Editorial

A crucial part of human life consists of (and depends on) economic activities, i.e., production, distribution, and consumption of goods and services. It is vitally important to make sure that the economy stays healthy, that people's level of living grows, that economic disasters are avoided. How to make economy prosper is still not fully an exact science: whether we talk about a country or a company, economic strategies are selected largely based on the intuition of experts.

Controlling the economy is not easy: seemingly reasonable economic ideas often lead to disasters, successful companies fail, even countries sometimes fail. It is therefore desirable to be able to predict the quantitative effect of different regulations and ideas on the economics. The branch of economics that applies quantitative (mathematical and statistical) methods to economic data is known as *econometrics.*

The idea of econometrics is not very new: quantitative methods were already actively used by economists in the 19 century, and the very term "econometrics" is used since 1910. However, until recent decades, only very simple and very crude models were obtained. The main reason for this is that economics is complex.

Economics is not the only complex phenomenon. The physical world is also very complex, and so is the world of living creatures. However, in physics and in biology, we can often overcome this complexity: by observing situations in which only a few factors were involved, by (if necessary) performing experiments to separate the effect of all these factors, we can find the effects of each individual factor, and then study how these effects combine. In real life, we have gravitational forces, electromagnetic forces, forces of friction, etc., but by cleverly staging experiments, we can separate all these forces. As a result, in physics, we have well-studied, well-formulated models that, in most cases, provide a very accurate description of the corresponding phenomena. For example, if we plan to launch a spaceship to Mars, we can predict its trajectory with a very high accuracy.

Economics is different. It is practically impossible to set up pure experiments, experiments on real people. In medicine, we have trials on humans, but they affect very few people and they only come after the medicine has been successfully tested on animals. One cannot test economic ideas on animals, so economic experiments are much riskier. Besides, economy is a collective phenomenon, so an economic experiment would inevitably involve a large group of people. (In some sense, experiments did happen: when the 20 century totalitarian regimes tried to control the economy and other aspects of human life, but economically, these experiments were complete failures.)

Since we cannot separate different factors, since we cannot extract simple models with a few factors in each, we have to deal with the economic situation in all its complexity. There are so many parameters affecting economics that even with the modern computers, it is not possible to take all these parameters into account. When we only use *some* of the parameters for predicting economic behavior, the outcome becomes non-deterministic – since the actual outcome also depends on the parameters that we had to ignore. In other words in economics (in contrast to physics), deterministic predictions and deterministic models are rarely possible – we have to deal with stochastic models, models in which we can only predict the *probabilities* of different outcomes.

Probabilistic models are also known in physics – e.g., in statistical physics. However, most phenomena described by statistical physics are static equilibrium phenomena. By the time the process reaches equilibrium, the corresponding probability distributions tend to few families corresponding to such equilibria – Gaussian, Gibbs, etc. In a physical system, equilibrium is a norm, this is a state to which a system resorts when there is no outside influence. In contrast, an economic system is always changing, always trying to grow: new innovations appear that challenge (and change) the existing equilibrium, and old ways of manufacturing goods become obsolete. As a result, economic systems are highly dynamic, and the corresponding probability distributions are often very different from the usual ones (like Gaussian): we have asymmetric (skewed) distributions, we have heavy-tailed distributions (in which large deviations from the means are much more probable than for normal distributions), and, on top of that, we have distributions which change in course of time. To analyze such distributions, we can no longer use traditional statistical techniques, techniques which were originally developed for physics and engineering applications. For example, for a heavy-tailed distribution, even the variance is often undefined: it is infinite and thus, useless.

Similarly, in econometrics, *dependence* between random variables is much more difficult to describe than in the usual case. For example, to describe a joint Gaussian distribution, it is sufficient to describe the distribution of each variables and the correlation coefficient. In the general case, no such simple one-number description of dependence is possible: often, to describe a joint distribution, we need a general *copula* (a function of two variables that describes dependence).

This non-equilibrium character of economic systems leads to yet another source of complexity. Indeed, in physics, we are usually close to the equilibrium, so even when we describe non-equilibrium phenomena, the differences between the actual phenomena and the equilibrium are relatively small. As a result, we can often safely ignore terms which are quadratic or higher order in terms of these differences, and thus, use linear models. Simple-to-analyze linear models are indeed ubiquitous in physics. In economics, linear models are rare, most models are non-linear.

Summarizing, in economics, we have complex non-linear stochastic models with strongly non-Gaussian distributions and heavy non-trivial dependence between different variables. Economic models are the most complex in *financial* econometrics, because in contrast to production – which involves material objects and thus, takes time to change – financial transaction can occur at the speed of our communications.

How accurate are these models? On the one hand, the more observations we have, the more accurate the resulting models. Economic models are based on a large number of observations. However, the more parameters we need to determine based on the given set of observations, the less accurate the corresponding model. Economic models contain a large number of parameters that characterize different phenomena. As a result, the predictions based on the existing models are not always very accurate. For example, financial institutions try their best to predict the cost of different investment and insurance strategies – and, as everyone ones, sometimes these sophisticated models spectacularly fail.

The main reason why quantitative models lead to bad economic decisions is that the users of these models often do not take into account the *uncertainty* with which we know the corresponding dynamics, the *inaccuracy* of these models. Moreover, few tools and techniques exist for gauging the uncertainty of these models.

It is thus clear that dealing with uncertainty is the main challenge for econometrics, especially for financial econometrics. Uncertainty in econometrics – with an emphasis on financial econometrics – was the main topic of the 5th International Conference of the Thailand Econometric Society TES'2012, which was held in Chiang Mai, Thailand, on January 12–13, 2012. This issue contains extended versions of the selected papers presented at this conference. These papers range from theoretical ones – which design new complex mathematical techniques for describing economic phenomena – to applied papers that perform a non-trivial task of "distilling" the complex mathematical techniques into feasible algorithms capable of processing large amounts of economic data.

We hope that the readers will enjoy these papers. The authors tried their best to make sure that the corresponding economic and mathematical models are clear to non-econometricians (readers who are familiar with econometrics can skip the corresponding introductions). The resulting texts are still not always easy to read – but the complexity of the papers and of the corresponding models simply reflects the complexity of the economic phenomena. The papers may be difficult to read, but the result of reading can be very rewarding.

We hope that specialists in uncertainty – typical readers of this journal – will find these papers to be a good introduction into a new exciting field of applications. Many of the papers from this issue contain remaining open problems; hopefully, some readers of this issue will come up with ideas that will help solve these challenging problems.

As we mentioned, the authors of these papers did a lot of work – not only they produced excellent research and application results, they also tried their best to make sure that these results are accessible to the general readers of this journal. For these efforts, we give them our deep thanks. We also want

to thank the anonymous referees for their challenging task, and our colleagues Thierry Denoux and Hung T. Nguyen for their unwavering support and help in producing this special issue. Many thanks!

Van Nam Huynh and Vladik Kreinovich, editors of the special issue