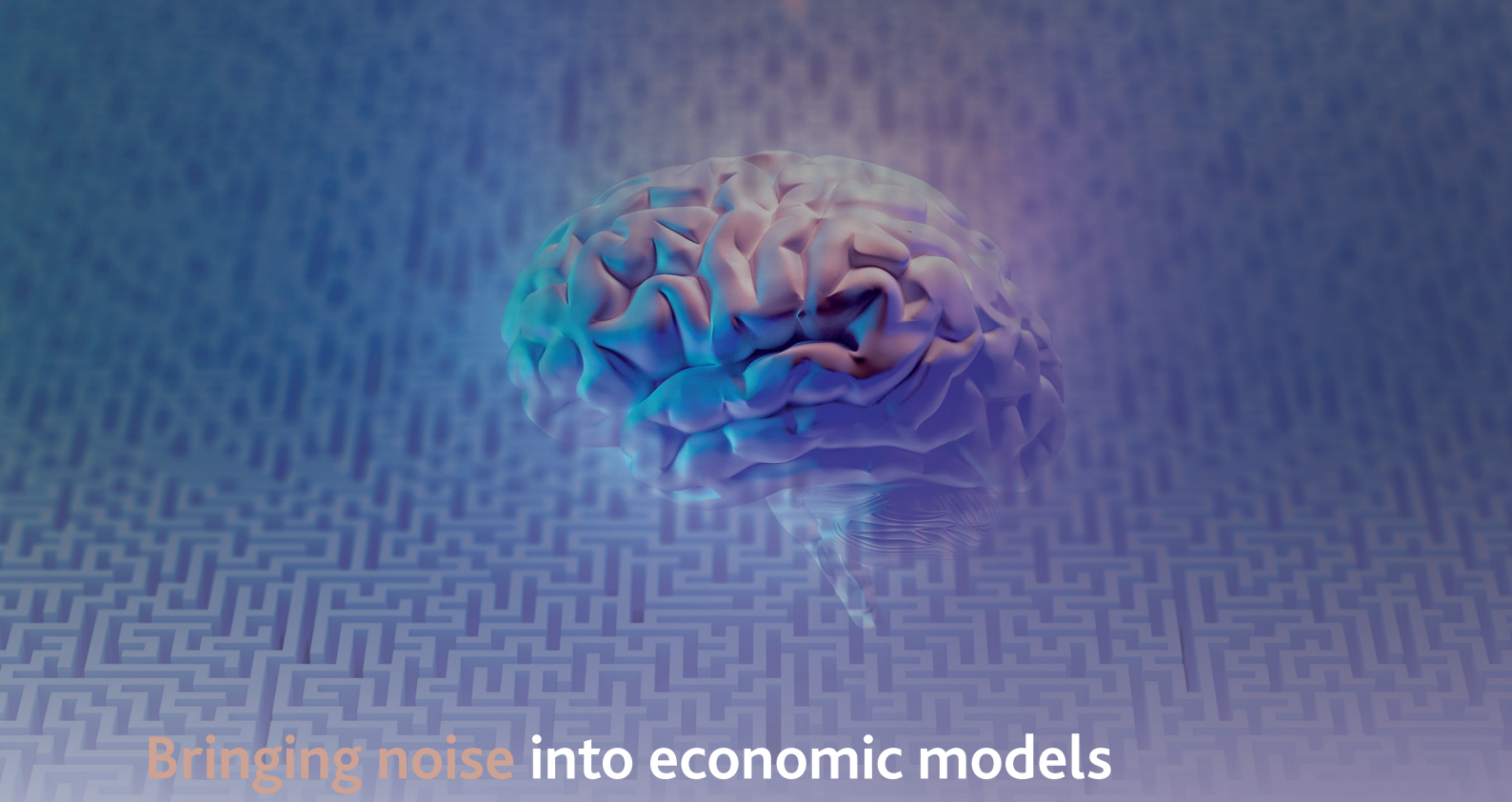


Bringing noise into economic models

Stochastic choice can be thought of as the idea that we don't always make the same decisions even when confronted with exactly the same choices, so the appropriate model of human behaviour is one which incorporates this randomness. **Professor Carlos Alós-Ferrer** is bringing together insights from several different fields to work more effectively with random utility models.

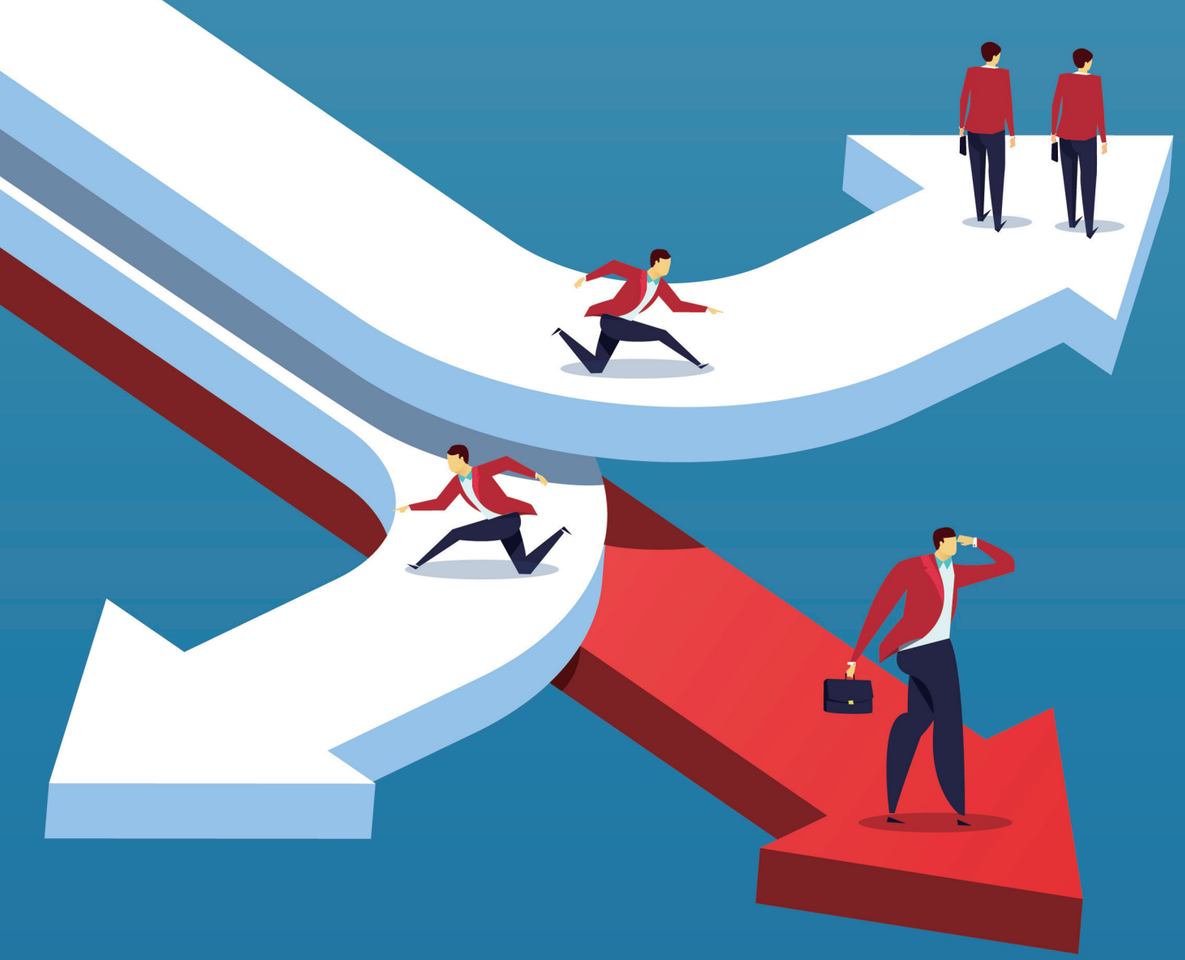
The topic of individual preferences, or the way in which people rank different options, is of great interest to economists, psychologists, and neuroscientists. Traditional economics models are deterministic, in the sense that they are based on the assumption that if an individual prefers option A to B then they will always choose A, yet this is not backed up the available data, says Carlos Alós-Ferrer, Professor for Decision and Neuroeconomic Theory at the Zurich Centrer for Neuroeconomics (ZNE). "The data suggests that there is a lot of noise, and when confronted with exactly the same options, people do not always make the same choices," he explains. As the head of a research project based at ZNE, Professor Alós-Ferrer is investigating questions around stochastic choice. "This is the idea that decision processes in the brain are inherently noisy, and hence our choices always have a random component," he outlines. "This means that the appropriate model of human behaviour is not one which uses deterministic preferences, but rather one which uses randomness."

Random utility models

This involves incorporating 'noise' at the behavioural level, which can be broadly thought of as inaccurate data which makes it more difficult to identify underlying trends. Researchers are working with random utility models – the standard for estimating preferences in economics – and bringing together insights from several different disciplines. "We are incorporating insights from psychophysics, psychology and neuroscience, so we can work more effectively with these random utility models," says Professor Alós-Ferrer. Two particularly important insights have been identified. "The first is that, for any kind of decision, if you are close to being indifferent then you are going to make more mistakes," continues Professor Alós-Ferrer. "The second is that if you are close to being indifferent, then your decisions are going to take longer. Those two points are regularities which are very strong and have been known about for more than a century in psychology, for example for perceptual decisions where people have to decide which of two objects is larger – we call them psychometric and chronometric effects respectively. What we are finding is that these effects are also very clear for economic decisions, which are typically based on unobservable scales as individual preferences instead of, say, the size of an object."

Researchers have been investigating how to incorporate these insights in preference estimation and economic models of stochastic choice, work which involves several different strands of research. Recently, Professor Alós-Ferrer published a paper that essentially solves a long-standing problem in economics. "The problem is that when we think about recovering preferences, it is apparent that even if someone chooses A over B more than 50 percent of the time, we cannot really conclude that they prefer A over B," he outlines. The reason is that noise can do strange things – it could have a bias, it could be asymmetric – and is by nature very difficult to observe. Now researchers are using insights from other disciplines to modify economic models. "We take inputs from psychology, which tells us that if you are closer to indifference, your decision is going to take longer. Thanks to computers, response times are easily observable today, so we have a lot of data on this," says Professor Alós-Ferrer. "In that paper we built the response times into the models."

This enabled researchers to prove a formal result which identifies the conditions under which a distribution of response times shows that an individual indeed prefers option A over B, for example red wine over white wine, or a certain policy over an alternative. Personal choices are the result of underlying preferences



and behavioural noise, and in a sense Professor Alós-Ferrer has used response times to disentangle noise and preferences. "We can use response times to filter out the behavioral noise," he explains. In the recent paper, researchers also explored how preferences for unobserved choices can be addressed with data about response times, building on insights from a previous experiment comparing various types of chocolate and snacks to a reference category, say, M&Ms. "People were asked a few questions - do you prefer M&Ms or Mars? M&Ms or Hersheys? M&Ms or some other snack?" outlines Professor Alós-Ferrer. "If somebody says that they prefer Hersheys to M&Ms, and also that they prefer Mars to M&Ms, it is still not clear which option they prefer out of Hersheys and Mars."

The time that an individual takes to make a decision involving comparisons to M&Ms are however predictive of whether they prefer Hersheys or Mars, or some other option. If they rapidly decide that one option is superior then that means the utilities are very far apart, while if they take longer then that means the difference in utilities is relatively small, from which researchers can draw wider insights. "We can predict your preference from those observations, without having seen your decisions between Hersheys and Mars," explains Professor Alós-Ferrer. Researchers have built on the data gathered in this experiment. "We applied our techniques to the first part of the data. We predicted the decisions that we were going to see later in the experiment, using our techniques, and then we compared those predictions to what actually happened," continues Professor Alós-Ferrer. "Around 80 percent of our predictions were correct, which is pretty positive. We are now working on other applications of that, in areas like stochastic choice."

Preference reversal phenomenon

A further dimension of Professor Alós-Ferrer's research centres on what is called the preference reversal phenomenon, which is related to perceptions of risk. When asked to choose between gaining a relatively small sum with a high probability and gaining a larger sum with a lower probability, many people tend to choose the safer option. "Not many people take the long shot," says Professor Alós-Ferrer. The problem is that those who prefer the safer bet to the long shot should logically value it more highly in monetary terms, yet Professor Alós-Ferrer says there is abundant data to show that this is in fact not the case. "People for example may say; 'I prefer an 80 percent probability of gaining £20 to a 20 percent probability of getting £100'. That is perfectly fine, as it just means that people are typically risk averse. The problem is that when you ask the same people to give a monetary value to those options, many of them will give a larger value to the option they did not prefer. So in effect they are saying that they prefer less money to more," he outlines. "This is one of the most robust phenomena in economics, there's 50 years worth of research on this. This represents a significant behavioural anomaly, and it has been studied by researchers in psychology, economics and neuroscience."

Researchers have ben able to essentially uncover the roots of this anomaly by using a model of stochastic choice. Analysis of previous data shows that many people miscalculate the value of the long shot, and as money is easier to comprehend than probabilities, they often end up with an incorrect number. There is a clear shift in attention toward outcomes (relative to probabilities) when evaluations are monetary, and this attentional shift drives the reversals. "We have essentially been able to show that this is what is happening, using both choice and eye-tracking data," explains Professor Alós-Ferrer.

These behavioural anomalies are also an important consideration in terms of evaluating public opinion on spending priorities. "In evaluating what kinds of public works people are interested in, two different methods are often used to get at our preferences. On the one people are asked; 'do you prefer this or that?' That's a direct method, an ordinal one. On the other hand, they're also asked; 'how much money is this worth to you?'" continues Professor Alós-Ferrer. This is a cardinal method which focuses you on monetary amounts. "There is an inconsistency there, and so it's not has nothing to do with a bias. This is important because it is very typical, whenever you see an apparent anomaly, to try to explain it with a bias in the human brain, but this is the wrong way of analysing the data," he outlines.

The two methods should be equivalent, yet when we examine reversals, we are looking at evaluations conditional on a choice, say, an observed preference for the long shot. If most people are risk-averse but choice is stochastic, then a lot of those choices are actually mistakes, in the sense that people have made choices that contradict their own preferences. Now suppose you condition on those choices. The evaluations going the other way simply reflects the fact that you were conditioning on a lot of mistakes. "If eight people out of ten say that the long shot is worth less than the safe bet, even though they have chosen the long shot, then you may conclude that there is an anomaly, there must be a bias," says Professor Alós-Ferrer. The reason that conclusion would be wrong is that when you are conditioning on the alternatives, on people's choice of the long shot, and most of those are in fact mistakes. "This is just because people are risk-averse," explains Professor Alós-Ferrer. "If most of those are

Stochastic choice is the idea that even when we are confronted with exactly the same decision situation, we don't always make the same choices. This means that the **appropriate model of human behaviour** is not one which uses deterministic preferences, but rather **one which uses randomness.**

clear which method should be used in order to accurately gauge public opinion."

A further experiment was also conducted in which participants were asked to choose between taking part in lotteries with a high chance of winning a small amount or in others with small chances of winning a large amount. However, instead of being asked to provide monetary values, they were also asked to rank the lotteries in the experiment from least- to most-preferred. Now, both the choices and the rankings are ordinal methods, yet they also produce inconsistent results, and the inconsistency goes in exactly the opposite way to the other experiment on lotteries described earlier. "Amongst the people who chose the long shot, a lot of them valued the long shot lower than the safe bet," says Professor Alós-Ferrer. While on the surface this result seems very difficult to understand given the similarity of the methods, Professor Alós-Ferrer has discovered that it is in fact exactly what should be expected once the regularities of stochastic choice are taken into account. "It's perfectly normal, and mistakes then when you look at evaluations, and take into account that choice is stochastic and the probabilities of mistakes in different methods are independent, most of the time the evaluations you are seeing reflect the actual preferences and are not reversals.."

The wider problem here is that applying incompatible methods to assess public opinion can produce contradictory results, making it difficult to reliably gauge public views on spending priorities or other issues. As a decision scientist, Professor Alós-Ferrer holds a deep interest in uncovering personal rankings, or preferences, a topic which will remain high on his research agenda. "This is fundamental because only by uncovering personal preferences can we make predictions about future behaviour," he says. "The other fundamental problem in economics is to evaluate welfare. If I implement a policy at aggregate level, what effect is this going to have on individual welfare? I can only evaluate that if I know what you prefer. So we're always interested in uncovering preferences."

THE NEUROECONOMICS OF CONFLICT

The Neuroeconomics of Conflict and Preference Strength in Decision Making

Project Objectives

Homo Oeconomicus does not play dice, but Homo Sapiens might. The human brain makes decisions in a gradual, stochastic way. When people are closer to indifference, they make more mistakes and take longer to decide. These robust effects can be used to understand decision anomalies and to estimate preferences better.

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Contact Details

Project Coordinator, Carlos Alos-Ferrer
Co-Editor in Chief, Journal of Economic Psychology
NOMIS Professor for Decision and Neuroeconomic Theory
Zurich Center for Neuroeconomics (ZNE), University of Zurich
T: +41 79 866 71 60
E: carlos.alos-ferrer@econ.uzh.ch
W: https://alosferrer.github.io/

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Carlos Alós-Ferrer

Carlos Alós-Ferrer graduated in Mathematics and received his Ph.D. in Economics from the University of Alicante. He became a professor of microeconomics in Konstanz and later in Cologne. In 2018, he joined the University of Zurich as Professor of Decision and Neuroeconomic Theory. He is the Editor in Chief of the Journal of Economic Psychology.

University of Zurich[UZH]

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