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## EDUCATION

Ph.D., Management (Marketing), 2004-2008 (expected), INSEAD, France  
Ph.D., Computer Science, 2003-2007, Eotvos Lorand University, Hungary  
M.Sc., Mathematics, 1998-2003, Eotvos Lorand University, Hungary

## DISSERTATION

### **“Buying and Selling Traffic: The Internet as an Advertising Medium”**

*Committee:* Miklos Sarvary (chair), Elie Ofek, Paddy Padmanabhan, Timothy Van Zandt

The Internet is rapidly growing as a marketing medium. This year online advertising expenditures will reach approximately \$20 billion in the US alone. Two formats dominate online advertising: (i) websites buying advertising links from each other and (ii) search engines selling sponsored links on their results pages. The first part of the dissertation studies the former advertising model and investigates the network structure that emerges from advertising links. In a world in which consumers ‘surf’ the WWW, websites’ revenues originate from two sources: the sales of content (products and services) to consumers, and the sales of links (traffic) to other sites. In equilibrium, higher content sites tend to purchase more advertising links, mirroring the Dorfman-Steiner rule. Sites with higher content sell fewer advertising links and offer these links at higher prices. Thus, sites seem to specialize in terms of revenue models: high content sites tend to earn revenue from sales of content, whereas low content sites tend to earn revenue from sales of traffic (advertising). I test these findings in a variety of empirical studies. The second part of the dissertation explores the other dominant form of online advertising: paid placement. Here, a search engine auctions sponsored links next to the search results to advertisers who submit bids for the price that they are willing to pay for a click. The model focuses on two key characteristics of this problem: (i) the interaction between the search list and the list of sponsored links and (ii) the dynamic forces that influence bidding behavior when sites compete for the sponsored links over time. The findings explain the seemingly random order of sites on the sponsored links list and their variation over time.

*Research Interests:* Online Advertising, Search Advertising, Social Networks, Word-of-Mouth Marketing, Community-Based Brands

## PUBLICATIONS AND ACCEPTED PAPERS

Katona, Zsolt and Miklos Sarvary. 2007. “Network formation and the structure of the commercial World Wide Web,” conditionally accepted at *Marketing Science*. [download](#)

Katona, Zsolt and Tamás Móri. 2006. “A new class of scale-free graphs,” *Statistics and Probability Letters* **76**(15) 1587-1593.

- Katona, Zolt. 2006. "Levels of a scale-free tree," *Random Structures and Algorithms* **29**(2) 194-207.
- Katona, Zolt. 2005. "The width of a scale-free tree," *Journal of Applied Probability* **42**(3) 839-850.
- Katona, Zolt. 2005. "3-wise exactly 1-intersecting families of sets," *Graphs and Combinatorics* **21**(1) 71-76.
- Furedi, Zoltan and Zolt Katona. 2004. "Multiply intersecting families," *Journal of Combinatorial Theory - Series A*, **106**(2) 315-326.
- Katona, Zolt. 2001. "Intersecting families of sets, no 1 containing two common elements," *Discrete Mathematics* **226** (2001) 233-241.

#### WORK UNDER REVIEW AND WORK IN PROGRESS

- Katona, Zolt, Joseph Lajos, Amitava Chattopadhyay and Miklos Sarvary: "CAM: A spreading activation network model of sub-category construction when categorization uncertainty is high," under revision for 3rd round at *Journal of Consumer Research*, won the 2006 Association for Consumer Research Best Working Paper Award [download](#)
- Ofek, Elie, Miklos Sarvary and Zolt Katona: "Bricks & Clicks: The Impact of Product Returns on Multi-Channel Retailers," under revision for 2nd round at *Marketing Science* [download](#)
- Katona, Zolt: "The Race for Sponsored Links: A Model of Competition for Search Advertising" [download](#)
- Katona, Zolt and Peter Zubcsek: "Joining the Network: Personal Influences as Determinants of Diffusion" [download](#)
- Katona, Zolt and Elie Ofek: "Quality and Advertising in a Vertically Differentiated Market" [download](#)

#### MAJOR PRESENTATIONS

- Katona, Zolt and Miklos Sarvary: "Network formation and the structure of the commercial World Wide Web"
- *Marketing Science Conference*, Singapore, 2007 (upcoming)
  - *Interdisciplinary Workshop on Games and Networks*, INSEAD, 2007
  - *Summer Institute in Competitive Strategy (SICS)*, Berkeley, 2006
  - *Large-Scale Random Graph Methods for Modeling Mesoscopic Behavior in Biological and Physical Systems*, Budapest, 2006

Katona, Zsolt, Joseph Lajos, Amitava Chattopadhyay and Miklos Sarvary: “CAM: A spreading activation network model of sub-category construction when categorization uncertainty is high”

- *Marketing Science Conference*, (presented by Joseph Lajos) Singapore, 2007 (upcoming)
- *Association for Consumer Research Conference*, (poster) Orlando, 2006
- *HEC-ESSEC-INSEAD Seminar*, France, 2006

Katona, Zsolt and Peter Zubcsek: “Joining the Network: Personal Influences as Determinants of Diffusion”

- *Marketing Science Conference*, (presented by Peter Zubcsek) Singapore, 2007 (upcoming)

Katona, Zsolt and Elie Ofek: “Quality and Advertising in a Vertically Differentiated Market”

- *Marketing Science Conference*, Singapore, 2007 (upcoming)
- *LBS Transatlantic Doctoral Conference*, London, 2007

Katona, Zsolt: “Properties of Evolving Networks”

- *University of Illinois at Chicago Seminar Series*, Chicago, 2005

## TEACHING

### MATERIALS

- IWIW - Social Networking in Hungary, INSEAD Case Study 05/2007-5445

### EXPERIENCE

- Instructor, Discrete Mathematics, Technical University of Budapest, Fall 2000, 2002, 2003; Spring 2001, 2002, 2003, 2004 (Average Rating: 4.56/5)
- Instructor, Probability and Statistics, Eotvos Lorand University, Fall 2001, 2002, 2003; Spring 2002 (Average Rating: 4.67/5)
- Instructor, Probability and Statistics, Budapest University of Economic Sciences, Fall 2001

## AWARDS, FELLOWSHIPS

Sasakawa Young Leaders Fellowship, 2007

Association for Consumer Research Best Working Paper Award, 2006

AMA Sheth Foundation Doctoral Consortium Fellow, 2006

Budapest University of Economics, Microeconomics Contest, first prize, 2003  
Scientific Students' Associations Conference, third prize, 2003  
Hungarian State Fellowship, 2002  
Excellent Student of Faculty Award, Eotvos Lorand University, 2002  
Scientific Students' Associations Conference, second prize, 2001

## REFERENCES

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# Abstracts

“Network formation and the Structure of the World Wide Web” [download](#)

We model the commercial World Wide Web (WWW) as a directed graph emerging as the equilibrium of a game in which utility maximizing Web sites purchase (advertising) in-links from each other, while also setting the price of these links. A key feature of our model is that we consider sites to be heterogeneous in terms of their “content”, i.e. their inherent value to consumers. In a world where consumers ‘surf’ on the WWW, sites’ revenues/profits originate from two sources: (i) the sales of content (products) to consumers, and (ii) the sales of links (traffic) to other sites. We find that in equilibrium, higher content sites tend to purchase more advertising links mirroring the Dorfman-Steiner rule. Sites with higher content sell less advertising links and offer such links at higher prices. As such, there seems to be specialization across sites in terms of revenue models: high content sites tend to earn revenue from the sales of content while low content ones from the sales of traffic (advertising), a tendency that is increasing with the size of the browsing population. In an extension, we also allow sites to establish (reference) out-links to each other beyond the sales of advertising links and find that there is a general tendency to establish reference link to sites with higher content. Overall, there is a strong positive correlation between a site’s content and the number of its in-links. We also explore network formation in the presence of search engines and find that the higher the proportion of people using these, the more sites have an incentive to specialize in certain “content areas”. Our results have interesting practical implications for ‘search-engine optimization’, the pricing of Internet advertising as well as the choice of Internet business models. They also shed light on why successful search engines (e.g. Google) can use simple heuristics based on in-links to rank sites with respect to their content.

“CAM: A spreading activation network model of sub-category construction when categorization uncertainty is high” [download](#)

A large body of research suggests that people process the entities that they encounter by placing them into mental categories (Barsalou 1992). Although previous research examines how people access information in hierarchical category structures, it does not examine how people construct individual new categories and, in particular, how the locus of these new categories may depend on the structure of the entire hierarchy. We describe this latter process with a spreading activation model of hierarchical category structures that we call the Category Activation Model (CAM). In an experiment and an empirical study, we show that the CAM reliably predicts the probability that a person will construct a new category at a specific location within a category structure, and we provide evidence that accessibility is the mechanism that underlies category construction.

## “Bricks & Clicks: The Impact of Product Returns on Multi-Channel Retailers” [download](#)

The Internet has increased the flexibility of retailers allowing them to operate an online arm in addition to their physical stores. While the online channel offers retailers potential advantages in selling to customer segments that value the conveniences of online shopping, it also raises new challenges. These include the higher likelihood of costly product returns when customers’ ability to “touch and feel” the product is important in determining fit. We study competing retailers operating dual channels (“Bricks and Clicks”) and examine how pricing strategies and the level of physical store assistance change as a result of the additional Internet outlet. On the supply-side, firms endogenously determine prices and how much to invest in store characteristics that assist customers in finding matching products (e.g., greater shelf display capacity, more qualified staff, floor samples). On the demand-side, we capture two relevant sources of customer heterogeneity: (i) retailer preference, and (ii) shopping trip costs. A central result we obtain is that when differentiation among retailers is not too high, having an online channel actually increases (costly) investment in store assistance levels while prices are set higher. We also examine how firms’ range of product categories can vary between the two channels. Our main finding here is that even though it is costless to offer products online, retailers will sell only a limited assortment over the Internet. In particular, only “safe” products with a low chance of being returned will be sold online, while retailers’ full range of products will be sold in physical stores.

## “The Race for Sponsored Links: A Model of Competition for Search Advertising” [download](#)

We model search advertising as a game in which a search engine sells sponsored links to competing websites on a search page. We focus on two key characteristics of this problem: the interaction between the list of search results and the list of sponsored links on the search page and the inherent differences in click-through rates between sites. We find that both of these characteristics have a significant effect on sites’ bidding behaviors and equilibrium outcomes. In three extensions, we also explore (i) the endogenous choice of the number of sponsored links that the search engine sells, (ii) the case in which sites bid for sponsored links in multiple search contexts and (iii) a dynamic model in which websites’ bidding behaviors are a function of their previous positions on the sponsored list. Our results give meaning to the seemingly random order of sites on search engines’ lists of sponsored links and provide normative insights for both buyers and sellers of search advertising.

## “Joining the Network: Personal Influences as Determinants of Diffusion” [download](#)

We study the word-of-mouth effect in a diffusion process in a social network. Aggregate diffusion models ignore the possibility that an individual who is connected to many others in a social network may have a higher adoption probability (degree effect). Furthermore, the density of connections in a group of already adopted consumers may also affect the adoption of individuals connected to this group (clustering effect). We analyze data from one social network for which we know the individual connections between every pair of members. The results support the existence of both degree and clustering effects. We also show how a linear degree effect at the individual level can be the underlying determinant of the Bass model. Furthermore, we present a new methodology to determine the influential power of every individual. Surprisingly, we find that highly connected individuals have a lower average influential power (average influence on a particular person). However, the results suggest that the large number of connections counterbalances the small average influential power, such that highly connected individuals have a higher total influence than their less connected counterparts. We also find evidence that gender and age affect influential power.

## “Quality and Advertising in a Vertically Differentiated Market” [download](#)

In this paper, we examine firms' quality positions when consumers can only consider purchasing products that they are aware of through advertising. Consumers compare the products they are aware of, and choose the product that maximizes their utility net of price. Firms choose product quality in a first stage, their advertising strategy in a second stage, and set prices in the last stage. Two forms of advertising are studied— *blanket* and *targeted*. Under blanket advertising, firms communicate to all consumers and the probability that each consumer sees an ad depends on the level of ad expenditure. We find that when blanket advertising is relatively ineffective, i.e., it is costly to ensure high consumer awareness, both firms will choose a light level of ad spending. This allows firms to select relatively undifferentiated qualities, without concern of intense price competition. When blanket advertising is very effective, the high quality firm expends heavily on advertising, while its rival differentiates with a low quality product and expends less on advertising. Interestingly, in a mid range of advertising effectiveness, one firm chooses a high quality product, but because its rival positions close by, it selects a low ad expenditure to avoid competing fiercely in prices. Under targeted advertising, firms choose the specific segment(s) they wish to make aware of their product. We identify conditions such that both firms choose equally high quality products, but advertise to different segments. This can result in a middle pocket of unserved consumers, even though consumers with lower willingness to pay are served.