data transmission industries for Codelco, and the automotive industry for Alcoa, among others. A key feature of multiindustry equilibrium models is the modeling of interindustry interfaces. This is an area that can benefit from OM research since it involves capturing the links between the operations of interrelated industries (see, e.g., Carr and Karmarkar 2005).

Market (strategic) level. In business settings firms deal with a small number of customers and the value of a single customer, relative to the total value of a firm's customer portfolio, can be large (see §§2-3). In this environment, one of the most important strategic

choices a firm has to make is deciding which customers to serve and, more generally, how to build profitable relationships with them, i.e., customer bonding. CRM is an approach designed to support these decisions that includes the following activities/components (Winer 2001): a database of customer activity, analysis of the database, deciding which customers to target based on the results of this analysis, tools for targeting customers, relationship building with the customers, dealing with privacy issues, and success measurement metrics. The goal of CRM technology is to provide marketing managers with a tool to determine the value of each individual customer, based on data analysis, and to target customers accordingly, e.g., through a variety of media, possibly including the Internet. Hax and Wilde II (2001, pp. 170-174) provide an insightful discussion of the role of CRM within the TCS strategy.

CRM has coined the term lifetime customer value (LCV) to refer to the profitability of a customer, from the perspective of the seller, during a “long” period of time. With this a value in hand, a marketing manager can select which customers to target and/or retain. There is a growing marketing literature on designing quantitative models to optimize the CRM marketing intervention mix (see, e.g., Rust and Verhoef 2005, Rust and Chung 2006). The objective of these models is to optimize the change in the long- or intermediate-term profitability of the company’s customers, where profitability is derived from subtracting direct and marketing related costs from future revenue streams. This is an area where OM research can play an important complementary role with respect to marketing research. Under the TCS strategy, the objective of the firm is to develop a strong bonding with each of its individual customers. Hence, one of the areas where OM research is particularly relevant is the modeling of the *integrated* operations of the firm and each of its customers, i.e., the firm-customer complex, when estimating a customer LCV.

In contrast to the BP strategy, the focus shifts from the valuation of a generic customer to the valuation of specific customers with respect to their usage of a bundle of the firm’s products. In addition, while in the BP case the contract structure plays a central role in determining the value created by the firm and a customer, in the TCS case contract structuring decisions may play a less prominent role. In this case, the firm and its customers develop deep and collaborative business relationships, and their primary focus is more likely to be on maximizing the total value created by the firm-customer complex, than structuring a contract that eliminates the potential inefficiencies that competition might create. However, since creating value requires combining the firm’s and its customers’ resources, this process inevitably requires negotiation of differing views, even if the parties involved operate in a

collaborative environment. Thus, contract structuring, that is, value splitting, decisions remain important in the TCS case. The information sharing literature developed in the context of supply chain management is relevant here (see, e.g., Chen 2003).

Market (tactical) level. Tactical splitting of value between the firm and its customers in the TCS case is analogous to list price setting in the BP case. As in the latter case, capacity has been set at the strategic level and value splitting is a tactical level business pricing decision, made simultaneously with medium-term capacity and inventory/production decisions. This decision can be supported by extended revenue management models. What is different from list price setting in the BP case is that in a collaborative environment the firm and each of its customers can *jointly* develop these models. Moreover, while in the BP case a firm's model of its customer demand is an exogenous input to the list price optimization model, in the TCS case the customer requirements can be derived endogenously in a model that links the firm's and its customers' operations, which in turn depends on a representation of its customers' own demand. The literature on collaborative forecasting and replenishment is relevant here (see, e.g., Aviv 2004).

Transaction (operational) level. This tactical division of value needs to be adjusted at the operational level to take into account real-time changes in the firm's and its customers' operations. As in the BP case, these adjustment decisions continue to be negotiated and opportunely modified revenue management models can be useful in supporting them. The concept of BATNA value, both for the firm and its customer, remains relevant here. Given the collaborative nature of the TCS strategy, estimation of these values could be implemented by exploiting the capabilities of existing information and decision support systems, e.g., by running sensitivity analyses based on the ERP systems of the firm and its customers.

6.3 SLI Strategy

The future trends associated with the SLI strategy extend those discussed in the TCS case. As summarized in Table 2, the main extension is the firm's need to consider the role played by the complementors. At the strategic level, the industry/multiindustry equilibrium model would have to take into account the effect of the complementors on the industry demand for the firm products. The complementor definition directly implies that the supply and/or the demand models with complementors should be different than the same models without them. For example, since the complementors enhance the firm's offering, one would expect to see more customer demand for the same value provided by the firm, or a higher willingness

to pay given the same amount of customer demand served by the firm. Similar observations apply to the supply, when the complementors enhance the firm's production or distribution efficiency. Thus, both in the equilibrium models and in the valuation of customers, it would be important to capture the operations of the complementors, and how changes thereof might affect the supply of and/or the demand for the firm's products. Similarly, the splitting of value created by the firm, the complementors, and the customers becomes relevant at the tactical level, and changes in the complementors' operations need to be considered in the real-time division of this value at the operational level. Modeling multiparty (buyer, seller, complementor) negotiations might be also relevant.

7 Conclusions

This section summarizes the relevance of OM in the context of the outlined future trends, examines the implications for OM researchers in pursuing them, and highlights the pricing of business *services* as a timely application area with significant potential practical impact.

OM relevance. OM is relevant to the outlined future trends for the following reasons.

1. At the industry level, the focus is on modeling the operations, that is, the supply and demand processes, of an entire industry or of multiple industries. While this has not been the typical focus of OM researchers, this modeling effort can benefit from a *managerial* and *decision support*, as opposed to a public policy/economic, orientation in terms of the output of the analysis to be conducted.
2. At the strategic market level, detailed modeling of the operations of a firm's customers and of the operational implications of contract structuring decisions seems important to obtain an accurate representation of the firm's demand. Investigation of these issues can benefit from the extensive literature on supply chain management and contracting. At the tactical market level, the profile of the firm's capacity and inventory availability/replenishment over time becomes relevant to make medium-term pricing decisions. OM seems to be remarkably well positioned to contribute to the development of the outlined trends at the market level.
3. At the transaction level, leveraging current revenue management research and applications to address the negotiated nature of business transactions seems particularly appealing. In addition, the design of proper incentives to the salesforce can build on

the emerging literature on incentives in operational settings. This is also an area where OM is well positioned to contribute to the study of the outlined trends.

Implications. The main implication of the discussion of the outlined future trends is that OM-based pricing research should *broaden* its scope beyond revenue management. As discussed in §4, the primary interest of OM researchers in the field of revenue management is the ability of its tools to act as regulators of demand in operational situations distinguished by supply inflexibility. This operational view remains important in business pricing, but OM research in this area should also address issues related to industry equilibrium models, contract theory, real option valuation, design and management of incentives, negotiation analysis, and bargaining theory. An additional implication is that OM researchers should forge ties with researchers in these areas. Several interfaces between OM and other fields are relevant here: OM-Marketing, OM-Accounting, OM-Economics, and OM-Finance. While some of these interfaces have already been the object of investigation by OM researchers, others are only starting to emerge, e.g., the OM-Finance interface.

Another implication of the previous discussion is the need to integrate the different hierarchical levels that characterize business pricing decisions. This is a great opportunity for OM, which has developed substantive knowledge in the management of hierarchical systems, in particular production planning systems (see, e.g., Hax and Candea 1984, Chapter 6). While business pricing does not coincide with production planning, the challenge in managing the hierarchy of business pricing decisions shares similarities with the challenge of managing the hierarchy of production planning decisions, and can benefit from existing research in this area. For example, the following is an excerpt from Hax and Candea (1984, p. 395):

The obvious alternative to a detailed monolithic approach to production planning is a hierarchical approach, where decisions are made in sequence. Aggregate decisions are made first and impose constraints within which more detailed decisions are made. In turn, detailed decisions provide the feedback to evaluate the quality of aggregate decision making. Each hierarchical level has its own characteristics, including length of the planning horizon, level of detail of the required information and forecasts, scope of the planning activity, and type of manager in charge of executing the plan.

These observations remain relevant for the management of business pricing decisions. However, apparently very few, if no, methods are available in the literature to manage the

hierarchical cascade of business pricing decisions.

One insight of previous OM research in hierarchical production planning is that even in the unlikely event that one might be able to efficiently solve a monolithic model that explicitly addressed all the relevant issues at the strategic, tactical, and operational levels, the usefulness of this model in practice might be in question. This is well articulated by Hax and Candea (1984, p. 393):

[...] production management encompasses a large number of decisions that affect several organizational echelons. These decisions can be grouped into three broad categories:

1. strategic decisions, involving policy formulation, capital investment decisions, and design of physical facilities
2. tactical decisions, dealing primarily with aggregate planning
3. operational decisions, concerning production scheduling issues

These three categories of decisions differ markedly in terms of level of management of responsibility and interaction, scope of the decision, level of detail of the required information, length of the planning horizon needed to assess the consequences of each decision. These considerations have led us to favor a hierarchical planning system to support production management decisions, which guarantees an appropriate coordination of the overall decision-making process, but, at the same time, recognizes the intrinsic characteristics of each decision level.

This insight should be useful for informing future research on hierarchical business price management.

The success of revenue management in practice has implications for the development of the outlined trends. First, revenue management originated from practice, and it is important that the advocated future research trends be grounded in practice and informed by the concerns of managers, both in terms of methods and insights. In fact, the ultimate success of the proposed research hinges on the development and use of systems to support business pricing decisions. Second, with the benefit of hindsight, part of the practical success of revenue management is due to the types of models employed in applications, which arguably satisfy Little's (1970) requirement that a model to be used by a manager should be simple,

robust, easy to control, adaptive, as complete as possible, and easy to communicate. These same criteria should enlighten the design of business pricing decision support systems.

Pricing systems tend to interface with systems used in such functional areas as operations, marketing and sales, and finance. This points to the relevance of linking any system supporting business pricing decision to other systems used within the firm and across firms, leveraging Internet based information technologies, such as ERP/CRM and e-commerce systems. The implication here is that the methods to be developed should exploit these decision support environments. For example, an ERP system provides both the data, mainly in terms of supply, and the transactional mechanism needed to conduct pricing analyses. A CRM system provides customer/demand related data. These systems have benefited from e-commerce, e.g., the ability to use Internet communication technology to streamline the execution of business transactions. Any business pricing system, especially at the tactical and operational levels, could similarly benefit from being connected to these internal systems and, potentially, to the ERP/CRM systems of the firm's customers (especially in the TCS and SLI cases) and/or complementors (in the SLI case). This improved ability to leverage and exchange information, support the development of relationships among the firm, its customers, and its complementors, and aid the negotiation related to the division of value created by this network of players has also been recognized by Hayes (2002) as an important feature impacting OM research in the Internet economy.

Business services. The future trends outlined in this paper span the management of both manufacturing and service operations, but developing them in the latter area seems to hold more promise both in terms of research novelty and practical impact. A large part of the extensive supply chain management literature can be interpreted as managing B2B operations. For example, the basic single-manufacturer/single-retailer setting is clearly a B2B environment, and the study of what contractual structures coordinate this simple supply chain could be labeled as an investigation of the effectiveness of different contract structuring strategic pricing decisions. At the tactical and operational levels, there also exists a substantial literature on the integration of inventory/production management with pricing, and more generally, marketing decisions in manufacturing environments (see, e.g., Eliashberg and Stenberg 1993 and references therein).

In contrast to the extensive manufacturing operations literature, the volume of the service operations literature is substantially smaller (see, e.g., Roth and Menor 2003; Fitzsimmons and Sullivan 1992, Schmenner 1995, Lovelock 1988, and Fitzsimmons and Fitzsimmons 1994

are textbook treatments of service OM). Fitzsimmons and Sullivan (1982, p. 26) observe that in service operations “the traditional separation of the production and marketing functions, with inventory at the interface, is neither possible nor appropriate.” Karmarkar (1996, p. 129) points out that “because of the concurrency of production and consumption, services require a deeper examination of the service process – one that does not attempt to decouple marketing issues from operations and production.” Hence, the future trends discussed in this paper should produce results that are significantly different from those generated by previous research focusing on the integration of inventory/production-management and marketing decisions in manufacturing.

Developing these future trends by focusing on services seems also more relevant from the point of view of practical impact. This follows from the fundamental service orientation of the U.S. economy and of those of the other major developed countries (see, e.g., Schmenner 1986, Karmarkar 2004, Rust and Chung 2006, and the service OM textbooks referenced above). In such an environment, recent developments, such as the growing importance of outsourcing (*BusinessWeek* 2006), make the management of demand for B2B services a key managerial concern. Examples of potential applications abound: executive education programs, software development, financial, telecommunications, transportation, and insurance services, services related to the trading of commodities, energy, and financial derivatives, and professional services such as design and market research, various information technology services such as data storage and web hosting, call answering services, and, more generally, the outsourcing of entire business processes. For instance, consider the case of Navitaire. According to *BusinessWeek* (2006), this company “can manage reservations, plan routes, assign crew, and calculate optimal prices for each seat” for airlines. In other words, this company allows airlines to outsource key business processes such as fleet assignment, crew scheduling, and revenue management itself.

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