Contemporary Issues and Ideas in Social Sciences
April 2007

Challenges Facing Econometrics in the 21st Century[1]

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Abstract

This paper is a general reflection on the major challenges facing econometrics in the future, not only in terms of research directions but also with respect to the method of teaching the science and its value for the society as a whole.

Key words: Econometrics, Science, Teaching, Future, Society.
JEL Classification: A1, A2, C1

[1]Paper prepared for a talk at the Madras Institute of Development Studies, Chennai, July 2006.

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Econometrics was born out of economists' concern for empirical verification of economic theories and quantification of economic relationships. The Econometric Society was founded in 1930 at the initiative of the Yale economist Irving Fisher (the Society's first president) and the Norwegian economist Ragnar Frisch. According to its Constitution, it is an international society "for the advancement of economic theory in its relation to statistics and mathematics"[3]. Its main objective is "to promote studies that aim at a unification of the theoretical-quantitative and empirical-quantitative approach to economic problems"[4]. Thus one can think of econometrics as a rigorous combination of economic theory, mathematical modelling, statistical methods and numerical calculations, carried out for empirically verifying theoretically postulated causal relationships among economic variables.

The above exercise involves many stages that we will briefly outline below. Although it may be an oversimplified description of the actual work done in an econometric study, its purpose is to throw some light on the vast scope of econometrics as a science both in theory and in practice. The first step is of course the definition of the phenomenon to be investigated and the learning (or the making) of the theory underlying it. It is then given a mathematical formulation resulting in a theoretical model often involving one or more relationships to be analysed. The lack of experimental setting in most cases makes it necessary to account for the fact that the theoretical model can at best be a close approximation to the complex reality, through proper insertion of stochastic terms and assumptions on their properties. Further, the theory has a big role to play in helping to distinguish between variables determined by the model and those that can be assumed to be given outside the framework of the model as well as to justify exclusion of factors considered unimportant for the question under examination (and hence need not be controlled for in the model). Then comes the confrontation between theory (model) and reality (data) starting with the use of appropriate estimation procedures for assigning values to the unknown parameters of the model, deriving their properties and test statistics for verifying relevant hypotheses. There may be a reformulation of the theoretical model based on the conclusions of the tests conducted. Once a satisfactory empirical model is arrived at, it can be used to make forecasts and deduce policy implications.

The past century has seen great developments in econometric theory and in the use of econometrics for a better understanding of economic phenomena. This paper is not about making an exhaustive list of all the contributions as it is not only impossible but also irrelevant for its purpose. The range of areas in which

[3] 'The Constitution of the Econometric Society', http://www.econometricsociety.org
[4] *ibid.*

econometric models are successfully applied, has steadily widened including other subjects such as finance, business management, sociology, political science and so on. This is one of the most important achievements of this new science, which makes one hopeful of the future of this science and look forward to another very exciting century.

Let us take the most obvious example of finance. This is one area where econometric methods have rapidly gained ground in recent years. As economic growth is making more and more people wealthier (albeit widening the gap between the rich and the poor) and with the rapid progress in information technology, there will be a continuous need for improving the performance of financial models in forecasting returns, making use of all the information available, in particular the ultra high frequency intra daily data. The development of multivariate and simultaneous extensions of financial models is one area where research will grow, as the evolutions of different asset prices/returns are not only correlated among one another but also mutually influence one another, as more and more financial markets become global and open to foreign capital. Further the existence of data on numerous inter-related financial variables over long periods of time calls for the adoption of panel data methodology for providing greater insight in the understanding of the evolution patterns of these variables. Recent advances in empirical finance have explored various directions: continuous time modelling, structural breaks, regime switching, changing volatility, non-stationarity, cointegration and so on. A wide range of parametric and non-parametric methods have been proposed to tackle the complex situations arising out of increasing interactions in the financial sector. The same is also true in the field of macroeconomic analysis with its concern on relationships among aggregate variables such as income, consumption, investment, price indices, interest rates, exchange rates and unemployment.

Accounting for time trends/unit roots/structural shifts is extremely useful for a good fit and prediction but has little explanatory content. *Structural* relationships are required for a substantial behavioural explanation but they also need to incorporate the time series properties of the variables involved. Otherwise we run the risk of finding spurious regressions (cf. Granger and Newbold (1974)). A model combining both is the dynamic simultaneous equation system with cointegrated relationships (cf. Hsiao (1997)). In such a system the *practical* verification of the cointegration properties of structural equations, needed for the validity of the model, may lead to a respecification of some or all equations which do not necessarily have an *economic* interpretation. Thus a *statistically* valid equation may not reflect an *economically* meaningful relation and vice versa. Hence we need to be careful not to mechanically look for all possible cointegrating relationships

without any prior knowledge of the nature of the *economic* relation that we want to analyse.

The poor performance of many unit root and cointegration tests shown in many simulation studies may lead one to pool data from several units for increasing their power. This is only valid if pooling has a statistical *and economic* significance. If it is so, then panel data extensions of simultaneous models need to be revisited in the context of cointegration, as shown by recent developments in the literature.

One can similarly go on and consider possible future directions in many other areas. For instance, in micro-level modelling, there is still a lot to be explored in the econometric analysis of interdependent systems involving qualitative information from repeated surveys, but we would now like to turn to other types of challenges facing this science, especially from the teaching point of view and from the point of view of its relevance for an overall progress of ideas. However, before concluding our reflections on the theoretical side, let us add that one will witness the coming closer of macro- and micro-econometrics in future. In fact one can even say that there would be a reversal of the recent trend that saw time series or macro-econometrics as being fundamentally different from micro-econometrics which typically involves qualitative and panel data. The current availability of all types of data over long periods of time is bound to bring the two areas - somewhat artificially separated for a while - together.

Now, how should one go about teaching this science. As most of the other sciences, it should be taught with a lot of rigour but also with a lot of intuition. The student should be constantly reminded of the importance of the theoretical reflection that needs to be carried out prior to embarking on an empirical exercise to avoid finding causal influences which do not make any sense. A well-known example is "rain causing inflation" in the U.K. (cf. Hendry (1980)) which clearly shows that statistical significance is not causality and a strong correlation even less so! One can think of many other situations where theory can "save" us from drawing wrong conclusions and force us to look for possible specification mistakes (endogeneity issue, omitted variables, self-selection, measurement errors, multicollinearity, small sample size etc.).

From a pedagogical point of view it is important to introduce the subject through simple models and then go on to more complicated cases so that the student can follow the assumptions that are being relaxed at each stage and the (practical) reasons for doing so. It is also important that the teacher takes the time to motivate each model with economic examples, clearly states its assumptions and their implications, gives an intuitive interpretation of the results, draws attention

to the possible pitfalls that one can encounter if one does not have a sound theoretical understanding. The student needs to be well aware of the limitations of each model and possible extensions to go closer to reality. I would say all these elements are as important as the mastering of the technical aspects. This is not to underestimate the latter skill - suffice it to say here that all universities across the globe insist on a sound knowledge of mathematics and statistics as prerequisites for following econometrics courses.

Though the temptation is great, one should at all costs avoid presenting econometrics as a list of techniques that one can mechanically apply in each situation without understanding their logic hoping that some software will come up with the best model. The main purpose of an econometrics course should be to give the student enough background knowledge on the approach and adequate training in using its tools so that she can adapt them with full confidence as the situation demands before applying them. Just like a strong foundation is needed to build extra floors for a house, a solid foundation is what an econometrics teacher should aim to provide the student with, so that she can build her own extensions on it. Otherwise on the one hand we will have theoretical econometricians inventing more and more sophisticated techniques and on the other empirical researchers who will be following a cook-book approach to using econometrics in their studies. This will only widen the gap between the theoretical-quantitative and empirical-quantitative approach rather than reducing it and we will be moving away from the stated and legitimate concern of the Econometric Society.

Finally, I would like to turn to a deeper and more fundamental issue concerning the practice of econometrics. Though an econometrician needs a rigorous statistical foundation, she equally needs a solid knowledge of the discipline that she is trying to apply it to. Econometrics has to go beyond purely statistical concerns to the analysis and proper understanding of causal relationships that are crucial for a behavioral science such as economics or any human science for that matter (psychology, sociology, political science, management etc.). Economics and social sciences are concerned with models of *human* behaviour and have to remain so with all the uncertainties and challenges that it implies. Thus the proof of the 'econometrics' pudding is not only in the adoption of techniques used in 'hard' sciences (mathematics, statistics, physics etc.) to social sciences but more so in providing a successful modelling framework for incorporating the specialities of social sciences. A sound knowledge of the topic and the economic (social) context to be modelled is therefore a pre-condition for good econometric work.

By its very nature, the above approach is bound to produce many theoretical advances as one has to constantly innovate in order to deal with the changing

situations that need to be modelled. Keeping this in mind it comes as no surprise that many new theoretical models were first proposed in fields such as psychology while seeking the best way to go about for resolving a given practical issue. This is precisely the reason why the econometric *approach*, in the above sense of providing an adequate empirical framework for answering a relevant economic question, has gone past its field of origin to other social sciences where one is interested in identifying causal behavioral relationships.

This brings us to one of the greatest challenges of this science as I see it evolve in the future. Recalling that the main goal of the econometric approach is to give an appropriate framework for modelling and understanding human behaviour, either individually or collectively (social behaviour), using observations of the different aspects and outcomes of such behaviour, it seems that this science is still to make a breakthrough in the area of development and well-being. No doubt that there are an infinite number of empirical papers and studies examining several aspects of human well-being but there is no uniform evidence emerging on the key determinants of *human* development in its largest sense encompassing all the different dimensions that one can imagine - economic, social, political, intellectual, medical, psychological, environmental etc. It is not an easy task and progress has to be made on several fronts - definitions, concepts, measurements, modelling structures and so on. Disciplines are still quite disjoint and inter-disciplinary thinking is only in its beginning. Nevertheless, it is fundamental, especially in our current economic and social context, that we continue to make rigorous attempts to empirically identify the mechanisms that not only enhance human well-being but also enable *all* sections of population to benefit from this enhancement.

It is highly imperative to come up with strong empirical evidence for all the elements that we consider to be extremely valuable for a harmonious evolution of the society (or even humanity), such as equal access to *resources and means* for all (including future generations), participatory form of governance, fair distribution of outcomes, clean and healthy environment and so on. All these factors go hand-in-hand and are definitely affected by human behaviour. But how to demonstrate their indispensable role in the overall progress of mankind, of which each and every one of us is convinced? Without a clear and serious proof of the good virtues of these factors in enhancing human development there will be temptations of self-centered behaviour, narrow visions and short-term benefits which will only lead to a slow deterioration. On the other hand, if one can show solid pieces of evidence for the occurrence of a *virtuous* cycle of development using econometric modelling, then econometrics as a science would have attained its highest and most noble goal of paving the way for a brighter future for humanity.

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