An Interview with Marco Avellaneda

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When and how did you start looking at mathematical problems arising in finance?

I became interested in Mathematical Finance and option pricing in the mid-80's when I was finishing my dissertation at the University of Minnesota. David Heath, who would later invent a famous model for interest rate derivatives, gave a very interesting talk in the Probability Seminar on the Black-Scholes model. I think that this was the first time that I heard about options. Later, in New York, I had friends that were using the models in the early stages of interest-rate derivatives. My own entry into theoretical finance was in 1994, after teaching courses at Courant Institute. The demand for looking at these problems then came from graduate students and the industry, not from the mathematical community.

Has it been a rewarding experience?

In many ways. First, it gave me a window into an application of mathematics that I did not know. As I learned more about the subject, I became involved in consulting and the more applied aspects of the field. Already in my first consulting project, I realized that I needed to learn how to program computers, in order to get numerical results from models involving PDEs. Doing research in Math Finance made me learn computing, finance and economics, which were new to me. It has also been, to some extent, financially rewarding, although I am not rich.

In your opinion what are the major differences between the type of models and analysis in areas like composite materials or porous media and those applied to finance? Do you look at all of them just as applications?

Before entering mathematical finance, I worked in other fields such as composite materials and porous media. A lot can be said with regards to the differences in methodologies between Physics and Quantitative Finance. Whereas Physics is based on understanding and describing natural phenomena, Finance is ultimately a social science. This means the way that we think is very different. What the two fields share in common is that they are based on data analysis. My strategy, as a mathematician is always to try to "improve the science", by selecting those problems where I think that I can contribute. However, I always try to learn as much as possible about the field, to avoid being a dilettante.

What have been for you the major contributions in the theory of option pricing?

Without a doubt, the Black-Scholes-Merton formula and its consequences is the major contribution. It takes some knowledge of finance to actually appreciate the scope of the BSM theory. In other words, one must look beyond the equations and the mathematics and understand the ideas behind it. The impact of Black-Scholes is tremendous, because it gives a "roadmap" for transferring financial risks across financial instruments of different kinds. The latest fashion in finance, credit derivatives, makes heavy use of Black-Scholes-Merton technology.

From a mathematical point of view what is still open to prove or conjecture?

I think that the scope of the question may be too narrow, in this context. Quantitative Finance is mostly modeling, followed by algorithms to extract numbers from models. To this, one has to add a heavy dose of statistics and econometrics. Proving theorems is essentially a 'quaint' endeavor, since the field is not based on axioms, but on data and market observation.

How do you measure the impact that the more recent and intense academic research in mathematical models for finance had in practice (from a trader point of view)?

As always, some research is better than others. Surprisingly though, Wall Street (in the generalized sense) is an avid consumer of academic research. I think that every honest attempt at contributing to the implementation of theoretical ideas in the practical world is taken very seriously... Let me give examples. In equity derivatives, the calibration of volatility surfaces, studied by many academics (too many to mention here), has been incorporated in the pricing of exotics and in managing volatility risk. The Heath-Jarrow-Morton (Cornell University) and Brace-Gatarek-Musiela (University of New South Wales) interest rate models, found their way from academia to the trading floors of the major houses. The Duffie-Singleton (Stanford University) model for pricing credit derivatives is also widely used. And the list goes on. In my opinion, the top investment houses, which have the best traders and make the most money, also have the best quantitative finance teams. In certain areas of trading, like correlation trading in equities and credits, traders are often former academics and researchers that use models to find opportunities and to manage their positions.

The Black-Scholes formula for pricing options is still heavily used by traders despite the amount of research since Black and Scholes. Is that surprising for you?

Not in the least. The reason is that the Black Scholes formula is used to convert prices into implied volatility and Greeks. So, in practice, Black Scholes establishes a correspondence between complex financial instruments, such as a callable-convertible bond, and a number called the implied volatility. Implied volatility gives you a common measure of the expected rate of change (in absolute values) of the underlying asset. For example, the implied volatility of Google should be higher than the implied volatility of GE (at least most of the time). Implied volatility allows, for instance, to compare the values of derivatives on different markets. Also, BSM provides traders with the Greeks (delta, gamma, vega, theta), which are used to set limits on exposure to market moves on a large, portfolio, scale. If there were no Black Scholes, derivatives markets could not exist. It would have to be invented quickly, since it is absolutely necessary for trading for the reasons explained above.

Financial derivatives have developed so much over the last 20 years. There are always new products coming up. How do you predict the evolution of derivatives? Will we ever reach a sort of "stationary point" in this field?

The evolution of derivatives will continue as markets become more interconnected, information flows more freely, and people find ways of "slicing-and-dicing" and trading financial risks. The current phenomenon is the Credit Derivatives markets, which have grown from zero in 1994 to 1 trillion dollars in 2005. Credit derivatives give ways in which the risk of defaults on bonds and loans are transferred from lenders to third-party investors, who "sell protection" to the lenders. This has interesting consequences in terms of credit risk, some of which remain to be fully explored. The credit derivatives markets are now in the process of producing radical innovations every few months. Based on this development, it is difficult to anticipate that the activity will diminish. It should be noted, however, that derivatives markets in different underlying assets, go through periods of growth and then reach a level of maturity characterized by strong liquidity and price-discovery and limited arbitrage opportunities. For example, options on interest rate swaps were exciting 10 years ago and are now "plain vanilla" instruments. The expansion of derivatives markets usually go in the direction of new products: derivatives on weather, the trading of carbon emissions, earthquake contracts, and so forth. I think that the 800-pound gorilla is now credit derivatives.

Do you think that Internet has improved the efficiency of financial markets? What is your opinion about the impact of the finance information spanned by the Internet?

The Internet has definitely improved the efficiency of financial markets. First of all, it renders possible to deliver almost real-time information at very low cost across geographical boundaries. Since finance is based on information, it was only natural that people would take advantage of the web. Low cost trading systems (not only for retail investors but also for professionals) are increasingly delivered as ASPs. This means more trading, hence more competition, hence more efficiency. Also, the amount of research and data that is available on the web distributes information more efficiently, a fact that obviously impacts markets.

Let us take a break from finance for a little while. You have been recently in Coimbra, for the CIM Scientific Council Meeting. What do you think about CIM? Could you share with us some of your impressions about CIM or about Portuguese mathematics in general?

I think CIM can serve two purposes: facilitate the access to mathematical research for graduate students and young faculty and attract foreign mathematical scientists to Portugal. I think that a good model might be in Institute for Mathematics and its Applications at the University of Minnesota. The dynamics of CIM will be to solicit and finance workshops and meetings which specialize in one or other aspect of mathematics, allowing communication between researchers and transfer of information between those who are experts and those who are interested in learning a new field. I have been exposed to Portuguese mathematics and engineering since the 1980's. I have interacted with good mathematicians, such as Irene Fonseca, Joaquim Júdice, José Francisco Rodrigues, Pedro Girão, Marcelo Viana, Hugo Beirão da Veiga, Maria Grossinho, Paula de Oliveira, and you of course, just to name a few. Prior to coming to CIM, I visited the University of Coimbra during the Y2K celebrations, in a very nice meeting organized by Paula de Oliveira. I am fluent in Portuguese, with a *Carioca* accent, which helps...

Since we took the conversation to Portugal, we would like to ask you about the prospects of mathematical finance in a small country like Portugal. Do you think derivative markets in small countries will ever reach a desired liquidity?

Globalization works against local markets. This means that, in the current state of affairs, Portuguese financial companies would most likely add value by their knowledge of local companies and investment opportunities, attracting outside investments, that sort of thing. This is obviously far from mathematics. On the other hand, the perspectives are brighter if you think about the question from an European perspective. After all, Portugal is in Europe, so if it develops local talent in finance, this will probably make it attractive for financial firms to establish businesses in Portugal and hire local talent. The fact that a company is in Portugal, Spain or Germany is more a question of cost than anything else, because boundaries and regulations are falling rapidly. This creates opportunities for highly educated people. For example, Paris has small financial markets compared to the financial capital of Europe, which is London. Nevertheless, there is a lot of quantitative finance activity in France due to the strong mathematical education, and a lot of new financial products and ideas come from there.

Should Portuguese universities invest in Math Finance curricula? At what level?

Portuguese universities should invest in Mathematical Finance curricula taking into consideration the demand from students and from industry. This should be a gradual process, in which faculty can acquire a sense of which are the best areas to pursue, and then guide the students towards them. When I say "best", I mean that they combine intellectually challenging mathematics with useful material that young graduates can use in their first professional experience. The subtle thing about Math Finance programs is that you are not necessarily training individuals to be professors but, yet, you must give them a high-quality education. As far as funding is concerned, I also believe that Math Finance programs should satisfy the "law of the market": those who will use this education to go into business should not expect the government to finance their studies. For this reason, it is important to explore the possibilities of internships of fellowships sponsored by financial companies, a system that works very well in other countries. Funds from basic sciences should not be diverted into mathematical finance, but rather new funding opportunities should be identified. I am sure they exist.

What balance can you make of the Math Finance program at Courant?

It is a complete success, in terms of having an excellent placement ratio (which may be due to the current market conditions) and, to my delight, a group of students that are very gifted mathematically. A significant proportion of these come from Europe. By and large, we are keeping a high mathematical level as well as a high level in financial modeling and tracking what Wall Street is doing.

It is typical to end these interviews asking the interviewees about the favorite papers they have written, their plans for future work, and so on. What do you expect to do ten years from now?

Part of me wants to continue doing Finance and another wants to relax more and perhaps find a new area of research to dive into. I don't know what I will be doing in ten years. I find that research is a lot of fun and, in this sense, I have been well rewarded. I would love to continue to travel and to spend more time in Brazil and Argentina, where my parents and siblings live. Also, I love the "easy living" of Latin America when I was growing up, and one day I may just end up there.

Interview by Luís Nunes Vicente and Ana Margarida Monteiro (University of Coimbra)

Marco Avellaneda is Professor of Mathematics and Director of the Division of Financial Mathematics at New York University's Courant Institute of Mathematical Sciences, where he has been since 1985.

Since his PhD in Mathematics obtained at the University of Minnesota in 1985, Marco Avellaneda has published approximately one hundred research papers in applied mathematics. He is co-author of the book Quantitative Modeling of Derivative Securities: From Theory to Practice, CRC Press, 1999. He is well known in Finance for his pioneer work on the Uncertain Volatility Model and the Weighted Monte Carlo pricing algorithm.

Marco Avellaneda has been on the board of a number of journals and consulted for several international financial companies. Professor Avellaneda is a founding partner of Finance Concepts, a financial consulting and training firm with offices in Paris and New York. He is currently the Managing Editor of the International Journal of Theoretical and Applied Finance.

Professor Marco Avellaneda is also a member of the Scientific Council of CIM.