

Robert Engle: Archway to Nobel >>>

Interview of Robert Engle by Y.K. Leong and K.S. Tan

Robert Engle started his university education as a physicist at Williams College and Cornell University but switched to economics for his PhD at Cornell, specializing in the use of time series in econometric analysis. In 1982, he formulated a model, known as an ARCH (acronym for “autoregressive conditional heteroskedacity”) model, to study time-varying volatility in inflation. Soon afterwards, it was realized that his model could be applied to financial econometrics. In subsequent work and in collaboration with others, he extended his model to the so-called GARCH (generalized ARCH) and GARCH-M models, and introduced fundamental concepts which have set new directions for modern econometrics. His ideas and techniques have become indispensable tools in risk management in the financial sector. For his fundamental contributions, he was awarded in 2003 the Nobel Prize in economic science with his collaborator Clive Granger.

Engle taught at MIT and University of California at San Diego (UCSD), and in 2000 joined the Stern School of Business at New York University, where he is now the Michael Armellino Professor of the Management of Financial Services. He is active both in academic research and in consultancy work for financial institutions. He is a member of the American Academy of Arts and Sciences and a Fellow of the Econometric Society and of the American Statistical Association. He has given prestigious lectures like the Fisher-Schultz lecture, the William Phillips lecture, the Pareto lecture, the Frank Paish lecture, the Journal of Applied Econometrics Lectures and the first Econometric Institute/Princeton University Press Lectures at Erasmus University.

He was a key speaker at the program organized jointly by IMS and the School of Economics and Social Sciences of SMU in April and May 2004 on econometric forecasting and high-frequency data analysis. The Editor (Y.K. Leong) of *Imprints* and Kim Song Tan of SMU interviewed him on 10 May 2004 at SMU. In the following edited and vetted excerpts of the interview, Engle talks about his intellectual passage from the sequestered “basement realm” of superconductivity to the gregarious, if not glamorous, world of economics and finance, how the seeds of his Nobel Prize winning work were planted and his views on academic research and consultancy work.

Imprints: Thank you, Professor Engle, for kindly agreeing to be interviewed by us. Your bachelor and masters degrees were in physics. What made you switch to economics for your PhD degree?

Robert Engle: I went to graduate school in physics without being sure that I wanted to continue in physics. I’ve always loved physics but after I started my graduate work in the



Robert Engle

Courtesy School of Economics and Social Sciences, SMU

basement of the physics building studying superconductivity, I decided that I didn’t really want to spend my life doing research on a topic which only a handful of people would ever understand. So I went to talk to people in the economics department because economics is the most quantitative of the social sciences and I thought that there was a possibility of doing something useful and interesting for a large number of people. To my amazement, they were interested in having me switch. And so I did. That was in Cornell.

I: Did your doctorate work set the direction for your later ground-breaking work in econometrics?

E: There were connections. My doctoral work was in time series and some of the mathematics I learned in physics was involved with spectral representations and things like that. That was carried forward into my thesis. The work on the ARCH model was rather different although it’s still time series. It was about second moment properties rather than first moment properties. It was a different class of models, but there is a relationship.

I: What led you into formulating the innovative ARCH model?

E: I was on sabbatical at the London School of Economics at that time. I was interested in a question that Milton Friedman had posed. That was a macroeconomic question. He said that he thought that the cause of business cycles was not just the level of inflation but the uncertainty of inflation. The argument is that businesses try to invest in the future. If they don’t know what the price level or wage level is going to be (and there’s a lot of uncertainty about it) they are likely to withhold their investments. So that will lead to a downturn in the economy. If that is really the case, then you will expect to see the uncertainty of inflation forecast changing over time and being correlated with business cycles. So that was the question I was trying to solve.

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I always say that there are three inputs to the ARCH model. I brought two ideas from time series. I had done a lot of work on Kalman filtering and using predictive densities to write likelihood functions. The third input was that Clive Granger, my long-time collaborator and friend with whom I shared the Nobel Prize, had just proposed a test for a bilinear process which is a type of time series model that involves looking at the correlations of the squares of the residuals of an econometric model. One day I was on the computer and Clive came by and said, "Let's take a look at your residuals, square them, fit an autoregression." And lo and behold, that was very significant, and I said, "Wow, isn't that interesting? The data really had evidence of this sort of thing in it." But I didn't really believe that it was evidence of a bilinear model. I thought that it was evidence of something else – I didn't know what. It turned out that if I were working with this data evidence, I was able to come up with a model which could be used for convoluting volatilities to answer the Friedman hypothesis.

I: Did your physics training contribute towards some kind of insight?

E: I think my physics training was particularly important in the relationship between theory and evidence. Sometimes it starts with a theoretical hypothesis and then you look for empirical evidence. Sometimes there is empirical evidence first and the theorist looks for a model that works. I feel that whichever way it happens, that's the role the econometrician takes. He is the person who really must strive to relate the data that we see for the economy with the theoretical models to make it move. I think that econometrics is a natural way for a physicist to approach the world.

I: Would it be correct to view your ARCH model as the mother of all econometric models? In retrospect, are you surprised that it led to so many ramifications?

E: I don't think it's the mother of all econometric models. It's really the first model to be interested in volatility and it is the mother of all volatility models, but econometrics is much wider than that. So it's not at all the mother of all econometric models. I'm quite surprised how popular it was. I knew it was a good idea at that time but I thought that if econometrics is the size of a table, then the part that is interested in predicting volatility and uncertainty is only a small part of the table. But it has turned out to be very important for so many applications that are still growing.

I: Which is more important in creating models: technical mastery or intuition?

E: I think they are both important. I tend to try to prove theorems with my intuition before I get technical about them. They have to make sense to me how this could be true and

then I say, "Ok, now, how can I prove it?" To me, the intuition comes first. But when I say the intuition, you have to have the technical skills to rewrite your intuition in such a way that it looks like you can understand where it fits. It's very hard to develop a new idea, because you can look at it in so many different ways. Unless you've got a wide technical background, you don't know how to begin proving the theorem. How do you phrase this theorem? You need a lot of technical background before you can even formulate the question. I'm better at intuition than I am at the technical details.

I: It seems that econometrics uses a lot of statistical theory and methods. Do you think that behind the algorithms and computations there are some fundamental economic concepts that could be subject to some kind of objective economic laws?

E: You know, when physicists talk about laws, they think about Newton or Einstein or something like that. These are inexorable laws. I don't think that there are going to be economic laws in that sense for economists because what we are looking at when we build models for the economy is the average behavior of a lot of people. By averaging you can get a lot closer to a law, but it isn't clear that it is amenable in the same way as physical laws are going to be, so I think probably not. We find general principles, tendencies and patterns that are preserved over time.

I: You mention principles, but a principle is some weak form of a law.

E: Yes, I suppose it is. When I said that, I wondered whether you would point that out. A lot of economic models are based on very strong optimizing results and general equilibrium results. Rational behavior gives you very strong hypotheses about how the world is going to be. Many of those are good descriptions of how you see behavior. So in a sense, I suppose you would think of those as economic laws but it's not that they explain things exactly. There's a lot of dynamics and adjustment that you have to make to the system that you see.

I: Modern physics deals with random behavior and so does econometrics. Do you think that there could be some physical analogies that may be useful in economics and econometrics? In particular, what are your views about quantum finance?

E: Well, I have not found that interesting – the finance theory that the physicists are doing – "econophysics", that's what I would call it. I think that it is, in an interesting way, mechanical. It tries to apply mechanical principles to economic systems and doesn't recognize that there is behavior and that it is not actually a physical model. These

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are agents with dual optimizing and behaving in ways that atoms and molecules don't do. So I think that while there may be interesting things that could come up out of this, I think it's not obvious that there's something very useful that physical principles can be applied to economics. I don't think that quantum mechanics has any direct implications for finance because quantum mechanics is a probabilistic statement about the future evolution of particles and atoms. It doesn't talk about the fact that in every price movement there is a buyer and a seller and somehow sellers and buyers have to agree to this kind of outcome. It isn't that one person can push the market without somebody agreeing to sell it to them. There is an optimizing character of the economy which is really not present in quantum physics.

I: You teach at the university and do research and at the same time run your own consultancy services for industry. How do you manage that?

E: I manage it by keeping them working together. So when I do my consultancy, I make sure that what I do in my consulting work is actually going to be an important part of my research, and I have had some wonderful problems that come out of consulting projects. I think that this is a way of keeping your research focused on problems which people are interested in. I think it's important to do that but I do not like doing my consulting on things that would never end up as part of my research.

I: Do you have students?

E: I have students. I am now in the finance department of NYU (New York University). I have some finance PhD students and I have some economics PhD students, and I still have some students from UCSD (University of California at San Diego) whom I'm working with. I have a range of students.

I: How has the Nobel Prize affected or influenced your life?

E: In a way it changes everything and, on the other hand, it doesn't change anything. I have lots of things which are different. The press was never interested in talking to me before that. Now I have lots of interviews with the news media. They wanted to know about things that I never thought I was expert in. But I ended up talking about them anyway. I'm now more of a generalist. I've met so many interesting people from different areas of science, economics and journalism and so forth. It's fascinating about the people you meet. I meet finance practitioners. I have an interesting experience that people like hedge fund traders and so forth tell me their strategies which nobody would want to reveal in the past.

I: It's their trade secrets or something.

E: That's right, trade secrets. I don't quite know what that is but I think it's got something to do with the Nobel Prize. In that sense, a lot of things have changed. In many ways, I do my best to keep my research and my life the same as before. I'm continuing to give talks and do my research and I think I don't want that to stop.

K.S. Tan: You were saying that after the Nobel Prize you are in a way forced to speak as a generalist in many contexts. Do you find you are more influential as a generalist in that context than as an econometrician?

E: Well, people always want to know some things like "Is the stock market going to go down?" I don't know whether that's being influential. I haven't actually taken on any causes. Sometimes Nobel Prize winners do say, "I want to do this thing." I haven't done that yet. It could happen. I think I reach a bigger audience because I'm speaking about more general things. My general comments would be about financial management and risk assessment and that sort of things. Now I end up talking about general macroeconomic issues in the US and international issues. In about five minutes, the BBC is going to broadcast whatever I said this morning on the BBC Asia Report.

T: The reason why I ask that question is because you must have heard many times that economists these days are so focused and so specialized in their fields that they cannot deal with larger economic or even for that matter political issues. Yet economics and econometrics are part of the social sciences. How do you respond to that?

E: Well, I think specialization is natural. It's a lot to ask people to be expert in a particular area and making innovations that are valuable to the profession and to people in that particular area and still be able to speak as a generalist. However, I think a lot of times making advances in a particular area is aided if you've got a little broader interest so that you can bring things from other disciplines. You can bring stuff from mathematics, from statistics and from other areas of economics to answer problems in your particular area. So I think that some amount of generalism is a good thing anyway, but it's a lot to expect anybody in any particular area to be able to comment widely on economic issues of the day.

T: That brings us another question. Do you think that when a student wants to do economics, he should be someone who has some interest in general social, economic phenomena first, or should he just approach economics as a form of science? I'm asking you this question because you came from physics, and yet you were able to deal with economic questions and issues. I don't know whether all

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econometric students are of this type today.

E: I think actually it's probably true they are not. It took me a long time. When I started graduate school as a student in economics, I could do problems that someone would set but I couldn't figure out what the problems should be, what should be an interesting problem. I think it took me probably ten years of my time teaching at MIT and so forth. I was continually trying to develop and understand this economic intuition that so many other people had taken so easily. But it was hard for me to grasp. So I don't know whether in the beginning you should expect that. But I think people should try and develop it. Of course, that's what graduate education is about. That's why you go to meetings and you listen to talks. You try to develop your economic intuition.

T: Would you go so far as to say that without it you would not be able to make it as a successful econometrician?

E: No, I don't think so. I think actually there are a lot of successful econometricians who are very narrow, technical people. They have to pick good problems. That's where you make your name. You solve a good problem and it's a kind of intuition which makes you choose the problem. I like to take problems from the world around me and figure out what actually is the nature of this problem and how you can solve it. But people who take problems from the current state of econometric research realize there is a problem here, they formulate it and they solve it. I think that's a valuable contribution.

T: A question on consultancy. Do you often find yourself in a conflicting position where the private sector tends to look for definitive answers to their questions and think there are some numerical answers to their questions and we know that it's not possible in all cases to provide this kind of answers. How do you deal with that?

E: I'm more of a tool builder. The ARCH model is a tool which allows you to study risk and a lot of consulting that I have done is not actually so much looking for answers as looking for tools. How do you build the tool that's good for measuring risk in this kind of setting? How do you build the tool that helps people form their portfolios? You build one and it helps a little bit but maybe not enough. So then there's another one you might want to develop along the way. It's not so much getting an answer. It's advancing our real understanding and our ability to solve these problems.

T: How do you find from your experience how useful econometric solutions are to hedge fund strategy or general financial trading strategy, treasury and other types of trading?

E: I'm not so involved in trading strategy. I've avoided that because that actually doesn't ever lead to publishable

research. Either it works, in which case you can't publish it, or it doesn't work and nobody cares. Even if you do publish one that does work, no one will really believe you because then people will ask, "Why did you publish it?", and it goes away as soon as you publish it anyway. I have tried not to get involved in trading strategy. But if you talk about strategies like what is the best way to forecast risk or something like that. I think those are not proprietary typically. Maybe initially you wait a little bit before you put it in the academic discipline. I try not to get involved in things that have too much conflict. Another set of consulting that I did for a long time (although I'm not doing it any more) is energy research, electricity modeling. What is the demand for electricity at different times of the day, how do you forecast that, how does it depend on appliances and things like that. This is another example of how you develop statistical methodology. People build these models for utilities and forecast what the needs will be in the future. You know it's not proprietary. There's a lot of non-proprietary stuff you can do both in the financial sector and more broadly in the industrial sector.

T: A lot of people in the finance industry these days, especially when it comes to training, tend to be engineers by training. In fact, many of them have no economic qualifications whatsoever. They seem to be doing well and form a large group in the finance industry. Do you think that in that sense finance might be closer to physics than to economics?

E: I think that finance education is typically not as quantitative as what financial practitioners require. In financial practice you need to handle an enormous amount of data, a lot of computing tasks. Finance PhDs are often not that well trained in econometrics or in computer methods and they are often trained in particular corporate finance theory or something like that. I think that finance service sectors hire a lot of engineers, physicists, chemical engineers and mathematicians because they have skills that they need and they cannot get a finance person to do. I think that academic finance is not as close to practitioner finance as you might think. In fact, practitioner finance does have a lot of economics and econometrics in it.