



Game theoretic pricing models in hotel revenue management: An equilibrium choice-based conjoint analysis approach



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HIGHLIGHTS

- Bridges economics and marketing by exploring (non)price competition in a game theoretic conjoint analysis approach.
- Develops a framework where hotels with different attributes sustain different prices but still are in equilibrium.
- Uses conjoint analysis to measure the relative weights of attributes, and to handle the inclusion of a none-option.

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ABSTRACT

This paper explores a game-theoretically founded approach to conjoint analysis that determines equilibrium room rates under differentiated price competition in an oligopolistic hotel market. Competition between hotels is specified in terms of market share functions that can be estimated using multinomial logit models of consumer choice. The approach is based on choice-based conjoint analysis that permits the estimation of attributes weights (“part-worths”) for an additive utility formulation of the utility function. From this, room rates that equilibrate the market, conditioned on the differences in services and facilities offered by competing hotels, can be determined. The approach is illustrated by an example.

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1. Introduction

Pricing is perceived to be one of the most difficult marketing decisions in hotel management practice (Dutta, Zbaracki, & Bergen, 2003; Johansson, Hallberg, Hinterhuber, Zbaracki, & Liozu, 2012; Van der Rest, 2006). It is variously seen as: the centerpiece of strained customer relationships, a strategy used to steal market share, and a source of intra-company conflict. Not unexpectedly, pricing tops the list of problematic issues in marketing (Dolan &

Simon, 1996). Moreover, behaviors such as price collusion, deceptive price advertising, and predatory pricing have enormous impacts on consumer welfare. ‘It is not surprising then that a great deal of government legislation and judicial decision making focuses on the pricing behavior of firms’ (Grewal & Compeau, 1999, p. 3). Over the years, pricing has, therefore, attracted research in the areas of economics, law, accounting, marketing, operations research, and more recently strategic management (Van der Rest & Roper, 2013). Much of this work utilizes some degree of economic analysis.

Economic analysis of price is founded on the notion of equilibrium (Bridel, 2001). Through time the concept of equilibrium has received both academic and practitioner criticism. As early as Edgeworth (1881), doubts were casted about the stability of equilibria. von Hayek (1937, pp. 43–44) stated: ‘the only justification for this is the supposed existence of a tendency toward equilibrium [...

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] an exercise in pure logic'. Game theoretic models of oligopoly pricing accommodate an embarrassingly rich set of equilibria, which cannot all be mapped in terms of observables to patterns actually observed in markets (Vives, 1999). Comparative studies spanning different types of markets have led to the conclusion that the concept of equilibrium has only limited validity in the real-world (Fog, 1994).

In the field of hospitality a number of equilibrium pricing models have been proposed, with notable contributions from Baum and Mudambi (1995), Chung (2000), Friesz, Mookherjee, and Rigdon (2005), Gu (1997), Guo et al. (2013), Pan (2006), Schwartz (1996), Song, Yang, and Huang (2009), Wachsmann (2006), and Yang, Huang, Song, and Liang (2008). However, this body of knowledge suffers from some obvious limitations from a hotel marketing and business practice perspective, in as much as it relies on conventional price theory – 'both as a paradigm for guiding theoretical model development and as a conceptual framework for steering empirical efforts' (Diamantopoulos & Mathews, 1995, p. 19). Pricing in practice is 'much more complex than any theoretical perspective suggests' (Diamantopoulos, 1991, p. 166). As Gijbrecchts (1993, p. 117) laments, commenting on Tellis' (1986) unifying taxonomy of the many pricing strategies described in the literature: 'as a "simple" integrative scheme, [the approach] can provide only an indirect treatment of some important issues [...] In real life, a manager may [...] face the problem of combining various principles into one set of pricing rules.' As Bonoma, Crittenden, and Dolan (1988, p. 359) argue, 'it seems that academic researchers have not known, or do not focus on, the key pricing concerns of managers in order to conduct rigorous pricing research'. In the words of Cressman (1999, p. 456) who observes an overreliance on neoclassical price theory whilst reviewing Noble and Gruca's (1999) proposal to integrate existing theoretical pricing research into a new two-level framework for pricing strategies: 'why are there no pricing practices based on the value delivered to customers in the marketing literature?'

Conventional price theory does not offer practical decision rules by which hotels can make actual price decisions in practice. Theory's task has been to explain certain (rational) decisions or outcome, 'excluding or holding constant many real variables that are not germane to its theoretical objectives' (Nagle, 1984, pp. 3–4). Neoclassical economics focuses on the distal end *state* or equilibrium (outcome) of the process by which prices are formed. No reference is made to the behavioral decision *process* by which hotels arrive at prices. And yet, economic theory does provide 'useful heuristics for understanding the consequences of action' (Nagle, 1984, p. 4). Concepts and insights, analytical methods, and models can be brought to bear on various practical pricing decisions. Ultimately, hotel pricing policy is the task of marketing and revenue management. As Hauser (1984, p. 65) states: 'in the extreme, price theory in economics deals with how markets behave, while price theory in marketing science deals with how managers should act'.

Economic analysis is not the only approach to optimizing prices and revenue. In recent years a whole body of work founded on the well-established tradition of operations research, and not constrained by the limitations of the economic equilibrium paradigm has developed, gaining a strong track record in practical applications (e.g. Pekgün et al., 2013). This field of pricing and revenue management, as reviewed comprehensively in, for example, Weatherford and Bodily (1992), McGill and Van Ryzin (1999), Elmaghraby and Keskinocak (2003), Bitran and Caldentey (2003), and Talluri and Van Ryzin (2004), is less restrictive in the theoretical assumptions. The approach uses methodologies – predominantly stochastic programming and simulation – to address complex optimization problems in perishable asset revenue management (PARM), taking into account, inter

alia, how pricing is affected by demand uncertainty and forecasting errors (e.g. Yüksel, 2007), demand learning (e.g. Den Boer & Zwart, 2014). Applications include the problem of multiple-night stays (Aslani et al., 2013) and upgrades (Gönsch et al., 2013). Whilst game theoretic models in economics predict prices resulting from the dynamic interaction of competitors, such models are unable to incorporate the range of real-world problems that are addressed in the PARM literature. A melding of these different perspective is much needed.

With a view to bridging the gap between theoretical and methodological perspectives of economics and marketing science in the context of hotel revenue management in operations research, this paper explores the potential benefits of integrating conjoint analysis, a statistical technique originating from mathematical psychology, with game theory. We build on Choi and DeSarbo (1993) who propose a mathematical programming approach for product optimization, incorporating competitors' reactions in a game theoretic structure. But, rather than finding the specific set of multi-attribute product alternatives that constitute an equilibrium, this paper focuses on the equilibrium price for each of the competitors, conditioned on the differentiated product attributes and prices offered by all competitors. As the essence of equilibrium pricing among hotels in a local market is differentiated price competition, we use differentiated Bertrand competition as the oligopoly model. Each hotel's profit is driven by its market share which, in turn, is defined as a function of the hotel's own price, and non-price attributes (such as quality, location, and service level), as well as its competitors' price and non-price attributes. It is obvious that hotels with a superior offering on non-price attributes generate customer value which justifies a higher price compared to competing hotels with a lower levels of non-price attributes. Obviously, market prices of hotels may be markedly different from each other in equilibrium (i.e. no hotel has an incentive to change its price, *cet. par.*). To incorporate the preferences of potential guests over attributes, the market share is operationalized through a discrete choice model, the parameters of which can be estimated using choice-based conjoint analysis.

This paper extends Choi and DeSarbo (1993). First of all, it utilizes a choice-based conjoint approach instead of a traditional full profile conjoint approach, which not only brings the model up to date with contemporary standards in conjoint analysis, but more importantly enables the use of the "none-option" in the choice set, making the model more realistic. This is a crucial step towards increasing the practical applicability of equilibrium pricing. Secondly, the model focuses on determining price, which is treated as the only (continuous) choice variable, and treats the other (non-price) attributes as fixed. This is in contrast to the approach by Choi and DeSarbo (1993) where multiple attributes can be optimized over discrete sets.

In this way, the paper specializes the general framework of Choi and DeSarbo (1993) for pricing in the hotel service sector. It seeks to make a beginning in connecting the (oligopoly) pricing literature with contemporary work in revenue management from the field of marketing science and operations research. This should introduce a new perspective to the long-lasting discussion on whether discounting in the lodging industry works (Abbey, 1983; Croes & Semrad, 2012; Enz, Canina, & Van der Rest, 2015; Hanks, Cross, & Noland, 1992, 2002; Kimes, 2002; Van der Rest & Harris, 2008), and whether and to what extent differentiation can protect hotels from the pressure to reduce prices (Becerra, Santaló, & Silva, 2013).

2. Towards a managerial framework

The routines involved in setting room rates for a hotel can be viewed as choices made in a strategic game where the players are

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