

Understanding econometrics

Passionate about making sense of the world through mathematics and statistics, **Professor Bertille Antoine** discusses the importance of her research into economic modelling and how it is shaping the future of econometrics

What is your background and how did you become involved in research on econometrics?

I grew up in France. After graduating from high school, and spending two years in Classe Prépa, I joined the French National School for Statistics and Information Analysis (ENSAI), a graduate school affiliated with the French National Institute for Statistics and Economic Studies, because I wanted to do something less theoretical, more orientated towards data and real-world questions. This is where I discovered economics, and more specifically econometrics, which applies mathematical and statistical methods to address economic questions. I then spent one year at the University of Montreal and joined the MSc in mathematical and computational finance. After graduating, I worked as a research associate under the supervision of Professor Eric Renault, a leader in financial econometrics, at a local research center, CIRANO. I really enjoyed my experience and decided I wanted to do more research in econometrics. A few months later, I was starting my PhD in Economics under Professor Renault's supervision.

Could you discuss your current research focus and your aims and objectives?

My long-term research interests have two components: first, my aim is to develop relevant economic models that can best capture the complexity of the behaviour of economic entities such as countries, companies or individuals; second, my goal is to develop the associated reliable econometric procedures that can easily be used by applied economists to estimate the parameters of the model. More specifically, I have been looking at frameworks where standard models and methods yield inaccurate results. My current research focuses on two issues that often arise in practice: the estimation of weakly identified models, that is, models where some correlations in the data are so weak that standard econometric methods fail; and the estimation of time-varying parameters, that is, parameters in the model that are changing over time in unknown ways.



Why are user-friendly and reliable econometrics vital to the accuracy of the work of applied economists?

Applied economists often design economic models to address one of the following goals: either to forecast key variables such as inflation or growth rates; or to evaluate the impact of a programme or policy, such as the lunch box programmes or the reduction of class sizes on students' performance. The quality of these forecasts and programme evaluations hinges critically on the quality of the estimated econometric model.

Can you explain how the novel tests that you have created aid economists' everyday work developing models?

As mentioned, an economic model can only be useful to forecast or evaluate a given policy if its parameters are estimated as accurately as possible. When several estimation methods are available, this also means that the economist has to choose one of them: should she use the usual one that is easy-to-use and efficient under standard conditions, but may not produce reliable estimators if the identification is weak? Or, should she use some complicated

alternative method that is always valid, but may lead to conservative inference when the identification is not that weak? In practice, the level of identification is always unknown, and choosing the 'right' method is not an obvious task. From a practical point of view, it is therefore important to disentangle two classes of identification strength (eg. weak vs not too weak).

How is the stability of an economic model important?

Another issue that has received a lot of attention in econometrics is related to the stability of the economic relationships described by the chosen model. Indeed, the stability of the economic model (and its associated parameters) over time is often questionable, especially for macroeconomic models covering extended time periods, but also for microeconomic models. In many cases, it is important to account for such instabilities in order to develop an economic model that is relevant to address the issue at stake.

In what ways do you see your research into economic models developing in the future?

To develop economic models that can best capture the complexity of the behaviour of economic entities, richer datasets are needed. This is the great advantage offered by panel data (also known as longitudinal data), a dataset in which the behaviour of the same entities is observed across time. The worthiness of panel data is now well established in many areas of empirical research both in macro- and micro-economics. It has become increasingly available and popular among applied researchers because it allows identification and estimation of more sophisticated economic models which could not even be considered when using either time series or cross-sectional data alone. In the future, I plan to tackle some of the new issues related to the use of larger datasets.

Economic enigmas



Predicting economic trends is challenging. A researcher at **Simon Fraser University**, Canada, along with collaborators in the USA, France and the Netherlands, is using new statistical and mathematical techniques to tackle these difficulties and increase the reliability of current economic models

EVERYDAY, IMPORTANT DECISIONS are made based on information from economic forecasting models. Whether it is the rate of inflation or the success of a government scheme, the ability to reliably predict the outcome is vital to economic success. Subsequently, econometric models are used in a diverse array of environments to ensure financial profitability and stability. The complexities of creating a model are increased by the vast number of factors that must be incorporated and the scale over which it can be applicable, from individuals to whole countries.

The purpose of an econometric model is to hypothetically simulate a real-world event so that the physical outcome can be anticipated and the necessary actions taken. While common econometric techniques can go part way to making these predictions, some inaccuracy is prevalent. Consequently, to improve the success of such a model, two factors must be considered; how accurately the model reflects reality, and how correctly the individual parameters that comprise the model are estimated. The latter of these factors is an area which is, historically, the source of some uncertainty in economic forecasting. A researcher at the Department of Economics at Simon Fraser University in Canada is working with economists from

Brown University in the US, Toulouse School of Economics in France and Tilburg University in the Netherlands to alleviate this uncertainty by providing more tailored, and subsequently more reliable, models.

ESTABLISHING THE CONTRIBUTORS

To realise their ambition, the researchers must redefine some of the fundamentals of forecast model building by designing new methods of assessing how effectively existing techniques function. This task involves constructing unique ways of identifying parameters which may have a weaker, or more uncertain contribution to the statistical outcome. This step is commonly neglected in standard procedures that do not account for the relative influence the parameter may exert on the final model. Professor Bertille Antoine from Simon Fraser University highlights the importance of this exercise: "An economic model can only be useful to forecast or evaluate a given policy if its parameters are estimated as accurately as possible". She elaborates on this further using the example of the Generalized Method of Moments (GMM, Hansen 1982), one of the most popular methods to estimate parameters in statistical models, that relies on 'moment conditions' rather than the full specification of the distribution function of

the data (as done by the Maximum Likelihood Estimation), which is often unknown in practice. Such moment conditions naturally appear in many economic models as first-order conditions of an underlying optimisation problem (such as Euler equations). "Standard inference methods (such as GMM) may not be reliable when the identification of certain parameters is too weak," Antoine explains. Consequently, she and her colleague Professor Eric Renault have designed a system whereby this problem can be quantitatively assessed. This system involves a statistical test that gauges the strength of the identification of an economic model. In turn, this determines whether identification is sufficient that GMM may be used in its standard form. This test uses the rate of convergence of a moment condition to assess the quality of the statistical input, and subsequently whether the input is sufficiently reliable.

WHAT TIME?

The researchers' understanding of the individual influence of certain parameters has stretched to other areas of econometrics, including the influence of the timescale on the stability of economic relationships and subsequent economic modelling. In some economic frameworks, parameters are assumed to be fixed



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in time, something which is unlikely in reality where contributing factors can be variable and inconstant. Researchers at the University are striving to create models that allow for such variation. Antoine gives an example of why this is so crucial: "A well-known stylised fact in labour economics is that the gap between the earnings of college and high-school graduates grew sharply during 1970s and 1980s. Therefore, allowing parameters to change over time seems important if one aims at developing a model that reflects what happens in practice".

IDENTIFICATION AND STABILITY

While variation through time is an important factor to incorporate, there are still many further variations and correlations which must be included in a successful econometric model. The unpredictable nature of data produced from real-world events means that this is a complex task, but nonetheless, one in which Antoine and her colleagues are making significant headway. When considering the current econometric techniques available, one area that is lacking involves the design of frameworks that can handle several issues simultaneously, particularly in relation to stability and identification. Although some econometric frameworks allow the parameters of the model to be weakly identified, they hold the assumption that these parameters remain stable over time, while other models may account for their instability, but not for their poor identification.

To find a solution to the issue, Antoine has teamed up with Associate Professor Otilia

Boldea from Tilburg University, the Netherlands. She explains the difficulties of addressing the problem and why their joint research is at the forefront of econometrics: "Dealing with one of these issues is already a challenging task, mainly because it relies on state-of-the-art statistical and mathematical tools in order to develop the associated asymptotic theory required for valid inference. This is why teaming up with Dr Boldea was key to this research project". Using real-world data, the team has found evidence to suggest that economic processes often display poor identification while also changing in unexpected ways over time.

Consequently, developing economic models to account for both of these issues is crucial for creating accurate forecasts. Antoine points to the New Keynesian Phillips Curve (NKPC) – a leading macroeconomic policy model, which describes the dynamics of inflation in terms of unemployment, production costs and economic output – as a commonly used model which experiences this problem. "Inflation prediction via the NKPC has recently become more challenging, suggesting instabilities in the predictive power of the NKPC," she explains. "In addition, many empirical studies also document the weak identification and the instabilities issues related to its estimation." Antoine is working with Boldea to address this subject and is hopeful that they can design a framework that will account for both issues arising simultaneously. In the future, they hope to clarify this matter further by establishing the effect that this lack of integration may have on the validity of existing models.

With the advances already made, the next step is to integrate these refined and more accurate procedures with a larger range of datasets to create more comprehensive models with greater real-world relevance. With increased computational power and a vast spectrum of data available for incorporation into the adapted models, the study of econometrics holds promise of heightened model complexity and subsequent improved accuracy. In times of economic turbulence, the process of developing and redeveloping models to become as reliable as possible is essential for making sensible economic decisions. With financial markets implementing substantial international influence, decisions made using econometrics are likely to have global impact.

INTELLIGENCE

ON THE ESTIMATION OF THE PARAMETERS OF ECONOMIC MODELS: DEALING WITH STABILITY AND IDENTIFICATION ISSUES

OBJECTIVES

- To develop a new theoretical framework that reflects more accurately what is observed in the real world
- To develop econometric procedures to detect and precisely estimate changes in parameters and in their identification properties
- To demonstrate how the proposed framework and econometric methods improve the accuracy of estimated parameters using simulation studies and empirical studies
- To demonstrate how the proposed framework and methods improve the quality of forecasting exercises and programme evaluations

KEY COLLABORATORS

Associate Professor Otilia Boldea, Tilburg University, Netherlands

ADDITIONAL COLLABORATORS

Professor Eric Renault, Brown University, USA

Professor Pascal Lavergne, Toulouse School of Economics, France

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PROFESSOR BERTILLE ANTOINE graduated from Ecole Nationale de la Statistique et de l'Analyse de l'Information (ENSAI), a French Grande Ecole affiliated with the French National Institute of Statistics. She obtained an MSc in Statistics from University of Carolina, USA in 2005, and a PhD in Economics from University of Montreal, Canada in 2007. After being hired on a tenure-track position in the department of Economics at Simon Fraser University in 2007, she is now an Associate Professor with tenure at SFU.

