

# Pricing: A critical P for Software Marketing

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October, 2008  
Version 1.0

*As software companies embark on offering their applications in the cloud, pricing of the services becomes a real challenge. This paper by Dr. Kahn will give software marketers thought provoking suggestions on how they can go about pricing their services. Dr. Barry Kahn is Founder and Chief Executive Officer of QCUE, a company providing dynamic pricing solutions to the live entertainment industry. He holds a Ph.D. and M.S. in Economics from the University of Texas at Austin and a B.S. (cum laude) in Applied and Engineering Physics from Cornell University, where he was selected to All-Ivy, All-East, and Academic All-Ivy teams in Track & Field and Cross Country. Dr. Kahn has authored papers on a range of economic issues, been quoted in leading publications including The Financial Times and Fortune Small Business, and has appeared on CNN Money, Bloomberg, and CNBC.*

Price. It is the amount of currency exchanged for a good being sold. Often it reflects the cost of creating that good. Other times it reflects the intrinsic value of the underlying commodity. In some cases the intrinsic value of the commodity is dependant upon it; consider, for example, a diamond ring. While there is much literature on how it should be set, there is no debate as to its exact meaning. Stated clearly in the first chapter of any economics book, is the simple statement: Price is the intersection of supply and demand.

But there are revenue management techniques that result in different prices for the same commodities. There are auctions. There are targeted discounts and promotions. In short, there is no reason to believe that a single price exists and if it did, there is no reason to assume that it would be optimal. So how should price be set? How should it move? Can it be differentiated across consumers? If so, how?

Price, in its purest form, is the solution of an optimization equation. It is chosen to maximize profits, subject to a set of constraints. These constraints take the form of conditions such as: there must be a single price, price cannot change, price must be below a predetermined limit, etc. But perhaps a better solution is solve the unconstrained optimization problem, where rigid constraints are instead replaced by an understanding of consumer behavior, i.e. if we have multiple price points, consumers will attempt to buy at the lowest price.

How successful will they be? That needs to be modeled as well. Clearly, an understanding this deep of consumer behavior is far more difficult to obtain than standard price optimization, and the mathematics underlying it become far more complex. But the dollars at stake are immense. A Major League Baseball team stands to see a 20-30% increase in revenue from ticket sales by solving this problem, at no additional cost. Other companies face similar significant upsides.

## **I. The Effect of Price on Sales**

To examine the role of price in sales, one must begin with a very basic question: What is demand? It is an oft referred to concept, used by businessmen and academics alike. Any introductory economics textbook will inform you that at a price of zero, demand is infinite. Yet, the CEO of any start-up company will tell you that this most certainly is not true. Demand is difficult to precisely define, let alone measure. Instead, what is easy to measure, and is often used as a proxy for demand, is sales. But in order to increase sales, it is important to know what causes them.

I propose viewing sales as a function of price and marketing. That is, you only have the opportunity to sell to the customers recruited by your marketing department. The percentages of these potential customers that are converted into sales are highly dependent on price. Clearly there is some interaction between marketing and price; great marketing entices customers to pay a higher price, different prices target customer segments, etc.

Nonetheless, the fact remains; there are a limited number of customers exposed to your product. So even if it were free, you would have a finite number of customers. We will leave increasing this number to the marketing gurus and instead consider how to adjust price to maximize revenue and meet other objectives, given our potential customers.

## II. Setting Prices

Price is often set related to cost, but this is directly at odds with the premise stated above. Price needs to be set related to market demand in order to maximize revenue. This has two major implications, one limiting and the other limited.

First, pricing to market means that you can't generate sales at a price point above costs, you likely shouldn't be in business. I learned this lesson firsthand with my first start-up venture, 5RABBIT a manufacturer of bottle openers. Despite strong sales volumes, the cost of production was higher than originally anticipated and it was difficult to sell more than marginally above cost. Unable to solve this supply problem, we were forced to close our doors despite a steady stream of orders. It should be unsurprising that after a problem on this order, I move my attention over to software, where despite often heavy initial costs; the cost of selling to additional customers tends toward zero. This brings us to our second implication. Despite the claims of basic economics textbooks, price of goods like software shouldn't be zero even if the marginal cost is.

Even in software each sale has costs in excess of its physical cost. As CEO of QCUE, a company that dynamically optimizes prices in the live entertainment industry we see the marginal cost of selling an additional ticket is zero. In fact, it can be viewed as negative since attendees will likely purchase concessions and merchandise. Nonetheless, our customers face a cost to selling each ticket. That cost is not being able to sell it again. Despite sounding trivial, this is actually a very important point. During the recent stock market panic, I sold all shares I owned of VTI, an exchange traded index fund that tracks the Wilshire 5000, a broader index of US stocks than the S&P 500.<sup>1</sup> While that was a decision I was comfortable at the time and was calculated to avoid the risk of a further crash, I watched the market open on Friday September 19, 6% above where it had been before any of the news that precipitated this crisis had come. Clearly, the market was overpriced, but by selling when I had, I lost my opportunity to sell at this higher price.<sup>2</sup>

QCUE's customers face a similar problem. Just as I was afraid of the market plummeting and my investment becoming worthless, a ticket to a live entertainment event becomes worthless if not sold when the event occurs. Sellers face a tradeoff between this fear of lost value and the

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<sup>1</sup> September 2008, following the bankruptcy of Lehman Brothers, sale of Merrill Lynch, and government bailout of AIG. At the time of writing, further fallout is unsure, but this is a reference the week of September 14-19.

<sup>2</sup> Short-selling could have allowed me to make this sale, but restrictions on short sales had been put into place, and I am uncomfortable with short time restrictions since market irrationality can persist for some time before basic economic principles begin to take hold. Nonetheless, the market fell back to rational prices within minutes of the opening bell.

potential gains of holding a limited supply of high demand tickets. Even for service-oriented companies, a similar constrained, perishable commodity exists in the form of time. Hours an employee spends idle cannot be retrieved, but similarly, a full workload may prevent acceptance of new clients or jobs.

### **III. Revenue Management**

One means of using price to increase revenue is to differentiate customers. The airlines are the ideal example of this behavior. They have created a set of restrictions on an identical product (a seat on an airplane) that differentiates customers into two types: business and leisure travelers. By selling lower priced tickets early they fill capacity with cost sensitive leisure travelers. Last minute tickets are then held for business travelers, who are not cost sensitive. Taking advantage of the time in advance of travel that plans are known, weekend stays, and restrictions on changing reservations, they are able to set different price points in a manner that doesn't necessitate a tradeoff between volume and premiums. But one need not change prices in time to accomplish this objective. Consider a restaurant that charges different prices for the same menu during lunch and dinner, a movie theatre that charges less for the matinee, or a bar that has drink specials during the week. All of these are forms of revenue management.

The initial reaction to this type of price setting in an industry not accustomed to revenue management, and an obstacle QCUE has faced in terms of customer adoption, is that this pricing behavior will appear harmful to consumers. However, to quote Fred Rosen, former CEO of Ticketmaster, "No one has ever paid more for a ticket than they wanted to." This statement is true in almost all non-essential industries. By making a purchase, the customer indicates that they value the item above that quantity of money. While price discrimination does charge some customers higher prices, it allows them to obtain a product they are willing to pay for and would otherwise be unable to obtain.

Despite offering B2B product, QCUE was originally formulated as a B2C concept. Our name, which originated as a "cue" to avoid a "queue" is a remnant of that. Just consider the consumer problem of buying tickets to a high profile event like the Super Bowl. There are people who would gladly pay above "face value" to obtain tickets, but simply don't have the opportunity. Instead tickets are distributed in a manner that is inefficient, random, and inconvenient. It is little surprise that the market has corrected itself with those who have the time and means to suffer the inconveniences necessary to obtain tickets sell their tickets at huge premiums on the secondary market. Wouldn't these ultimate attendees and the original sellers both been better off had tickets been properly priced?

That is not to say that all tickets need to be sold at high prices, but to not provide someone who is willing to pay the opportunity to avoid being subjected to lotteries or other inconveniences is contrary to manner that a market should operate. And it is little surprise that black markets (recently legitimized in most places) have arisen to correct this market inefficiency.

But this brings about the obvious question: What is the proper price? Surely there is some price that would leave even an event like the Super Bowl with an empty stadium. One oft suggested answer is auctions should be employed to set prices.

#### **IV. Auction Theory**

Auctions have been prevalent for thousands of years. In various forms auctions have been used to sell commodities, artwork, slaves, financial instruments, automobiles, and debt among other things. Most recently, members of the live entertainment community have come to embrace auctions as the method for arriving at market value for a product with otherwise uncertain demand.

To reinforce the belief that the American public believes that an auction is the ideal strategy for obtaining full value for an item, one needs to look no further than the \$59 billion worth of goods sold on eBay in 2007. And while auctions are incredibly efficient in highly competitive markets with active participation, the \$3 trillion in US Treasury Bills auctioned every year being a perfect example, and one of a kind items, like many seen on eBay, there are questions that need to be asked before implementing auctions into more traditional selling environments.

The first question is how the auction should be conducted. Greed instinctively indicates that the winning bidder(s) should be charged as much as they are willing to pay. But in October 1998, the US Treasury changed the format of its auctions from this first-price format to a second price (or Vickery) auction that would have all winners buying notes at the same price, that of the lowest winning bid.<sup>3</sup> This followed a pair of studies that concluded that this format would increase the amount the Treasury could expect from selling its debt.

Despite the counterintuitive nature of this finding, consider how this change in auction structure effects the actions of market participants. The ideal strategy changes from a rather complex game theory problem to one in which bidders are encouraged to bid their true valuation. By bidding their true valuation, if the price is more than they are willing to pay, they will not win (which is ideal), and if the price is less than they are willing to pay, they will win, and the price they pay will be independent of their own bid. As a result this structure helps to gain accurate information about the market value of what is sold and both experimentally and theoretically proves to be a revenue increasing change.

However, these effects are on the intensive margin, and the literature neglects changes on the external margin relative to these changes. In a first price auction, players are forced to consider the actions of others to make an ideal bid. While a fairly costless process when buying a concert ticket on eBay, it can be a significant undertaking for many large business transactions. As a result, for companies with small probabilities of winning, or which are only in the market

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<sup>3</sup> Billions of dollars of Treasury Bills are at stake in each auction and a large number of winners, primarily banks and other large financial institutions, simultaneously purchase debt from the US Government.

for small quantities of goods such as Treasury Bills, this cost may be enough to dissuade them from participating.

Just how important is participation in auction design? Consider the auctions for 3G spectrum licenses in Europe in 2000. Switzerland employed a strategy that resulted in only the incumbent players to participate and as a result, generated a mere 20 Euros per capita, while Great Britain, which employed a two-tier auction, with the first stage consisting of a second price auction to set the floor for prices generated 650 Euros.

Another issue is complementarities. At QCUE, we often get asked whether auctions, which have generated billions of dollars for scalpers, would be the best way for our clients to learn the true value of their tickets. But the flaws in this system become apparent when taken to the extreme. Imagine if every ticket to a concert was auctioned. Now suppose that you are trying to buy tickets for your wife (husband), child and yourself. The amount that ticket is worth to you drops if your friends can't get all three tickets. Since tickets are generally sold in even lots (or as singles), what you are willing to pay on your auction depends on the outcomes of multiple auctions. This is an example of complementarities. And this problem gets more complicated if we consider assigned seating.

Randomness adds further problems. It is highly unlikely that the bidders willing to pay the most will choose different auctions. As a result, some auctions will be won at a price below what someone who lost another auction would have been willing to pay. Experimentally, we have found that this randomness effect can reduce the total revenue from a set of auctions by as much as 15%, neglecting complementarities. It is little surprise that after a short honeymoon period, the ticket sellers are moving away from auctions as a primary selling mechanism.

This brings us to multi-unit auctions, an area where the academic world has made little headway, but companies like QCUE have focused a great deal of our efforts. Our system of dynamically adjusting list price, while simultaneously accepting binding bids that are used to increase sales and re-optimize list price (which we discuss in the next section), is really a continuous time, multi-unit auction. As we evolve our understanding of such environments, we are able to offer increasingly accurate strategies for sellers to optimize their revenue.

Google is one company that has done a particularly impressive job using multi-unit auctions. Google's Adwords program employs a variant of a second price auction that has succeeded in encouraging participation of small players, ensuring that local advertisers submit bids and earn ad placement, even with behemoths like Wal-Mart and Dell vying for ad space as well. The result is that these multinationals are forced to pay close to their true valuation of that advertising space. This is quite different than the manner that they are able to dictate terms to many suppliers due to their immense market share

## **V. Dynamic Price Optimization – Moving Beyond Revenue Management**

What I refer to as Dynamic Price Optimization can be viewed as moving beyond Revenue Management. It is at the same time more sophisticated and yet far more basic than Revenue Management. DPO systems operate in cases when heuristics and business rules. In real time

DPO software must perform complex computations that revenue management systems perform once or twice a year to calibrate their heuristics. So while it relies on basic intuition, it is computationally far more complex and much more robust in the cases it can handle. Airline prices are set to move up.<sup>4</sup> Retail goods get discounted. But many products need the flexibility to move upward and downward in price. For these situations, dynamic pricing can't rely on heuristics.

The first time I began calibrating QCUE's dynamic price optimization software to a professional sporting team, I was surprised to learn how low a percentage of tickets were actually sold at face value. The team's VP of Ticket Sales was making real time decisions to discount tickets on a daily basis. Not only did he adjust the average price from face value, but in doing so, he would often change the price of sections differently so that the relative prices for each ticket class varied from face value as well. So, while QCUE was the first company to offer an official dynamic pricing product to the leagues, it would be naïve to claim that dynamic pricing had not been going on for some time in this manner.

Interestingly, but not surprisingly, our system automated decisions that were often nearly identical to those made by the ticketing office. It is difficult to say what I found more impressive, that the ticketing staff could reach the same results as complex algorithms being run through supercomputers, or that our software was able to come to the same conclusions as people with an intimate understanding of the people buying tickets based upon the numbers alone.

In live entertainment, there has been lots of talk about implementing dynamic pricing. Live Nation's CEO Michael Rapino, has stated at shareholders meetings that dynamic pricing was in the company's future. Industry conferences have seminars on yield management and "airline pricing" is an often stated phrase.

Yet some of the world's most prominent concert promoters have told me that they don't know what dynamic pricing actually means in their industry. And there is no magic formula for sporting leagues that can adjust prices based upon wins and losses. Ticketing companies are offering auctions as dynamic pricing, but the problems associated with using them on a large scale have largely limited their use.

The reason for this is that in this industry, like many others, the standard solutions don't apply. Like software and a host of different industries where revenue management has not taken hold, dynamic pricing has a different meaning in this industry that isn't revenue management. Revenue management, while a powerful tool, is a heuristic that operates in cases when demand is predictable and exact situations are repeated frequently.

What goals does dynamic price optimization need to accomplish in these industries? Our clients are equally concerned with capturing the upside of an under-priced ticket as covering

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<sup>4</sup> While downward price adjustments occasionally occur, it is generally the case of a reserved seat being returned to marketplace, essentially reversing the direction of traditional price increase. For additional details see Muller-Bungart (2007).

losses by filling stadiums. Clearly a solution set for one of the other would only work part of the time. What really needs to be done is to simply optimize.

DPO needs to perform that same optimization that is a six-month consulting job and automate that procedure so it can be performed repeatedly in close to real time. Additionally, it needs to learn where it was wrong, correct future expectations, so that subsequent recommendations reflect an improved understanding of demand and the seller's problem. So while dynamic pricing has often been viewed a mechanism to capture last minute markups or determine when to set discounts, it is actually a price discovery mechanism. Software like QCUE's exists to add science to this process and help sellers with a large variety of inventory, like an MLB team with 81 games and 20 sections for each game.

When inventory is running out, dynamic pricing should look appear to operate the same as revenue management techniques, raising prices to make sure that customers with a high willingness to pay are not turned away. And when lots of inventory is remaining, dynamic pricing should appear no different than a strategic pricing consultant, setting initial prices. But between these two cases, dynamic pricing needs to automate the decisions of good manager with his pulse on the business.

## **VI. Real Time Demand Learning**

A good dynamic pricing protocol reduces the cost of uncertain demand or limited initial data because it corrects itself. It has a predictive component (what is demand going to be) and a reactive component (inventory levels and time remaining to sell have changed). This reactive component is an important factor for price adjustment in live entertainment; tickets are perishable and limited in supply. We will discuss this in the next section.

Were demand known, we would be able to skip to the next section, discussing how to allocate

As discussed earlier, demand is incredibly difficult to measure as sales are the nearest proxy. If a dynamic pricing system was not employed, you can only measure sales at a single price point. This is a far cry from the robust understanding of demand that would be ideal to understand how price changes affect sales. Further complexity is added when each product being sold is one of like live entertainment events.

I would be trivializing the problem to claim that enormous strides should not be taken to gain the best understanding of demand to create accurate predictions of consumer responses to price adjustments. Yet, I would be overly optimistic to claim that these estimates will be correct. This is why a dynamic pricing system or at least flexibility in terms of adjusting pricing is critical.

QCUE's dynamic pricing system has mechanisms in place to minimize the cost of poor initial demand estimation. These mechanisms range from considering a probability distribution over a range of possible demand realizations to using realized demand to update expectations of future demand. Computationally these are expensive tasks, but they increase the ability of

pricing software to provide accurate recommendations. Without this ability recognize and cope with misinformation, dynamic pricing would be limited to the industries in which revenue management has already taken hold.

## **VII. Scarcity of Resources**

In a stadium or an airplane obviously there is a scarcity of seats. Airlines raise prices when there are few seats left, to ensure that passengers with a high willingness to pay will not be turned away. And they meticulously create expectations of no-shows so that they can overbook in order to increase expected revenue for each flight. When you check in for a flight online, Northwest Airlines now asks if you would be willing to have your flight changed in the event it is overbooked and even asks for the dollar amount you would want in compensation. They are simultaneously holding an auction and collecting data about how their customers value this inconvenience.

But even in an industry like SAS, scarcity and perishable commodities exist. It just manifests itself in different ways. When a new version of a product is being developed, what happens to the current version? Do you offer upgrades to purchasers of the older version? Do you discount? If you need sales to be posted this quarter or fiscal year, should you discount near that fiscal deadline? Raise prices at the start of a quarter? And how many customers can you truly service? Time is a scarce resource and needs to be treated accordingly. While all companies seek to be busy, if that prevents the acquisition of new clients due to lack of resources, it comes at a cost.

This section asks more questions than it provides answers, but its purpose is for you to understand how different circumstances can create significant differences in the value that your company may assign to a sale, irrespective of the product. While I began this paper stressing why it is important to price to market, not costs, these issues do need to be accounted for because they affect the quantity that you need to sell. They also affect how firmly you will stand alongside your price, an issue to be discussed in the next section.

Even while helping clients set prices, QCUE faces these same challenges as a software and service provider. And while we have yet to automate these decisions in-house, we rely upon the same strict rationale we employ in our software when confronted with perspective clients.

## **VIII. Bargaining Weights**

You would never go to the Continental counter 90 minutes before a flight and offer the attendant \$100 for a flight that is currently listed at \$900. Nor would you walk into Armani Emporium and offer \$1,000 for a \$5,000 suit. In both cases the company would have been better off accepting your offer. The marginal cost of adding you to the flight or making another suit is below your offer.

Yet at the same time, bargaining is expected in any third world bazaar and you would never expect to pay the quoted price for a pair of knockoff sunglasses on a street corner in New

York City. But the peanut vendor half a block over will always get his \$3. Why?

Bargaining is about power and credibility. And by nature, selling a product with a marginal cost below list price reduces the credibility that you will not drop the price, because the purchaser knows that it is in your best interest to accept some offers.

Fixed list prices are one solution. They created an image of credibility. The \$3 sign on the peanut stand gives that. But more important is that it is reinforced by the vendors' willingness to give up a sale to maintain that credibility. Similarly, Continental has strict company rules by which the attendant is not allowed to offer a different price than that quoted in the CRM system.

The price your customer is willing to pay is just as much of function of the amount he would be willing to pay for a good or service as how little he believes he can pay. In order to differentiate customers, it is necessary to have a set of pricing rules that is unambiguous and you can adhere to. Otherwise, it will be your customers who take advantage of your flexibility.

When it is possible to measure a customers' economic benefit from your software, a suggested pricing strategy is one that charges customers a fixed percentage of that economic benefit. This allows you to maintain reputability in not adjusting your pricing structure, while at the same time extracting more revenue from customers who will value your services more. While this does not address issues related to your own costs (and it may be that the expenses in delivering an application are independent of client size) it does take a first step toward developing a pricing strategy that differentiates clients and maintains your reputability in negotiations.

## **IX. Summary**

There is no optimal pricing strategy that accomplishes everything for everyone. Rather there is a set of principles and concerns that should always be considered. Pricing is a sensitive issue. Once a customer is interested in your product, it is often the single largest factor in determining whether you close the sale. Yet at the same time, the price you set reflects how you value your product and influences the opinions of others. I have largely ignored the impact of market positioning in setting price levels and restricted attentions to movement within an already set range, but market positioning is an important decision that should not be taken lightly.

While an automated pricing system, integrated into a CRM, is excessive for many businesses, the same decisions made by such a system should be made when setting and adjusting price. Flexibly pricing in this manner, allows for consumer differentiation, increased sales and margins, and can ensure that prices are up to date with your current needs and market demand.

## ***References***

- Ausubel, Lawrence M.** 2002. "Implications of Auction Theory for New Issues Markets." Center for Financial Institutions Working Papers.
- DiMicco, Joan Morris, Amy Greenwald and Pattie Maes.** 2003. "Learning Curve: A Simulation-based Approach to Dynamic Pricing." Special Issue on "Aspects of Internet Agent-based E-Business Systems," *Journal of Electronic Commerce Research*. 3 (3-4): 245-276.
- Eden, Benjamin.** 2001. "Inventories and the Business Cycle: Testing a Sequential Trading Model." *Review of Economic Dynamics*, 4: 562-574.
- Garbade, Kenneth D. and Jeffrey F Inger** 2005. "The Treasury Auction Process: Objectives, Structure, and Recent Adaptations.." *Current Issues in Economics and Finance*. Federal Reserve Bank of New York. 11(2).
- Hendricks, Kenneth, Robert H. Porter, and Charles A. Wilson.** 1994. "Auctions for Oil and Gas Leases with an Informed Bidder and a Random Reservation Price." *Econometrica*, 62(6): 1415-1444.
- Klemperer, Paul.** 2004. *Auctions: Theory and Practice*. Princeton: Princeton University Press.
- Lin, Kyle Y.** 2005. "Dynamic Pricing with Real-Time Demand Learning" *European Journal of Operational Research*, 174(2006): 522-538.
- McCabe, Kevin A., Stephen Rassenti, and Venron L. Smith.** 1992. "Designing Call Auction Institutions: Is Double Dutch The Best?" *The Economic Journal*, 102(410): 9-23.
- Moller, Marc and Makoto Watanabe.** 2005. "Should a monopolist sell before or after buyers

know their demands?" *Working Paper*.

**Muller-Bungart, Michael.** 2007. *Revenue Management with Flexible Products: Models and Methods for the Broadcasting Industry*. New York: Springer.

**Nagle, Thomas.** 1984. "Economic Foundations for Pricing." *The Journal of Business*, 57(1): 3-26.

**Ockenfels, Axel and Alvin E. Roth.** 2002. "The Timing of Bids in Internet Auctions: Market Design, Bidder Behavior, and Artificial Agents." *AI Magazine*, 3: 79-88.

**Phillips, Robert.** 2005. *Pricing and Revenue Optimization*. Stanford, California: Stanford Books.

**Wen, Ue-Pyng and Yen-Hsiang Chen.** 2005. "Dynamic Pricing Model on the Internet Market." *International Journal of Operations Research*, 2(2): 72-80.