

**Nineteenth
International
Working Seminar
on
Production Economics**

**PRE-PRINTS
VOLUME 2**

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*Edited by
Robert W. Grubbström and Hans H. Hinterhuber*

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The Scientific Field of Production Economics

Production Economics focuses on scientific topics treating the interface between engineering and management. All aspects of the subject in relation to manufacturing and process industries, as well as production in general are covered. The subject is interdisciplinary in nature, considering whole cycles of activities, such as the product life cycle - research, design, development, test, launch, disposal - and the material flow cycle - supply, production, distribution, recycling and remanufacturing.

The ultimate objective is to create and develop knowledge for improving industrial practice and to strengthen the theoretical base necessary for supporting sound decision making. It provides a forum for the exchange of ideas and the presentation of new developments in theory and application, wherever engineering and technology meet the managerial and economic environment in which industry operates.

Tracing economic and financial consequences in the analysis of the problem and solution reported, belongs to the central theme.



The International Working Seminars on Production Economics

The purpose of the *International Working Seminars on Production Economics* is to provide an opportunity for research scientists and practitioners to meet, present and develop their ideas on subjects within the field of Production Economics. A *Discussant* is appointed for each paper. The intention is that models and methods presented, and the discussion of them, will result in concrete ideas for future research and developments in this area. These seminars are *working seminars*, indicating that their main aim is to initiate and improve research results and to provide ample opportunities for interaction between Authors, Discussants, Chairmen and Audience, rather than to publish results. The purpose of these *PrePrints* is to have background working material for the discussion.

This special character of the International Working Seminars on Production Economics, most likely, makes them unique in the international landscape of scientific interaction.

First Seminar, Engelberg, Switzerland
February 20-24, 1978

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February 16-20, 1981

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March 3-7, 2008

Sixteenth Seminar, Innsbruck, Austria
March 1-5, 2010

Seventeenth Seminar, Innsbruck, Austria
February 20-24, 2012

Eighteenth Seminar, Innsbruck, Austria
February 24-28, 2014

Nineteenth Seminar, Innsbruck, Austria, February 22-26, 2016

Pre-Prints

**Nineteenth International Working Seminar on Production Economics,
Innsbruck, Austria, February 22-26, 2016**

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Should conference pricing mechanisms incorporate options?

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Abstract

The provision of many services is often characterized by demand uncertainty, as, at the time of purchase, consumers may not be completely informed about their valuation for the service or the possibility to utilize the service when it will actually be provided. For such reason, service providers implement several pricing mechanisms to maximize their profits in presence of consumer uncertainty and heterogeneity. A commonly adopted mechanism is intertemporal price discrimination, under which service providers charge different prices to consumers buying at different times. For instance, a lower price is usually offered to consumer buying early in advance, whereas higher price is practiced to latecomers. More recently, an alternative pricing mechanism incorporating *consumer options* has been proposed. Under this mechanism, consumers are offered early in advance (and at a certain price) the right (but not the obligation) to purchase the service in the future. After uncertainty is resolved, the consumer will decide on whether to exercise the option by paying the exercise price or give up. In this paper, we compare the above mechanisms in the context of academic conference registration pricing mechanism. Specifically, we consider professors' decisions of registering at a conference. Early in advance, some of them are (more) uncertain about their availability to attend the conference as some future, and perhaps more urgent, events may occur. Under intertemporal price discrimination, conference organizers take into account this possibility by offering early and late registration rates. However, conference organizers may instead decide to adopt a pricing mechanism based on consumer options. We investigate the consequences of using either mechanism analytically and then test them experimentally.

Keywords: Service provision, Inter-temporal price discrimination, Consumer options, Option pricing.

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Keywords: Inter-temporal pricing, Market segmentation, Options pricing

1. Introduction

“Should I register now to the SMS Conference to be held in Rome the first week of next June? In the same period my colleague from LUT (Lappeenranta University of Technology) could come to Palermo and we could arrange for a new round of experiments for the paper we want to submit to the International Journal of Production Economics before the summer holidays. But if I register after February, 29th, I'll miss the opportunity to save 200 \$. I'm quite sure eventually I'm going to the SMS Conference, but who knows!” (One of the authors worries).

Conference attendees can enjoy conference fee discount if are willing to commit in advance to it. If they are almost sure to join the conference, they can register early paying an early bird registration fee; otherwise they can wait (in some cases until the conference starts) and pay a higher late registration fee. Despite these rational reasons, often we do not register early because of omission bias (actions are typically regretted more than inaction especially in the short term) (Kahneman and Tversky, 1982): nonetheless you know that you are coming to the conference inertia pushes you to wait until the last minute! Do you experience this unwillingness to commit to your duties? Would you prefer to stay in the middle? If the early registration is 260 \$ and the late one 460 \$, what about to have the flexibility to decide as late as possible and to pay a total amount of 360 \$ with a little penalty in case of no show? How do you value this freedom to not commit? How much are you willing to pay for it? Can also the organizers benefit from a pricing mechanism new in this field?

Uncertainty in valuing products or services offers a wide range of marketing and pricing leverages to the firms, which can exploit market segmentation and offer a variety of price schemes.

The opportunity to try a tangible good (and return it) extends the range of pricing to protection mechanisms against uncertainty that can be hence embedded in pricing policies (full refunds, restocking fee, rebate...). Service characteristics (intangibility, customer's involvement during the service delivery, quality, etc) do not allow exerting to return policies, opening up in the meanwhile

to other scenario for pricing leveraging for example on the sold out risk (for example in case of non repeatable events with a limited capacity like a football match or a concert).

Beside inertia mechanism, scholars couldn't know in advance if conference attendance is the best opportunity for them at the time the conference takes place. In the same period: Will you receive an invitation from a prestigious university? Will you be revising a paper submitted to a top journal? Alternatively, won't the speaker of your favourite keynote of the conference make it unexpectedly? Will the program change over time? This uncertainty doesn't allow valuing the conference in advance when the registration is offered at a discount price and as a result it strengthens those behavioural aspects that lead to postpone decision.

Options price is not new in the literature, however to the best of our knowledge it hasn't been applied to the context we are focusing on neither to heterogeneous customers. Moreover options pricing hasn't not been compared with pricing offering similar leverage to the firms: Sainam et al., 2010, that proposed the option pricing in the sport markets context, compared it with advance selling (pricing before uncertainty is resolved) and spot-market price (pricing after uncertainty is resolved) that fix just one price then it is arguable that they would have turned out less profitable for the firm. In addition, advance selling is nothing more than an options pricing without exercise price; therefore it cannot dominate options pricing method. This research wants to assess the options pricing mechanism in a market with heterogeneous customers and compare it with the widely used inter-temporal pricing mechanism (early bird and late registration). Both pricing methods allow firms to set two prices, namely option plus exercise price and early plus late price, therefore they segment the market in a very similar way (same number of segments, but with different thresholds). As expected, in the hypothesized scenario, expected firms profit and customers surplus do not differ under the two mechanisms. However, the options pricing seems fairer. This point is supported by Sainam et al., 2010 experiments; indeed they find that customer believe that consumer options constitutes a "fair" pricing mechanism (compare with advance selling and spot-market price), even if they end up choosing not to exercise the option ticket. Options like pricing is also preferred to the equivalent partially refundable fares; Galego and Sahin (2009) refer to a discussion with senior managers at Air France bringing up that consumers prefer the real-option alternative because it requires a smaller up-front payment (instead of a higher up-front followed by a reimbursement later). Our model is a generalizable model that fits all the service markets where customers have ex ante a heterogeneous and uncertain service valuation. The model can be extended to take into account competition among conferences and behavioural issues for the potential participants. A literature review sharpens the research contribution; section 3 describes our model and compares inter-temporal pricing and advance selling with options pricing basing on firm's profit and customers surplus; section 4 concludes drawing the research results and speculates about future developments.

2. Literature Review

A very huge body of literature is available on pricing. Indeed, pricing is a very powerful tool to counter-balance, in the customer product/service overall valuation, variables related to the demand and offer-side, but also to product intrinsic characteristics (like fashionable products, perishable products, products with digital rights, new products) or market's ones (products facing counterfeiting issues, second-hands market, etc). Tilson and Zheng (2014) focus on the new products lunch of finitely durable goods pricing when firms have to face with not only the uncertainty in demand for new goods, but also how the future sales will be affected by the older goods that will become available via a second hand market. Zhou et al., (2014) also study pricing for product lunch in the fashion industry and propose a two period pricing model. Avinadav et al. (2014) analyze the relationship between pricing and protection (digital rights management) strategies in a two-echelon supply chain. Zhang et al. (2015) study the pricing problem for a third-party-logistics provider; as customers are

heterogeneous in their valuations, they propose a dynamic pricing strategy and show that with it, if compared with a static pricing, both the provider and its customers are better off.

Moreover, uncertainty about the satisfaction level realized ex post, when the product/service has been experienced, further increases the variety of pricing mechanisms. However, consumers face significant risks related to the value of purchased assets in many product and service markets. These risks can hamper market efficiency. To overcome this problem inter-temporal pricing, that is a dynamic pricing with prices varying over time, has been having a wide application in sports or entertainment events, flights and hotel, and also new products pricing. Inter-temporal pricing mechanisms address inter-temporal consumer behaviour (change in the customer evaluation over time) exploiting market segmentation opportunity and basically consist in lowering the price or increasing it over time. In the first case, a lower price wants to incentive a customer with an ex ante high uncertainty about the value of the product/service; in the second one it leverages on the customer worry about product/service sell out. As an example, consider a business travel who becomes more certain about his ability to travel based on other events, such as unforeseen emergencies, that compete for his time. This topic is clearly related to the economics literature on inter-temporal price discrimination. Literature has investigated different scenarios: on the offer side, monopoly firms (Gale and Holms, 1992) and price taking firms (Dana, 1998); on the demand side, customers with homogenous and heterogeneous behaviour, both in the expected evaluation and probabilities of showing up (Stokey, 1979; Ringbom and Shy, 2004).

Moreover, inter-temporal pricing trigger regret: consumer can regret an early purchase if later he doesn't want the product/service anymore (his valuation is became lower to the paid price), and also late purchase that usually have a higher price or could be no more available (in case of limited capacity). Nasiry and Popescu (2012) address emotionally rational customers, that is customers that take into account in their decision to buy these behavioural aspects related to regret. Their customers' valuation has a common-knowledge cumulative distribution, while they regret heterogeneously. They found that firms should optimally respond to consumer regret and fix a normative regret threshold above which they should not advance sell.

Along with dynamic pricing, firms exert to mechanisms that allow to protect the customer against uncertainty: these mechanisms are based on refund in case of ex post dissatisfaction. Refund can be partial or full, conditioned (Sainam et al., 2015) or unconditioned. Conditioned refunds are contingent upon events that are independent from customers but influence their valuation (in our case a sudden withdraw of a guru in the field of the conference already be listed in the program draft). For example, Sainam et al., 2015 refer to the sports market setting, where a forward allows consumers to make a modest upfront investment to "conditionally reserve" a seat at the tournament, subject to their favourite team making it to that stage. Recently, some firms have offered fans the opportunity to purchase forwards on tickets *before* knowing which teams will play and Sainam et al., 2015 analyze data from one of these companies operating in a sports ticket market to capture fan purchase and resale behaviors. Gallego and Sahin (2010) study refundable fares when customers' valuations are uncertain and evolve over time and firms struggle to find revenue-enhancing market segmentation mechanisms. In their model consumers distribution of the willingness to pay is known in advance but the actual realizations are not known; moreover customers have independent and identically distributed valuations. They argued that, if we ignore the time value of money, pricing with refund possibility can be viewed as a real option. Indeed in presence of real options based pricing, customers buy the option (paying the option price) in advance to have the right to purchase the product/service later paying the exercise price (or strike price); this mechanism is equivalent to buy the product/service in advance at a price equal to option price plus strike price, and be partially refunded later (being refund equal to the strike price) in case of customer changed mind. Gallego and Sahin (2010), show that the use of option in case of limited capacity is socially optimal and efficient. Gallego and Sahin (2009) show that even under competition, capacity providers are better off using partially refundable fares.

So far in the literature about inter-temporal and option/forward pricing customers have identical, even if uncertain, product/service evaluation or their uncertain preferences can be clustered in two groups (Sainam et al., 2010). Our attempt is to consider, with the aim to depict a more realistic situation, ex ante (before uncertainty is resolved) heterogeneous customer with uncertain utilities. Our customers' valuation depends on events that influence all the customers (for example events related to the conference program) and individual events (better alternatives during the conference time or emergencies impeding to attend the conference). Differently from Nasiry and Popescu (2012), we do not consider regret issue but speculate on a market with customers with individual valuation. Moreover, while we refer to the option pricing mechanism already available in the literature (Sainam et al., 2010) we compare it with a similar mechanism as inter-temporal pricing and also with advance selling. This research aims to contribute to the literature of pricing in a monopoly market characterised by customer inter-temporal valuation, investigating consequences of option pricing in terms of firm profit and customer surplus when customers' valuation is heterogeneous.

3. The model

We develop a simple model under three possible pricing strategies utilized by the conference organizers. Specifically, we consider advance selling, where only one price is set early in advance to register to the conference, similarly to the International Working Seminar on Production Economics (IWSPE) held every two years in Innsbruck. We consider the intertemporal price discrimination strategy, where two prices are set: one for early bird registrations and one for late registrations (similarly to the Production and Operations Management Society (POMS) conferences). Finally, we consider consumer options pricing strategy, under which people potentially interested in participating to the conference are given the possibility to buy the option to register at the conference early in advance and later decide whether to exercise the option at a certain price after uncertainty is resolved. However, under the consumer options pricing strategy, only those who have purchased the options have the right to exercise the option.

We assume that potential conference participants suffer from uncertainty early in advance, as they may not be completely informed about events that could occur at the time conference will be held. For instance, more urgent duties may occur, or some other important meetings not scheduled at the time of conference registration may arise. There could be uncertainty about keynote speakers, invited talks or sessions, or certain research topics and authors. All these factors are likely to affect the valuation that participants can have about the conference. We particularly consider the case of an event that changes potential participants' valuation in the same manner. For instance, this could be the case of the presence of a famous keynote speaker that everybody would love to listen and to talk to. We define α the probability that the positive event will occur. Naturally, $1-\alpha$ is the probability that the negative event will happen. We model each potential participant as having his own personal preference about the conference. Specifically, we assume that potential participants are uniformly distributed in an ideal segment of preferences $[0,1]$ and the conference is positioned at 0. Therefore, the potential participants closer to zero are those very loyal to the conference, those close to 1 have low preference about the conference. Each potential participant is identified by its position x in $[0,1]$. In case of positive event, the value attributed to the conference by potential participant located in x is:

$$U_H(x) = v_H - tx \quad (1)$$

where v_H is the base valuation common to all consumers in case positive event and t is a parameter measuring the "weight" of the distance in terms of preference toward the conference. A higher t implies a higher sensitiveness of the valuation with participants'

“distance”. Similarly, in case of negative event, the value attributed to the conference by potential participant located in x is:

$$U_L(x) = v_L - tx \quad (2)$$

In the following subsections we develop the model for each of the three pricing strategies identified above.

3.1 Advance selling

Under this strategy, one price p_{AS} is set by conference organizers early advance before the uncertainty about the positive or negative event is resolved. Therefore, the potential participant located at x will register if:

$$E[S(x)] = E[U(x)] - p_{AS} = \alpha v_H + (1 - \alpha)v_L - tx - p_{AS} \geq 0 \quad (3)$$

Therefore the potential participant indifferent between registering and giving up is:

$$x_{AS} = \frac{\alpha v_H + (1 - \alpha)v_L - p_{AS}}{t} \quad (4)$$

The conference organizers' profit is:

$$\Pi_{AS} = p_{AS} x_{AS} = p_{AS} \frac{\alpha v_H + (1 - \alpha)v_L - p_{AS}}{t} \quad (5)$$

Note that, without loss of generality, we normalize unit operating cost and fixed costs to zero. Therefore, the optimal price, expected number of participants, and expected profit and expected consumer surplus are respectively:

$$p_{AS}^* = \frac{\alpha v_H + (1 - \alpha)v_L}{2} \quad (6)$$

$$x_{AS}^* = \frac{\alpha v_H + (1 - \alpha)v_L}{2t} \quad (7)$$

$$\Pi_{AS}^* = \frac{(\alpha v_H + (1 - \alpha)v_L)^2}{4t} \quad (8)$$

$$E[S_{AS}^*(x)] = \frac{\alpha v_H + (1 - \alpha)v_L}{2} - tx \quad (9)$$

Therefore, the expected (ex-ante) surplus is:

$$E[S_{AS}^*] = \frac{(\alpha v_H + (1 - \alpha)v_L)^2}{8t} \quad (10)$$

Ex post, participants have the following surplus with probability α :

$$S_{AS-\alpha}^* = \frac{(v_L + \alpha(v_H - v_L))((4 - 3\alpha)v_H - 3(1 - \alpha)v_L)}{8t} \quad (11)$$

With probability $1 - \alpha$, the ex-post consumer surplus is:

$$S_{AS-1-\alpha}^* = \frac{(v_L + \alpha(v_H - v_L))(v_L - 3\alpha(v_H - v_L))}{8t} \quad (12)$$

3.2 Intertemporal price discrimination

Under this strategy, two prices are set p_{EB} for those who register early in advance (before the uncertainty is resolved) and p_{LB} for those who register late (after uncertainty is resolved). It can be shown that there can be located three segments in this case. First, those who buy early in advance (before the uncertainty is resolved). Second, those who buy only after uncertainty is resolved and when the positive event occurs. Third, there are those who do not buy.

The threshold participant between the first and the second segment is:

$$x_{EB} = \frac{(1 - \alpha)v_L + \alpha p_{LB} - p_{EB}}{(1 - \alpha)t} \quad (13)$$

The threshold participant between the second and the third segment is:

$$x_H = \frac{v_H - p_{LB}}{t} \quad (14)$$

Therefore, the profit function for the organizers (Π_{int}) is:

$$\begin{aligned} \Pi_{int} &= p_{EB}x_{EB} + \alpha p_{LB}(x_H - x_{EB}) = \\ &= p_{EB} \left(\frac{(1-\alpha)v_L + \alpha p_{LB} - p_{EB}}{(1-\alpha)t} \right) + \alpha p_{LB} \left(\frac{v_H - p_{LB}}{t} - \frac{(1-\alpha)v_L + \alpha p_{LB} - p_{EB}}{(1-\alpha)t} \right) \end{aligned} \quad (15)$$

Therefore, the optimal price, expected number of participants, and expected profit and the expected surplus are respectively:

$$p_{EB}^* = \frac{\alpha v_H + (1-\alpha)v_L}{2} \quad (16)$$

$$p_{LB}^* = \frac{v_H}{2} \quad (17)$$

$$x_{EB}^* + \alpha(x_H^* - x_{EB}^*) = \frac{(1-\alpha)v_L + \alpha v_H}{2t} \quad (18)$$

$$\Pi_{int}^* = \frac{\alpha(v_H)^2 + (1-\alpha)(v_L)^2}{4t} \quad (19)$$

$$E[S_{int}^*] = \frac{\alpha(v_H)^2 + (1-\alpha)(v_L)^2}{8t} \quad (20)$$

Ex post, participants have the following surplus with probability α :

$$S_{int_\alpha}^* = \frac{(v_H)^2 + 2(1-\alpha)v_H v_L - 2(1-\alpha)(v_L)^2}{8t} \quad (21)$$

With probability $1-\alpha$, the ex-post consumer surplus is:

$$S_{int_{1-\alpha}}^* = \frac{(v_L)^2 - 2\alpha v_L(v_H - v_L)}{8t} \quad (22)$$

3.3 Consumer options pricing

Under this strategy, people potentially interested in participating to the conference are given the possibility to buy the option to register at the conference early in advance at a price p_0 and later decide whether to exercise the option at a certain price p_E after uncertainty is resolved. However, under the consumer options pricing strategy, only those who have purchased the options have the right to exercise the option. It can be shown that there are three segments in this case. First, those who always buy and exercise the option. Second, those who buy the option and exercise it only when the positive event occurs. Third, there are those who do not buy.

The threshold participant between the first and the second segment is:

$$x_L = \frac{v_L - p_E}{t} \quad (23)$$

The threshold participant between the second and the third segment is:

$$x_B = \frac{v_H - p_E}{t} - \frac{p_0}{\alpha t} \quad (24)$$

Therefore, the profit function for the organizers is:

$$\begin{aligned}\Pi_{CO} &= (p_O)x_B + p_E(x_L + \alpha(x_B - x_L)) = \\ &= (p_O)\left(\frac{v_H - p_E}{t} - \frac{p_0}{\alpha t}\right) + p_E\left(\frac{v_L - p_E}{t} + \alpha\left(\frac{v_H - p_E}{t} - \frac{p_0}{\alpha t} - \frac{v_L - p_E}{t}\right)\right)\end{aligned}\quad (25)$$

Therefore, the optimal price, expected number of participants, and expected profit are respectively:

$$p_O^* = \frac{\alpha(v_H - v_L)}{2} \quad (26)$$

$$p_E^* = \frac{v_L}{2} \quad (27)$$

$$x_L^* + \alpha(x_B^* - x_L^*) = \frac{(1-\alpha)v_L + \alpha v_H}{2t} \quad (28)$$

$$\Pi_{co}^* = \frac{\alpha(v_H)^2 + (1-\alpha)(v_L)^2}{4t} \quad (29)$$

$$E[S_{co}^*] = \frac{\alpha(v_H)^2 + (1-\alpha)(v_L)^2}{8t} \quad (30)$$

Ex post, participants have the following surplus with probability α :

$$S_{co-\alpha}^* = \frac{(3-2\alpha)(v_H)^2 - 2(1-\alpha)v_H v_L}{8t} \quad (31)$$

With probability $1-\alpha$, the ex-post consumer surplus is:

$$S_{co-1-\alpha}^* = \frac{(v_L)^2 - 2\alpha v_H(v_H - v_L)}{8t} \quad (32)$$

4. Conclusions

From the above optimal solutions under the three pricing mechanisms it can be easily seen that the intertemporal price discrimination and consumer options pricing lead to the same expected profit for the conference organizers and expected surplus for participants. Both profit and consumer surplus are higher than those under the simple advance selling. Moreover, it is interesting that while on expectation the surplus is the same for both intertemporal price discrimination and consumer options, they show differences ex-post. In case of bad event, the consumer option pricing leads to lower consumer surplus for participants than the intertemporal price discrimination. On expectation, this is compensated by the fact that in case of positive event, consumer option pricing leads to higher consumer surplus than the intertemporal price discrimination. Options pricing on one hand can act as a commitment mechanism for the customer like the early bird registration does, but in a less expensive way. On the other hand it gives to the conference organizer an upper bound to the number of participants in advance, since the option purchase is a prerequisite to exercise the option and register to the conference. Future research will investigate the social effect of adding the competition among firms and customers behavioural issues in the analysed framework.

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