Practice Article

Variable opaque products in the airline industry: A tool to fill the gaps and increase revenues

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ABSTRACT This article presents a new airline product class termed variable opaque product, VOP. What distinguishes a VOP is that the passenger self-selects the travel product based on how much uncertainty she is prepared to accept in one or more product attributes: for example, to which destination she wishes to fly or for which dates she requires the outbound and inbound flights. VOPs have been tested at two airlines in dissimilar markets and geographic regions and it was found that, in each case, the VOP made a significant increase in revenues and there was no competitive response to its introduction (Mang *et al*, 2009). This article extends on this previous research and presents a pricing heuristic that maximizes the incremental revenues from a VOP.

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INTRODUCTION

It is proposed that an airline customer's flexibility of flight itinerary is related to her willingness to pay (WTP). If a link can be established at an individual level between the need to fly and the WTP[1] for that travel solution, then this would offer airlines a range of marketing options not available to them previously. The interactive nature provided by the Internet allows marketers to collect much richer data at an individual level, which was not available in the past. It is believed that these data can provide insights into individual need-to-fly and that a much better estimation of individual WTP can be established. This article provides airline revenue and pricing managers with a method for how prices can be calculated for flexible airline customers.

It is generally recognized that it is extremely difficult for airline managers to create sustainable and attractive profit margins (Doganis, 1996, 2001). One strategy that an airline has at its disposal to generate extra revenues and improve profitability is to effectively apply revenue management techniques. However, another strategy is to exploit new market segments.

The key criteria are that these markets are composed of customers who have either not flown at all or those who have flown with a competitor. Southwest, a highly successful airline, targeted travelers who were previously traveling on Greyhound buses.[2] EasyJet, another low-cost airline, took the same approach and targeted low-income UK citizens who wanted to fly to continental European destinations but were unable to afford it.

However, a fundamental premise when attempting to exploit new markets is that these markets are genuinely new and that it is not simply a buy-down effect from the existing market, commonly referred to as the 'cannibalization effect'.

One method to reduce the danger of the cannibalization effect is to offer opaque products. In the case of Priceline, the opaqueness is provided by not revealing the airline or the route to be flown. This means that the customer may end up flying a much more circuitous route than she might wish and also not necessarily with the most preferred carrier. The logic behind this approach is that the cannibalization effect is minimized for higher-priced airlines, as this type of traveler would generally be expected only to fly on the cheapest carrier between the city pair. The negative aspect of this type of marketing is that travelers are educated to be impartial to the airline they fly with. A similar type of negative education has occurred in the package tour industry in which customers have been encouraged to purchase last-minute offerings.

However, despite these issues, the concept of using opaqueness to sell distressed inventory to a new market of travelers has the potential to increase revenues (Jiang, 2007).

If it can be assumed that a relatively untapped new market does exist, one might also ask whether the effective exploitation of this market is a step function or more of a gradual process as the product becomes more opaque. It would be logical to assume that if the product were only slightly opaque, then the threat of cannibalization would be greater than if the product were highly opaque.

This article uses this logic to present a method in which the level of opaqueness can be varied in order to increase the amount of consumer surplus that can be extracted from travelers who are prepared to accept differing degrees of uncertainty in their travel solution.

A heuristic is presented, which offers a method to optimize the price that an airline should charge for a variable opaque product (VOP) of a particular opaqueness. In conclusion, new areas of research are suggested that might help to make the VOP concept a useful tool for airlines and other industries that sell inventory using the Internet.

PREVIOUS WORK

As the airline product becomes more opaque (that is, less specified in one or more important attributes), one can argue that the quality of the airline solution is reduced. The idea that variations in quality have an impact on a consumer's reservation price is intuitive and has been discussed extensively in the economics literature (for example, Shapiro and Varian, 1998). Furthermore, the concept that heterogeneous markets can be segmented into smaller 'micromarkets' with similar valuations and/or quality requirements is a cornerstone of modern marketing. In an attempt to quantify the benefit that the quality of a product attribute has for consumers, researchers from the fields of psychology, econometrics and marketing have developed the random utility theory (RUT). Many leading researchers adopt RUT as the theoretical framework for studying human behavior and explaining choice.

The concept of discrete choice has not only been a predominant topic in the marketing literature (for example, Louviere and Woodworth, 1983; Henscher *et al*, 1999) but has also been applied to transportation (for example, McFadden, 1980, 1981; Ben-Akiva and Bierlaire, 1999). Also, the connection between discrete choice and WTP has been Q2 discussed in a number of papers (Train and Weeks, 2004; Breidert *et al*, 2006).

One can argue that airlines vary the quality of their services by imposing restrictions on travel (such as the Saturday-night stay rule). One important input to airline revenue management algorithms is the forecast demand for these quality-differentiated products.

However, the consumer theory approach that uses demand as an indicator of WTP may not always be appropriate, particularly if supply is not constrained. This is often the case in the airline situation when there are many competing airlines between a city pair. Furthermore, where the consumer considers a VOP product she is, by definition, prepared to accept a number of possible flights and, therefore, the supply is essentially unconstrained. In such cases, it may be more useful to focus on market segmentation because the goal is to establish incremental demand from new market segments.

In his PhD thesis, Belobaba (1987, p. 22) states that the price versus service trade-off is a major determinant in market demand segmentation. Littlewood (~~1972~~) also makes the point that the 'standard of service' is more important to the high yield passenger and that 'the low yield passenger is probably much more prepared to be directed towards those flights on which the airline would prefer him to fly'. However, service is only one of the components that make up the 'quality' of the travel product. One can also argue that the certainty of knowing which destination one is flying to or when the flight is departing are also components of the quality of the travel product.

The idea of segmenting the market between discretionary and non-discretionary travelers using time flexibility is also not new and was proposed by Schwieterman (1985). More recent research using time flexibility as a value driver has been done by Garrow (2009), and by Carroll *et al* (2007). However, there appears to be no research done to date, in which destination flexibility is used as a value driver.

VARIABLE OPAQUE PRODUCT

An opaque product may be defined as a product in which one or more of the attributes that make up the product are hidden from the purchaser (that is, they are not fully specified by the supplier) until after payment is made (Gallego and Phillips, 2004~~, 2008~~; Fay and Xie, 2008). Q3 Sometimes, the completely specified product is revealed immediately after payment and, in some situations, it is revealed some time after payment is made but before product consumption. Two well-known providers of opaque products are Priceline and Hotwire. At Priceline, the unknown attributes of the flight product are the carrier and the route. At Hotwire, the carrier is revealed but the customer has the ability to state her degree of flexibility (for example, 2 to 4 days duration at the destination); based on this information, a price is presented. On closer inspection, it can be seen that Hotwire is primarily a sophisticated search engine that picks out the cheapest possible combination of flights based on the parameters that the customer provides.[3] Thus, it appears that the prices that Hotwire presents are based on the underlying tariffs of the supplier airlines. Priceline, on the other hand, uses a reverse auction method to determine the price that a consumer pays, which is independent of the supplier airline pricing schedules.

Although a substantial amount of academic literature has been written on the subject of opaque products in the travel industry (for example, Gallego and Phillips, 2004; Gallego *et al*, 2004), most of the research has concentrated on Priceline (Kannan and Kopalle, 2001; Fay, 2004; Spann *et al*, 2004) and no research has been done on opaque products in which the level of opaqueness is varied. These products may be described as VOPs, and they are the focus of this article.

A VOP differs from a standard opaque product in two key ways: (1) the opaqueness in one or more product dimensions is set by the consumer rather than the supplier; and (2) the opaqueness is dictated by a *bandwidth* of possible attribute values. If this bandwidth is narrow, the number of possible product combinations (the 'consideration set') will be small, whereas if the bandwidth is large, particularly where there are multiple product dimensions in which one can specify a bandwidth of values, the consideration set will be much larger.

An example of a simple one-dimensional VOP in the airline industry is one in which a customer can select a group of possible destinations, any one of which, she is prepared to fly to on a particular departure and return date. A penalty fee is charged for each destination that she deletes from the group, thereby making the group smaller and reducing the uncertainty. This type of VOP is used by Germanwings (www.germanwings.com) under the product name 'Blind Booking'. Only after payment is made is the customer informed of her flight itinerary.

This VOP has increased load factors at the airline ~~by 1.5 per cent~~ and the revenues from these new passengers are acknowledged as being almost completely incremental (Mang *et al*, 2009). Apart from some minimal marketing at the launch of the product, a steadily increasing stream of bookings has since been generated by what can only be assumed word-of-mouth (including Internet blogs) marketing from satisfied customers.

Another VOP variant that has been used by the airline industry was where the destination and the number of nights at the destination were known, but the outbound and return dates were not. This variant was used by Freedom Air, a subsidiary of Air New Zealand, from May 2003 until April 2006. In this VOP, the dates of the outbound and return flights were hidden within a customer-specified time window until some time before the actual departure date. In addition, the consumer could vary this advance warning as an additional parameter to influence the offer price.

The increase in airline profits from this VOP was approximately 6 per cent (Mang *et al*, 2009). Furthermore, Freedom Air contracted a marketing research company to gauge customer satisfaction with the VOP, in which 95 per cent of the respondents reported that they were either satisfied or extremely satisfied with the product.

From a theoretical point of view, the question of whether VOPs add value for a supplier might be considered in the context of whether traditional opaque products are useful for the same supplier. A similar argument holds for the social welfare of a VOP. Recently, a number of publications have appeared (Jiang, 2007; Fay, 2008; Granados *et al*, 2008; Jerath *et al*, 2009b), which have made theoretical judgments as to whether the use of opaque products, under various conditions, is worthwhile for a supplier to offer as part of its product portfolio. In most cases, the authors make a strong argument for the use of opaque products.

A paper by Fay and Xie (2008) describes a concept similar to a VOP. The authors find that, theoretically, the use of this marketing strategy has the potential to benefit the seller in that it reduces the seller's information disadvantage and demand uncertainty, as well as reducing the mismatch between demand and capacity and thus enhancing efficiency. Jiang (2007) uses a theoretical analysis based on the Hotelling economic model (1929) and finds that, in most cases, firms can effectively discriminate among customers with opaque selling. Jerath *et al* (2009b) discuss whether opaque selling via an intermediary is preferred over direct last-minute selling in order to dispose of distressed inventory. They extend on the earlier work of Jiang (2007) by incorporating the effect of competition in their model and also allow for sellers who are strategic with their use of a dynamic model. A very recent paper by Petrick *et al* (2009) presents a number of revenue management models that incorporate flexible products and shows how these products can be used to mitigate the negative impact of demand forecast errors.

A major advantage with the VOP approach is that customers have been shown to interact significantly in order to create a product–price combination that the customer finds acceptable (Mang *et al*, 2009). In the study at Freedom Air, customers changed their parameters a large number of times[4] before purchasing. These individual-based data are much richer than what the airlines collect at present and may be sufficient to create forecasts suitable for new revenue management models. At present, VOPs are only targeted at the leisure market as no sensible businessman would accept a travel product not knowing when or where he is flying until after he has purchased his ticket. However, within this leisure market there is a continuum of price versus service trade-offs.

In summary, one can conclude that, both theoretically and in practice, VOPs are beneficial for suppliers and, in most cases, for consumers.

PRICING HEURISTIC

Now that it has been established that VOPs can improve an airline's revenues, it would be convenient to develop a model that optimizes the revenues from a VOP. The approach taken in this article departs from that of traditional revenue management, which attempts to forecast the aggregate demand for each of the differentiated products. In contrast, this article focuses on how likely an individual customer will (a) have bought the cheapest fully specified (non opaque) product in the consideration set at its list price[5]; and (b) purchase the VOP as a function of the discount from this list price.

Conceptually, the problem involves two dimensions. One dimension is that of decreasing quality, which is associated with increasing opaqueness. When the level of opaqueness is quite low (that is, there are only very few possible product alternatives in the consideration set), the VOP is very similar to the fully specified product and, thus, there will be a high probability that someone considering that VOP would also purchase the fully specified product. Therefore, in order to limit the opportunity cost of such 'cannibalistic' customers, the price discount from the reference (list) price should be small. On the other hand, a customer whot indicates an acceptance for a greater level of opaqueness has a lower probability of being a 'cannibal' and so the airline can risk giving that customer a greater discount off the reference price. The level of opaqueness can therefore be considered a type of segmentation 'fence' that becomes more impenetrable as opaqueness is increased. It is simple to show that the lowest price that an airline should offer a VOP, in order to make no net loss owing to opportunity costs, is the probability of cannibalization multiplied by the reference price.[6] However, the challenge for the airline is to determine this probability function. One suggestion would be to show each customer the cheapest fully specified alternative in the consideration set as well as the additional amount that it would cost over and above that of the VOP price. The airline could possibly place a 'Buy Up' button on the web page that allows the customer to purchase this fully specified option and could use this data to calculate the probability of cannibalization as a function of product opaqueness.

The other dimension is that of a bid response curve, which is commonly used in customized pricing. The advantage with customized pricing, which is ideally suited for VOPs, is that data are collected from non-purchasers as well as purchasers, and a bid response curve can be determined (Phillips, 2005). For a particular VOP (for example, this could be a flight from Frankfurt to Barcelona with three nights in Barcelona any time between 1 and 7 April and that the customer will be told the flight details two weeks before departure), one can assume that the probability that a customer will purchase will increase as the price for the VOP is reduced. Further, one can assume that the probability of purchase will be zero when the price equals the reference price and that the probability of purchase rises to a maximum when the price is zero. However, the airline will constrain itself to offering a price more than the reference price multiplied by the probability of cannibalism (for the reasons outlined above) or the marginal cost of transporting the passenger (airport fees, taxes, and so on), whichever is higher. One can also assume that the bid response curves will not be identical for VOPs with differing opaqueness and that a number of bid response curves along the opaqueness dimension will, most likely, need to be determined. However, in order to determine any one bid response curve, a wide range of discounts off the reference price will have to be offered to inquirers who have considered essentially the same VOP. In order to gather these data, the airline can initially present the VOP option on its website with a static pricing profile. During this phase, the variation in the reference price, which is linked to the normal airline revenue management system, will generate the variation in the price differential between the reference price and the (static) VOP price. Once sufficient data have been collected, a bid response curve can be determined.

The price that maximizes airline net revenues, for any particular VOP, will lie somewhere between the reference price (where no sales are made) and the reference price multiplied by the probability of cannibalization (where net incremental revenues are zero) or the marginal cost of transport, whichever is greater. The shape of the bid response curve will determine the exact position for the price to optimize net incremental revenues.

The assumptions with the model are the following:

1. There is a range of consumers who are prepared to accept some level of product uncertainty. This VOP can be described by a vector[7] $\underline{b}$.
2. Each VOP customer is completely informed of the fully specified alternatives that make up the 'consideration set' and are aware of the price of each alternative. The lowest-priced alternative has a 'reference price', R.
3. Let $C(\underline{b})$ be the 'probability of cannibalization', which is the probability that a consumer who is prepared to accept a VOP with opaqueness $\underline{b}$ will also purchase the cheapest fully specified (non-opaque) alternative at price R.
4. The probability that a customer will buy a VOP with opaqueness $\underline{b}$ is $S_b(x)$ where x is a scalar defined by $Rx = P$. P is the offer price for the VOP.
5. The marginal costs are the same for a customer purchasing a non-opaque ticket as for those passengers who would have bought the opaque product.
6. The supplier is a monopoly. (This assumption may not be necessary if one assumes that the reference price makes allowance for the competition.)
7. The consideration set of possible flight alternatives (and, hence, the number of forecasted empty seats) is large enough that the purchaser of a VOP will not prevent a higher paying customer from purchasing a fully specified product.

Let the *net* expected incremental revenue, N, from an individual *purchaser* be:

$$\begin{aligned} N = & \text{ expected incremental revenues} \\ & - \text{expected opportunity costs} \\ = & [(1 - C(\underline{b}))\mathrm{P}] - [C(\underline{b})(R - P)] \\ = & [(1 - C(\underline{b}))Rx] - [(C(\underline{b}))(R - Rx)] \\ = & R(x - C(\underline{b})) \end{aligned}$$

An *inquirer* is only expected to have a have a certain probability of purchase, $S_b(x)$, where $S_b(x)$ is the bid response function for a VOP with attributes $\underline{b}$.

Therefore, the expected net incremental revenue for an *inquirer* would be:

$$E(x) \quad = S_b(x)R(x - C(\underline{b})$$

The airline will seek to find a value, x, that will maximize $E(x)$ subject to the constraints:

$$C(\underline{b}) < x < 1,$$

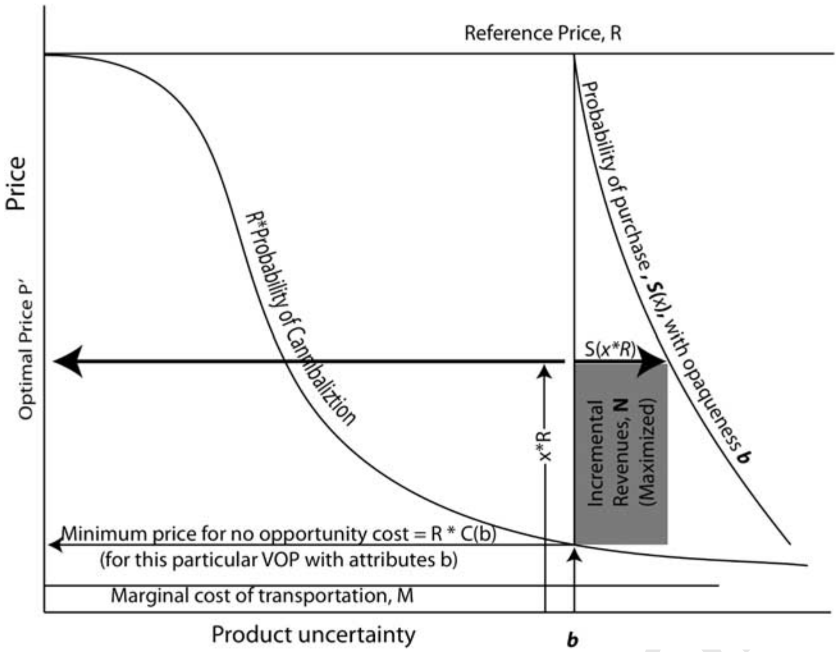

Figure 1: Graphical representation of VOP pricing optimization model.

and $x > M/R$, where M is the marginal cost of transporting a customer.

Once the value of x has been determined, then the optimal VOP price, P', is simply xR.

The model can be seen graphically in Figure 1.

CONCLUSIONS

Research has shown that the addition of opaque products in the marketing portfolio for airlines produces both financial benefits and welfare improvements for consumers. It is argued in this article that giving consumers the ability to vary the amount of opaqueness would be an additional enhancement and would provide further benefits. Furthermore, it has been shown that consumers interact extensively with such VOPs in order to create a product-price combination that is acceptable; this customer behavior information can provide a useful basis for price optimization models. An attempt at producing such a model is presented.

Although this article has focused on the airline industry, it is conceivable that VOPs could be useful in a number of other industries in which perishable inventory is sold over the Internet. Further research in other industries and/or using other uncertainty parameters apart from time and destination would shed more light on the viability of the VOP as an effective marketing instrument.

NOTES

1 Willingness-to-pay (WTP) and reservation price are used interchangeably in this document.
2 See 'Creating New Market Space' by Kim and Mauborgne, Harvard Business Review, January-February 1999.
3 This is evident by comparing the prices offered by Hotline and the prices offered at the individual airline websites.
4 A median value of 10 times.
5 The cheapest list price in the consideration set may be considered to be the 'reference price' for a fully informed customer.

6 Assume we have calculated that the average probability is 30 per cent that a VOP purchaser would have bought the cheapest flight in the consideration set at its normal fare of, say, \$1000, if the VOP had not been offered. The minimum price that the supplier should charge these passengers is therefore $\$1000 \times 0.3 = \$300$ in order not to have a net opportunity cost. We can prove this with the following calculation: Let there be, say, 10 passengers prepared to purchase the VOP above. The opportunity costs from the three cannibals is $(\$1000–\$300) \times 3 = \$2100$. The incremental revenue from the other seven non-cannibalistic (incremental) customers is $\$300 \times 7 = \$2100$. Therefore, the net loss owing to opportunity cost is zero.

7 It should be noted that *b* could include other variables describing the consumer's behavior but, for simplicity, we only consider the product uncertainty (opaqueness) that the consumer is prepared to accept.

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