

B8816 – Quantitative Pricing & Revenue Analytics – Fall (B) 2015

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Time: MW 2:15pm – 3:45pm Room TBD
Office Hours: Monday 6-7pm or by appointment

Course Description:

Pricing and revenue optimization --or revenue management as it is also called-- focuses on how a firm should set and update pricing and product availability decisions across its various selling channels in order to maximize its profitability. A familiar example comes from the airline industry, where tickets for the same flight may be sold at many different fares, the availability of which is changing as a function of purchase restrictions, the forecasted future demand, and the number of unsold seats. The adoption of such systems has transformed the transportation and hospitality industries, and is increasingly important in retail, telecommunications, entertainment, financial services, health care, manufacturing, as well as on-line advertising, online retailing, and online markets. In parallel, pricing and revenue optimization has become a rapidly expanding practice in consulting services, and a growing area of software and IT development.

Through a combination of case studies, lectures and guest speakers, the course will review the main methodologies that are used in each of these areas, and survey current practices in different industries. The ultimate goal is for students to learn to identify and exploit opportunities for revenue optimization in different business contexts. As the ensuing course outline reveals, most of the topics covered in the course are either directly or indirectly related to pricing issues faced by firms that operate in environments where they enjoy some degree of market power, and in many cases some ability to segment the market and differentiate its pricing and product offering across market segments and market conditions. Within the broader area of pricing theory, the course places particular emphasis on *tactical optimization of pricing and capacity allocation decisions*, tackled using *quantitative models* of consumer behavior (e.g., captured via appropriate price-response relations), demand forecasts and market uncertainty, and the tools of *constrained optimization* -- the two main building blocks of revenue optimization systems.

Textbook

The recommended textbook for the course is by Robert Phillips titled “Pricing and Revenue Optimization.” In addition to the “classic” material reviewed in class and in the book, we will go through 2-3 cases that highlight recent applications of these ideas, e.g., in keyword advertising, online retailing, etc.

Prerequisites / Connections to the Core

I will assume that students are familiar with the content covered in the managerial statistics, decision models, managerial economics and marketing core courses. In more detail, the course assumes knowledge in the following areas:

- Managerial statistics: basic understanding of probability; probability distributions; expected value calculations; knowledge of regression and how to run a regression in excel
- Business Analytics: some knowledge of spreadsheet modeling; linear & nonlinear optimization; how to formulate these problems in excel; how to use solver to get a solution; how to interpret the solution; how to interpret the shadow price variables (we will use this type of knowledge quite a bit). We will also use logistic regression as well as the tool used in the BA course (I will make it available anew).
- Marketing / Economics: basic understanding of demand functions; what they mean; some examples; some basic understanding of consumer choice.

Course deliverables

Apart from class participation (30% of the total grade), the other course deliverables consist of a set of homework assignments (40%) and a take-home final exam (30%).

- Class participation: I will routinely ask that you prepare some problems or cases prior to coming to class that we will use in our class discussion. Unless specified, your solutions to these problems will not be turned in for grading, but your participation will contribute to the corresponding part of your grade. These should not be too onerous.
- There will be three homework assignments (the third assignment has two parts due over time) that can be done in groups of up to 6 students. Each group should submit one assignment, listing the names of all group members.
- There is a take-home final that will touch upon multiple –but perhaps not all—topics of the course. The take-home final is an individual assignment that should not be discussed with your classmates.

Summary of the course:

Intro to revenue management (1 session)

Quantitative models of consumer demand (3 sessions): a) fitting demand models via regression; b) discrete choice models and the multinomial logit model; c) maximum likelihood estimation and logistic regression to fit the MNL based on choice data. Personalized pricing.

Pricing analytics and price optimization (3-4 sessions): a) formulation of pricing problems as constrained optimization problems; b) applications to keyword bidding; retail markdown pricing; event pricing; c) strategic consumer behavior.

Capacity control (2-3 sessions): a) capacity control as constrained optimization / opportunity cost; b) bid-price controls, application to hotels.

Implementation of revenue management solutions & performance evaluation (1 session)

Industry presentations (we will cancel one session; we will have a couple of evening presentations sampling applications; the sessions will be taped in case you cannot attend). Last year we had the following:

- John Bible, CBS '94, co-founder Profitlogic, later acquired by Oracle. (markdown optimization)
- Bruce Berman, CFO Bloomingdale's, President Bloomingdales.com (online revenue and price analytics)
- Spencer Lazar, Principal at General Catalyst (analytics and online marketplaces)

Detailed syllabus:

Class 1 – Wed Oct 21

Introduction

Overview of the course. What is pricing and revenue optimization? History of PRO; multi-pricing in the airline industry; applications.

Relevant reading: Background and Introduction (Ch. 1 of Phillips)

Class 2 – Mon Oct 26

A) Review of Pricing Theory; B) Valuation Game

Capturing consumer surplus via differential pricing: personalized pricing, group pricing. Pricing with capacity constraints.

Skim: The Pricing and Revenue Optimization Process (Ch. 2 of Phillips)
Read: What price Vertigo?

- Read “What price Vertigo?” Be ready to discuss q. 1, and prepare a solution for q. 2 using Solver (you do not need to turn this in... just a reminder of Solver in Excel).

Class 3 – Wed Oct 28

Quantitative models of consumer demand; estimation of demand models using regression

Models of consumer demand; Reservation prices; Aggregate demand models; Fitting demand models via regression.

Read: Personal training at the NY Health Club: Part A

Skim: Phillips section 3.1 (you may skip over the more technical parts)

Read through NYHC (A) and prepare solutions to question 1 and the first part of question 2 that involves fitting a linear demand function using linear regression (you do not need to turn in your solutions).

Class 4 – Wed Nov 4

A. Consumer choice models

Discrete choice models; The Multinomial-Logit (MNL) model; How to fit MNL model parameters using maximum likelihood estimation.

B. Customized Pricing

Background: Customized Pricing (Ch. 11 of Phillips book)

Download/Read: Nomis Solutions (A)

Brief introduction to customized pricing and discussion of Nomis (A). [An upcoming hand-in assignment is based on Nomis (B) and is due on Nov 13. The (B) case, data, and some preliminary analysis is on Canvas.]

Class 5 – Mon Nov 9 – NO CLASS

We will have 3 industry speakers throughout Nov/Dec related to the course. You should try to attend the respective talks. We will also tape and make available in Canvas their presentations:

- Wed Nov 11, 6:30-8pm: Spencer Lazar, Principal at General Catalyst (analytics and online marketplaces)
- Mon Nov 16, 6-7:30pm: Bruce Berman, CFO Bloomingdale’s, President Bloomingdales.com,
- Mon Dec 2, 6-7:30pm: John Bible, CBS ’94, co-founder Profitlogic, acquired by Oracle

Class 6 – Wed Nov 11

Pricing as Constrained Optimization; Application to keyword auctions

Read: Pricing with Constrained Supply (Ch. 5 of Phillips book)

Download: Pricing Problems with Capacity Constraints

- Skim through questions 1 & 3 from Pricing Problems with Capacity Constraints that we will briefly review in class

Download: EveryDay Medical (Case)
 EveryDayMedical (data file)

- Prepare solutions for questions 1 – 3. You do not need to submit a report to be graded, but you should try to think and work through the problems.

Hand In: Solutions to Nomis (B)

Class 7 – Mon Nov 16

Markdown Management

Read: Retailer: A Retail Pricing Simulation Exercise (Broadie and van Ryzin)

Skim: Markdown Management (Ch. 10 of Phillips book)
 Before Christmas, Wal-Mart was stirring (NYT, Jan 2005)

Download: The *Retailer* game and its data file (detailed instructions below)

- Instructions related to the simulator called *Retailer* can be found in the end of the assigned reading.
- Download the data file Retailer.xls and, heeding the suggestions offered on pages 8-9 of the assigned reading, analyze this data to extract the information needed to formulate a markdown strategy. (An artificial element of this exercise is that all the items included in the historical data had a list price of \$60, which happily is the list price for the item to be considered in the simulation.) Before starting the simulation exercise itself, work out at least a crude markdown strategy based on your data analysis, again paying careful attention to the suggestions offered in the case.
- Now download the zip file Retail.zip to a new folder called “Retail.” Extract all files into this folder and play five iterations of the *Retailer* game, following the strategy you have formulated. (To get started, double click on Retailer.exe, the icon that contains a dollar sign. To begin an iteration click (Re)Start on the menu bar. With a little experimentation it should become clear how the mechanics work.) Come to class prepared to discuss your results, the reasoning behind your strategy, and any second thoughts you may now have about that strategy.

The retailer code will work on macs running windows and on “32-bit windows 7 installations” following the instructions below:

To make this program work,

1. right click on retailer.exe
2. select Properties
3. click the compatibility tab
4. under compatibility mode check “run this program in compatibility mode for”
5. select windows xp from the drop down box
6. hit ok to leave the properties.
7. Run the program

If you have the 64-bit version of Windows 7 (**Professional or higher version**):

1. Go here: <http://www.microsoft.com/windows/virtual-pc/download.aspx>

2. Follow the steps to install XP mode, this requires downloading and installing three components (downloading each will take some time)
3. Restart Computer
4. Go to Windows Virtual PC on Start Menu and Start up XP Mode
5. If you are asked if you want the drives to be shared, answer yes.
6. XP Mode will set-up for about another 10 minutes
7. Go to My Computer within XP mode, find the share drive where you saved retailer
8. Run Retailer

Class plan: Review the retailer, run a “live” retailer pricing competition in class. Discuss your retailer pricing strategies, review practical markdown management policies, and possible quantitative pricing strategies for the retailer game.

Hand In: CTR

Class 8 – Wed Nov 18

Strategic consumer interaction effects

Download: Hannah Montana

- Prepare solutions to questions 1, 2 and 3.

Discuss Indochino: company, data, assignment – parts A-B

Class 9 – Mon Nov 23

Capacity Control via Linear Programming

Download: Westbrook Hotel
Capitol Airlines
Harrah’s Casino Case

- Prepare solutions for Westbrook Hotel
- Read through Harrah’s case; prepare answers to questions 1-3.

Hand In: Indochino -- A

Class 10 – Mon Nov 30

Capacity control with stochastic demand

Booking limits and protection levels. Critical fractile solution of the static allocation problem with two fare classes. Nested booking limits and dynamic booking control; introduction to overbooking.

Read: Introduction to ... Yield Management (Netessine and Shumsky), pp. 34-39
Revenue Management & Capacity Allocation (Ch. 6 & 7 of Phillips)

Download: Football Stadium Booking Control

- Prepare solutions for Problems 1-4 in Appendix B of the Netessine-Shumsky article, and be prepared to discuss them in class.
- Prepare solutions for the two questions posed in Football Stadium Booking Control, and come prepared to discuss them in class.
- The last third of this class session will treat the mechanics of dynamic booking control, specifically in an airline setting, discussing the elaborate systems that have been built around a few relatively simple formulas for determining booking limits.

Class 11 – Wed Dec 2

A. Case Study on Capacity Control

Read: Transportation National Group (TNG)

- What challenges does TNG face in managing its leases of trailers?
- What is your assessment of TNG's current lease performance measures and controls, especially its use of ROI measures?
- How might TNG implement revenue management? What ideas or approaches seem most viable in a business like this?
- Use linear programming (Solver) to answer the following question: based on the data for the Yakima branch (file TNG.XLS on the course website), what is the potential revenue opportunity at this location from optimally controlling the availability of leases of various durations?
- If TNG wanted to implement revenue management, what recommendations would you make going forward, and how would you prioritize your recommendations?

Class 12 – Mon Dec 7

Implementation of PRO

Download: Bloomingdale's case study

The main issue in the case is how to measure and quantify the benefits of a pricing optimization system. This was a serious concern facing Bloomingdale's and the case accurately captures the relevant issues. Basically, the question I would like you to consider is this: How should Bloomingdale's use the data from their pilot study to quantify the benefits of the Profitlogic PO system? I would like you to propose an approach for answering this question. You don't have to do a detailed analysis of the data, but I would like you to think through HOW you would approach it and make a concrete recommendation. You may work in groups on this and don't have to turn anything in but I expect you to have given the question serious thought.

Hand In: Indochino -- B