



## Research Summary November, 2012

One of the primary goals of the Center for Pricing and Revenue Management is to support research. The Center's affiliated faculty, graduate students, and research associates are active in performing research in all areas of pricing, market segmentation and customer analytics. Collaboration with corporations including major airlines, financial institutions, software providers, and entertainment companies ensures that Center research remains both innovative and relevant.

The Center publishes a series of working papers in order to make this research available to industry and academia. The Center working papers are available at [www.cprm.columbia.edu/cprm/research](http://www.cprm.columbia.edu/cprm/research).

This summary gives a brief description of the major areas of current research within the Center. For each area, several papers written or co-written by researchers affiliated with the Center are referenced for further reading.

### **DYNAMIC PRICING**

How to set and update prices over time is one of the classical problems in pricing and revenue management. In some sense, it is as old as retail commerce. However, it has achieved greater importance in the last few decades, first through the dynamic pricing and availability capabilities afforded to the airlines through automated reservation systems, then through the rapid sales, response, and updating capabilities provided by the Internet. It is not an exaggeration to say that the problem of how to set and update prices dynamically over time is one of the most important problems facing many retailers today.

Professor Omar Besbes and his colleagues from the Center have studied dynamic pricing and learning under different scenarios. Their specific areas of interest include how decision makers should balance "learning and earning" and how much effort should be spent on determining the underlying demand relationship before seeking to maximize profit. Additionally, Professor Besbes and his colleagues are currently exploring how changes in underlying customer behavior can be detected from demand data. These questions have immediate applicability to the pricing issues faced by anyone seeking to sell on-line.

### **Further Reading**

Besbes, O. and Zeevi, A. 2012. "On the (Surprising) Sufficiency of Linear Models for Dynamic Pricing with Demand Learning." [CPRM Working Paper 2012-3](#). Columbia Business School.

Besbes, O. and Maglaras, C. 2012. "Dynamic Pricing with Financial Milestones: Feedback-Form Policies." *Management Science*.  
Available at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1983308](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1983308)

## CONSUMER CHOICE

The first generation of revenue management models made the assumption that consumer choice would not be influenced by the set of products available at the time. Specifically, the consumer choice of a booking class would depend only on the price and availability of that class – not of other classes. While clearly unrealistic, this assumption made revenue management models much more tractable, and enabled the implementation of the first generation of revenue management software systems. Similarly, many dynamic pricing systems have considered price-elasticity on a product by product basis without incorporating the effect of prices and availabilities on the sales of other products.

Center researchers are moving beyond this simplistic assumption to incorporate more realistic models of consumer choice into pricing and revenue management. More realistic representation of consumer choice has been shown to substantially improve the potential profitability of pricing decisions.

### Further Reading

Gallego, G., Iyengar, G. Phillips, R. and A. Dubey. 2004. “Managing Flexible Products on a Network.” [CORC Technical Report](#), Columbia University.

Gallego, G. and R. Wang. 2012. “Multi-product Price Optimization and Competition under the Nested Logit Model with Product-Differentiated Price Sensitivities.” *Submitted to Management Science*. Available at <http://www.columbia.edu>.

## EMPIRICAL STUDIES

The key focus of empirical studies is to use real-world market data to determine how customers react to various choices that are presented to them. A key challenge in this area is disentangling the actions of the seller (who may be tailoring prices and offerings to individual buyers) from the actions of the buyers. Attempts to estimate price-sensitivity that do not appropriately disentangle these effects may lead to substantial misestimation of price-sensitivity and correspondingly poor pricing decisions. Center researchers including Professors Robert Phillips and Garrett van Ryzin have been working to apply advanced econometric techniques to real-world data in order to understand the magnitude of these effects and develop techniques that can be used to estimate true price-sensitivity in the face of substantial interactions between buyers and sellers.

### Further Reading

Phillips, R., Simsek, S. and G. van Ryzin. 2012. “Endogeneity and Price Sensitivity in Customized Pricing.” CPRM Working Paper 2012-4, Columbia Business School.

## SERVICES ENGINEERING AND PRICING

Professor Guillermo Gallego and his colleagues have contributed extensively to the research on the effects of service product design on customer behavior, revenue, and profitability. Professor Gallego's survey paper "Service Engineering: The Future of Service Feature Design and Pricing" recently published in the *Oxford Handbook of Pricing Management*, eds. Özer and Phillips (2012) provides an excellent overview of research in this area.

Professor Gallego and his colleagues continue to explore different approaches to the design, presentation and pricing of products and services. These approaches include different forms of bundling, optionality, flexibility, upgrading and upselling. Their research shows that using these approaches to create and price a menu of offerings can substantially increase revenue for a service or product provider.

### Further Reading

Gallego, G. and C. Stefanescu.. 2009 "Upgrades, Upsells and Pricing in Revenue Management." Working Paper, London Business School.  
Available at <http://dx.doi.org/10.2139/ssrn.1334341>

Gallego, G., Wang, R., Beltran, J.L. and S. Jain. 2012. "Pricing in Bounded Rational Markets." To be submitted to *Management Science*.

## EXTENSIONS TO NEW INDUSTRIES

Analytic methodologies for pricing and revenue management have been applied successfully in a wide range of industries including retail, airlines, freight transportation, CPG, industrial manufacturing, hospitality, and on-line advertising. Extension to new industries usually involves new challenges as existing techniques need to be adapted to the specific characteristics of new markets. Center researchers have been at the forefront of extending the techniques of customer analytics to apply to new industries and new situations such as sporting events, consumer credit, and highway tolls.

### Further Reading

Balseiro, S., Gallego, G., Gocmen, C. and R. Phillips. 2011. "Revenue Management of Consumer Options for Sporting Events." [CPRM Working Paper 2011-01](#). Columbia Business School.

Phillips, R. 2012. "Pricing Optimization for Consumer Credit." [CPRM Working Paper 2012-05](#), Columbia Business School.

## PRICING AND SOCIAL NETWORKS

Social networks are a prime example of a disruptive technology enabled by the Internet. Companies are still struggling to understand how social networking will affect their business and how social network data can be used to generate useful insights. Professor Costis Maglaras

and his colleagues have been exploring how social networks affect pricing, promotion and advertising decisions made by companies. *Review aggregator* sites such as TripAdvisor and Yelp influence consumer perceptions about product quality and therefore, purchase decisions. In a series of papers, Professor Maglaras and his colleagues are studying price optimization in a setting where consumers learn the quality of a new product from reviews.

Professor Maglaras is exploring optimal promotion strategies in the presence of social learning. He is examining timing, discount levels, and consumer segmentation of promotions in a social media environment.

### **Further Reading**

Ifrach, B. Maglaras, C. and M.Scarsini. 2012. "Monopoly Pricing in the Presence of Social Learning." [Working Paper](#), NET Institute.

Ifrach, B. Maglaras, C. and M.Scarsini. 2012. "Bayesian Social Learning with Consumer Reviews." Working Paper, NET Institute.