# CHOICE MODELLING: THE STATE-OF-THE-ART AND THE STATE-OF-PRACTICE


**Guest Speakers and Organisers**

*From left to right*: Moshe Ben-Akiva, Stephane Hess, Andrew Daly, Daniel McFadden, Riccardo Scarpa, David Hensher, Chandra Bhat, Michel Bierlaire

# CHOICE MODELLING: THE STATE-OF-THE-ART AND THE STATE-OF-PRACTICE

## Proceedings from the Inaugural International Choice Modelling Conference

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# Biography

## Editors

**Stephane Hess** is a principal research fellow in the Institute for Transport Studies (ITS) at the University of Leeds and holds a Leverhulme Early Career Fellowship. He is also research group leader for Economics and Behavioural Modelling at ITS, and is a visiting research scholar in the Institute for Transport and Logistics Studies at the University of Sydney. Hess holds a Ph.D. in transport demand modelling from Imperial College London, and a M.Phil. in statistical science from Cambridge University. His main research interests lie in the use of advanced discrete choice models for the analysis of travel behaviour. His contributions have been recognised by the 2005 Eric Pas award for the best Ph.D. thesis in the area of travel behaviour modelling. He is also the founding editor-in-chief of the *Journal of Choice Modelling*, and is the chair of the Innovative Methods in Transport Analysis, Planning and Appraisal committee at the European Transport Conference, as well as being a member of the council of the Association for European Transport.

**Andrew Daly** is a research professor at the Institute for Transport Studies in Leeds, a senior adviser to RAND Europe and the author of the widely used ALOGIT software. His work has attempted to bridge the gap between research and practice in choice modelling: pioneering the introduction of random utility models, making advanced models operational for large areas so they can be used in practical planning, and improving the credibility of stated preference methods. He has published and presented well over 100 papers on these subjects, was chair of the recent International Choice Modelling Conference, has contributed to a number of books and regularly reviews papers for the leading transport journals. He has directed large-scale transport modelling projects in The Netherlands, France, Sweden, Denmark, Norway, Australia and the UK and contributed to projects in several other countries. He frequently advises local, national and international government agencies on transport modelling issues.

## Guest Speakers

**Daniel McFadden** passed through the public school system of North Carolina, then graduated in Physics but soon developed an interest in human behaviour and turned

to economics. Following the completion of his Ph.D. at the University of Minnesota in 1962, he has spent his career largely at Berkeley, CA and from 1977 to 1991 at the economics faculty at MIT, where he became Director of the Statistics Research Center. He then returned to Berkeley to establish the Econometrics Laboratory, a facility devoted to improving statistical computation for economics applications, where he is now the holder of the E. Morris Cox chair.

From 1964 onwards, seeking methods to analyse institutional decision-making behaviour, he developed an econometric model based on an axiomatic theory of choice behaviour, showing how this model linked to the economic theory of choice behaviour. These developments are now called the multinomial logit model and the random utility model, which have turned out to be widely useful in economics and other social sciences. Over the years he has written papers on a variety of topics in economics and choice theory, almost all having origins in applied problems, often with an emphasis on binding economic theory, and on developing theoretical and statistical tools. In recent years, his research has concentrated on the deviations from the economic theory of choice and their implications for economic analysis.

In 2000, he was awarded the Nobel Prize in Economic Sciences 'for his development of theory and methods for analyzing discrete choice'. Characteristically, his lecture gave credit to a long list of inspirations and collaborators with whom he has worked. His own contribution to choice modelling is, however, unparalleled.

**Moshe Ben-Akiva** is the Edmund K. Turner professor of civil and environmental engineering and director of the Intelligent Transportation Systems Program at the Massachusetts Institute of Technology (MIT). He holds a Ph.D. degree in transportation systems from MIT and has received honorary degrees from the University of the Aegean, the Université Lumière Lyon and the Stockholm Royal Institute of Technology (KTH). His awards include a Transportation Science Dissertation Prize from the Operations Research Society of America (now INFORMS), the MIT Department of Civil and Environmental Engineering Effective Teaching Award, the MIT Samuel M. Seegal Prize awarded to professors who inspire students to pursue and achieve excellence, the Lifetime Achievement Award of the International Association for Travel Behavior Research and the Jules Dupuit Prize from the World Conference on Transport Research Society. He has co-authored two books, including the textbook *Discrete Choice Analysis*, published by MIT Press, and over 200 papers in refereed journals and conference proceedings. He recently co-edited the book *Recent Developments in Transport Modelling: Lessons for the Freight Sector* published by Emerald. Two traffic simulators have been developed under his supervision: MITSIMLab, a microscopic simulator; and DynaMIT, a mesoscopic simulator — which includes algorithms for dynamic traffic assignment, traffic predictions and route guidance. He has worked as a consultant in industries such as transportation, energy, telecommunications, financial services and marketing for a number of private and public organisations, including Hague Consulting Group, RAND Europe, ChoiceStream and Cambridge Systematics, where he is a senior principal and a member of the board of directors.

**David A. Hensher** is professor of management, and founding director of the Institute of Transport and Logistics Studies (ITLS): The Australian Key Centre of Teaching and Research in Transport Management at The University of Sydney. David is a fellow of the Academy of Social Sciences in Australia (FASSA), Recipient of the 2006 Engineers Australia Transport Medal for lifelong contribution to transportation, recipient of the 2009 Bus NSW (Bus and Coach Association) Outstanding Contribution to Industry Award, member of Singapore Land Transport Authority International Advisory Panel (chaired by Minister of Transport) and past president of the International Association of Travel Behaviour Research. David is the co-founder of The International Conference in Competition and Ownership of Land Passenger Transport (the Thredbo Series), now in its 20th year. David is on the editorial boards of 10 of the leading transport journals and area editor of *Transport Reviews*. He is also series and volume editor of a handbook series *Handbooks in Transport*. He has published extensively (over 425 papers) in the leading international transport journals and key journals in economics as well as 11 books.

**Chandra R. Bhat** is the Adnan Abou-Ayyash Centennial Professor at The University of Texas at Austin, where he teaches courses in transportation systems analysis and transportation planning methods. Bhat received the 2004 Walter L. Huber Award and the 2005 James Laurie Prize from the American Society of Civil Engineers (ASCE) in recognition of his contributions to 'innovative methods in transportation systems analysis and modeling.' He also received the 2006 Lockheed Martin Aeronautics Company Award for Excellence in Engineering Teaching from the Cockrell School of Engineering at UT Austin, and the 2006–2007 Outstanding Graduate Teaching Award from the UT Graduate School. Bhat was also named as the recipient of the 2008 Wilbur S. Smith Distinguished Transportation Educator Award, and was selected as a 2008–2009 Jefferson Science Fellow by the United States Department of State and the National Academies. More details about Prof. Bhat are available at his website: http://www.caee.utexas.edu/prof/bhat/home.html

**Michel Bierlaire**, Belgian, and born in 1967, holds a M.Sc. and a Ph.D. in mathematical sciences from the Facultés Universitaires Notre-Dame de la Paix, Namur, Belgium (University of Namur). Between 1995 and 1998, he was research associate and project manager at the Intelligent Transportation Systems Program of the Massachusetts Institute of Technology (Cambridge, MA). Between 1998 and 2006, he was a junior faculty in the Operations Research group ROSO within the Institute of Mathematics at EPFL. In 2006, he was appointed associate professor in the School of Architecture, Civil and Environmental Engineering at EPFL, where he became the director of the Transport and Mobility Laboratory. Since 2009, he is the director of TraCE, the Transportation Center at EPFL. His main expertise is in the design, development and applications of models and algorithms for the design, analysis and management of transportation systems. Namely, he has been active in demand modelling (discrete choice models, estimation of origin–destination matrices) and Dynamic Traffic Management Systems. As of October 2009, he has published 44 papers in international journals (including *Transportation Research Part B*, the transportation journal with the highest impact factor), 1 book, 20 book

chapters, 74 articles in conference proceedings, 84 technical reports and has given 134 scientific seminars. His article 'An efficient algorithm for real-time estimation and prediction of dynamic OD table', co-authored with Frank Crittin, has received the Best Paper Award of the Transportation Science & Logistics Society of INFORMS in 2006.

## Other Authors

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**Thomas J. Adler** is president of Resource Systems Group, Inc., a US-based transportation, market research and environmental consulting firm. Prior to co-founding the firm, he was a professor at Dartmouth College for 10 years, where he taught graduate-level courses in discrete choice modelling, operations research, statistics and transportation modelling methods.

**Ricardo Alvarez-Daziano** is doing a Ph.D. at Laval University since 2005 and member of the GREEN and CDAT Research groups of the Department of Economics. His thesis concerns the study of hybrid choice models (HCM) and aims to improve the representation of behavioural decision making.

**Gianluca Antonini** is a senior research scientist at the IBM Zurich Research Laboratory (ZRL), working with the Information Analytics group in the Mathematical & Computational Sciences Department. He holds a master degree in telecommunication engineering from the University of Siena, and a Ph.D. from the Signal Processing Institute, Ecole Polytechnique Federale de Lausanne (EPFL).

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**Denis Bolduc** is full-time professor at Laval University. His major fields of expertise include: discrete choice analysis, applied econometrics and demand modelling. He has performed applied and theoretical research mostly in the transportation field. He has been chair of the department during the 2002–2008 period. He is currently chair of the CDAT.

**Danny Campbell** is a lecturer in environmental economics at the Institute for a Sustainable World, Queen's University Belfast. He has obtained a Ph.D. in environmental economics, a M.Sc. in rural development and a B.Sc. in agricultural economics. Danny's research interests include environmental valuation and methodological issues associated with discrete choice modelling.

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**Jon Crockett** is a transport planner and researcher at MVA Consultancy. He is their technical group leader for behavioural research, modelling and analysis, and has specialised in understanding reactions to changes in the transport network(s) through the application of econometric theories.

**Javier Cruz** received the M.S. degree in mathematics and the M.S. degree in telecommunications engineering from the Technical University of Catalonia (UPC), in 2005 and 2006, respectively. In January 2007, he joined the Transport and Mobility Laboratory (Transp-OR) of EPFL, where he is now working towards his Ph.D. on image and signal processing under the supervision of Prof. M. Bierlaire and Prof. J.-P. Thiran.

**Matthieu de Lapparent** is researcher at the French National Institute of Research on Transport and Safety (INRETS). He holds a Ph.D. in economics from the Université de Paris 1 Panthéon-Sorbonne. He specialises in discrete choice modelling accounting for bounded rationality of decision makers and/or for risky choice situations.

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**Cristian Angelo Guevara** is author of several scientific papers in transportation demand and economics. He is a research professor at Universidad de los Andes, Chile. He holds an M.Sc. from Universidad de Chile and another from MIT, where he now pursues his Ph.D. He had been awarded the Fulbright and the Martin-Family fellowships.

**Hugh Gillies** is the development management/strategic roads safety manager for Transport Scotland. During the time of this study he led Transport Scotland's research programme on Land use And Transport Integration in Scotland (LATIS), which provided support for the appraisal of policies in areas such as transport, planning and the environment.

**Yaron Hollander** works for Steer Davies Gleave in London, and is very active in applied research on public transport reliability. In his Ph.D. thesis (at the Institute for Transport Studies, Leeds) and subsequent projects for various clients he investigated travellers' attitudes to unreliability, techniques for forecasting the level of unreliability and the introduction of reliability benefits to scheme appraisal.

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**Jean-Philippe Thiran** received the Elect. Eng. and Ph.D. degrees from the Universite catholique de Louvain (UCL), Louvain-la-Neuve, Belgium, in 1993 and 1997, respectively. Since January 2004, he has been an assistant professor, responsible for the Image Analysis Group at the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland. His current scientific interests include image segmentation, prior knowledge integration in image analysis, partial differential equations, and variational methods in image analysis, multimodal signal processing, medical image

analysis, including multimodal image registration, segmentation, computer-assisted surgery, and diffusion MRI. Dr. Thiran was co-editor-in-chief of *Signal Processing Journal* (published by Elsevier Science) from 2001 to 2005. He is currently an associate editor of the *International Journal of Image and Video Processing* (published by Hindawi), and member of the editorial board of *Signal, Image and Video Processing* (published by Springer). He was the general chairman of the 2008 European Signal Processing Conference (EUSIPCO 2008). He is a senior member of the IEEE, and a member of the MLSP and IVMSP technical committees of the IEEE Signal Processing Society

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**Ken Willis** is professor of environmental economics at Newcastle University. He has conducted numerous valuation projects using stated preference choice models, as well as contingent valuation, travel-cost and hedonic price models. Issues covered include biodiversity, cultural heritage, energy, forests, landscape, quarries, recreation, transport, waste disposal, and water quality and supply.

**María Francisca Yáñez** received her B.Sc. degree in civil engineering from Pontificia Universidad Católica de Chile (PUC). She is currently Ph.D. candidate at PUC, and is enjoying a 1-year stay at the German Institute for Economic Research (DIW-Berlin) financed by the Chilean Council for Scientific and Technological Research and the German Academic Exchange Service (DAAD). She has presented part of her thesis work at the most important conferences in Latin America and Europe.

# Editorial

The inaugural International Choice Modelling Conference was organised by the Institute for Transport Studies at the University of Leeds and was held at Harrogate in Yorkshire in the North of England from 30 March to 1 April 2009.

The conference brought together leading researchers and practitioners from across the many different areas in which choice modelling is a key technique for understanding behaviour and evaluating policy. The conference also came 29 years after another University of Leeds-organised conference on Research and Application of Disaggregate Travel Demand Models. Several of the delegates from the 1980 event were once again present at our conference, showing the longevity of the field. The presence of numerous new young delegates illustrates the growing international popularity of choice modelling as a topic of research.

The highlight of the conference was a presentation by Professor Daniel McFadden from the University of California at Berkeley, Nobel Prize laureate in Economics and chief architect of random utility modelling. We were similarly delighted to be able to secure the involvement of five other leading choice modellers as keynote speakers, namely Professor Moshe Ben-Akiva, Professor Chandra Bhat, Professor Michel Bierlaire, Professor David Hensher and Professor Riccardo Scarpa.

The diversity of the field was reflected in presentations by both academics and practitioners, coming from six continents and various different fields, with a similar mix in non-speaking delegates. This book brings together a selection of the best theoretical and applied papers from the conference, as well as five of the guest speaker contributions.

We specifically chose not to use this editorial for the purpose of summarising the various papers contained in this volume; we leave it to the readers to form their own opinions. We have, however, grouped the papers into a number of subsets. The first of these contains the five guest speaker papers referred to above and which indicate the achievements and current frontiers of the research area in a number of directions. This is followed by a set of four papers looking at data collection, primarily concerned with issues of experimental design and another set of four papers dealing with behavioural concepts and methodology which introduce a number of new ideas. Next are four papers looking in different ways and contexts at issues to do with endogeneity and heterogeneity, illustrating the rich variety of types of behaviour that can be addressed. The field of transport has always been one of the most fertile

breeding grounds in choice modelling, and this is reflected in the four papers contained in the next section. However, highlighting the multi-disciplinary nature of the field and the conference, the final subset contains six papers with applications from beyond transport.

It remains to us to once again thank our five conference sponsors, MVA Consultancy, Peter Davidson Consultancy, RAND Europe, Resource Systems Group Inc. and Significance, and our additional supporters, Accent and PTV. Further thanks need to go to the members of the academic committee, as well as Julie Hipkin, who worked tirelessly behind the scenes. Finally, all delegates will remember the wonderful musical performance by Supertram, joined on stage by the Red Hot Chilean Professors and John Bates Piano Services, with Mark Wardman on additional vocals and air guitar.

In closing, we hope to see many of the authors and readers of this volume at the second International Choice Modelling Conference, planned for 2011.

Stephane Hess
Andrew Daly
*University of Leeds, UK*

# PART I

# GUEST SPEAKER PAPERS

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Chapter 1

# Sociality, Rationality, and the Ecology of Choice

*Daniel McFadden*


## Abstract

This paper discusses the influence of human sociality on choice behavior, through association with social networks and the influence of these networks on constraints, perceptions, preferences, and decision-making processes. The paper discusses ways to incorporate these factors into choice models, while retaining the aspects of the theory of individual rationality that are predictive. Finally, the paper outlines an econometric method for solving the "reflection problem" of determining whether social affiliations follow preferences, or preferences follow social affiliations, by distinguishing opportunity-based and preference-based motivations for association with social networks.


## 1.1. Introduction

A defining feature of the neoclassical economic theory of choice is that consumers meet in the marketplace, but are individualistic and egocentric in their tastes and beliefs. They are indifferent to the welfare of others, with sovereign preferences that are immune to the influence of their peers. Jostling in the market, haggling over prices, and influences that are not effectively priced such as congestion, induce interdependence between consumers that may be intense. Consumers use these interactions to acquire facts and update their rational expectations, but in the classical theory, a consumer never lets social interactions get under her skin and

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