Quantitative Economics as an Option for Graduate Studies

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1 Quantitative Economics

I graduated from Indian Institute of Technology (IIT), Kharagpur in 1998 as a B. Tech. in Industrial Engineering. Like most of my batchmates, I did not have much enthusiasm for what I had learnt in my four years at IIT. As a result, for those of us who wanted to pursue higher studies, we were really confused about what areas to do our higher studies. I am sure the situation is not much different now.

This article is aimed at providing an alternative higher studies option for IIT students. I will argue that quantitative economics as an option for graduate studies, specially for IIT students, is an attractive and suitable option. Further, I will write about the Master of Science in Quantitative Economics (MSQE) program at Indian Statistical Institute (ISI), Delhi.

Quantitative economics is the mathematical and analytical side of economics. Like in engineering, it (a) tries to analyze existing systems to predict its outcome and (b) designs new systems from the scratch using mathematical techniques with economic objectives. What separates it from engineering is the economic objective part, and the fact that systems involve humans and not machines (like in engineering).

Quantitative economics is based on economics ideas but uses mathematics, specially optimization, statistics, and nowadays more and more computer science (algorithms and complexity theory) as tools for analyzing and designing economic systems. IIT students are reasonably familiar with these tools. Hence, the area becomes a natural candidate for higher studies. From my history with IIT students in quantitative economics (we at ISI Delhi have seen about 10 IIT students in our MSQE program in last few years), they tend to have some unfamiliarity with economic intuitions in early days, but they overcome it fast, and do exceedingly well in future. The fact that economic intuition is very logical and has a strong mathematical background helps.

2 An Example - Auctions (of cricket players, spectrum licenses etc.)

One wonders what kind of things are taught in a quantitative economics program. There are many things to talk about - from Black-Scholes formula in Finance to Nash equilibrium in game theory. I will give an example of something that you may have read about in

newspapers - auctions. Auctions are a natural competitive way to sell objects. Recently concluded IPL auction of cricket players created a lot of buzz. I will illustrate the economics part of an auction using a simple example.

Consider the sale of a single indivisible object (say, a house). Assume for simplicity that there are three potential buyers. Every buyer has some *value* for the object. For economists, value is the utility obtained by having the object. Informally, you can think of it being the *maximum amount* a buyer is willing to pay for the object. Suppose values of buyers are v_1, v_2, v_3. The problem is to allocate the object (house) to some buyer and charge an appropriate price for it. This problem is non-trivial because the seller is unaware of the values v_1, v_2, v_3. A crucial assumption is that if a buyer i pays an amount p to get the object his net utility (payoff) is $v_i - p$ and buyer i will always like to maximize this amount.

One can think of an auction as a procedure (algorithm) to elicit information about the values of buyers. Unless the seller gets information about the values of buyers, he cannot make a correct decision about the allocation and pricing of the house. For example, a natural objective of a seller is to give the house to the buyer who has the most value for the house. But if the seller does not have correct information about the values, the buyer with the most value will be impossible to detect.

Suppose the seller goes to every buyer and asks his value. Will the buyers tell their true value to the seller? The answer to this question depends on how the seller will use this information to determine the allocation and pricing of the house. Here comes the novelty of economics. The following auction procedure, known as the second-price (Vickrey) auction, does the trick. In this auction, buyers are asked to report the value and the buyer with the highest reported value is given the object but is asked to pay an amount equal to the second highest reported value (other buyers pay nothing). So, if $v_1 > v_2 > v_3$, then buyer 1 gets the object and pays v_2. It was shown by William Vickrey in a seminal paper that the net utility (payoff) of every buyer is maximized in this auction if he reports his true value to the seller [1]. You are encouraged to work out why this is true on your own.

Of course, such an auction is rarely used in practice. But auctions which essentially do the same thing (i.e., allocate and price the house the same way) but using a different method to elicit information from buyers are used in practice. For example, some of the auctions used in e-Bay are "equivalent" to the Vickrey auction.

Vickrey's ideas have been extended, in a non-trivial way, to sell multiple objects. Such procedures are called *combinatorial auctions*, and can be applied in settings like IPL auctions, auction of spectrum licenses etc. The beauty of these auctions is that bidders have a very straightforward strategy to maximize their payoff. There is also a literature to look at the seller side of the problem - maximize the revenue of the seller (2007 Nobel prize in economics was awarded to Roger Myerson for this work).

[1] Vickrey won the Nobel prize in Economics for his work in 1996.

Quantitative economics is much more than auctions alone. For example, banking policies are based on fundamentals of quantitative economics and are covered systematically in macroeconomics and finance. Econometrics is a major component of quantitative economics because of its wide spread applicability in government policies. Suppose the government wants to analyze the impact of National Rural Employment Guarantee Act (NREGA). Then, collecting appropriate economic data from NREGA and analyzing it statistically will give pointers to this fact. Such aspects of economics are taught in econometrics.

3 MSQE at ISI Delhi - Course Structure

Undoubtedly, ISI Delhi offers the best graduate program in quantitative economics in India. The MSQE program is offered by the "Planning Unit" department of ISI Delhi (visit http://www.isid.ac.in/∼pu). The program is unique in the country in various ways.

- Focus on quantitative part. We teach courses in microeconomics, macroeconomics, econometrics, game theory, finance, development economics, social choice and welfare, and many other advanced topics. A unique feature of all our courses is the focus on mathematical reasoning and analysis.

- Faculty of highest caliber. Planning unit is a small department with about 10 faculty members. But our faculty are some of the best in the world. All of us are active research-wise, and we take our teaching as an opportunity to learn while teaching. As a result, MSQE students are exposed to some of the best teachers in their respective disciplines.

- Small batch size. The batch sizes in the MSQE program are small. We take about 15 students every year. This ensures two things: (a) students are more or less homogeneous in their capabilities and (b) an excellent student to faculty ratio. Even in the small batch size, we encourage students from all backgrounds. Last year, we took students from engineering, physics, statistics, and economics background.

- Excellent placement. We usually get more than 95 percentage campus placement. Usual companies which come to campus for placements are banks and financial institutions. The median salary is the prevailing market salaries for economics and management graduates. However, the main attraction of the MSQE program is the opportunity to pursue doctoral studies. Usually, fifty percentage of our students go to top Universities in USA for doing their Phds. We always encourage our students to take up research as a career. Last few years, our students have got scholarships to pursue Phd at Columbia, New York University (NYU), CalTech among other US and European Universities. Some students stay back at ISI Delhi to pursue their Phds.

- Active research atmosphere. I have spent time in various campuses in India - IISc, Bangalore, IIT Kharagpur and Bombay, IIM Bangalore to name a few. I can safely say that the general atmosphere in Planning Unit is much more suitable for research than any of these campuses. Our research productivity matches well with any top US economics department. We have regular seminars on various topics. We have an active visitors program where faculty from abroad visit our department and interact with faculty and students. This is very motivating for students to take up research as a career.

- In south Delhi. Needless to say that an active social and cultural life is crucial in a student's development. Our campus is located in a very happening part of South Delhi. It is surrounded by nice market areas having good restaurants and pubs. IIT Delhi and Jawaharal Lal Nehru University (JNU) campuses are stone's throw away.

4 MSQE at ISI Delhi - How to Get There

ISI conducts an entrance test for the MSQE program. It is usually held in May every year. The relevant website is Dean's page: http://www.isical.ac.in/~deanweb/. The advertisement usually comes out in early February in this website and in major newspapers. The entrance test is a one-day event with two papers. The first paper is on Mathematics (Class 12th standard or JEE standard) and the second paper is on Economics (undergraduate level). The sample questions are available on the Dean's website and also in Planning Unit website. Based on the entrance scores, students are invited for an interview and the final list of candidates are selected based on weighted scores of entrance and interview. For students who do not have a background of economics, we emphasize more on the scores in the Mathematics paper.

5 Concluding Thoughts

Quantitative economics is an interdisciplinary field, joining economics with mathematics, statistics, and computer science. The analytical nature of this field makes itself an ideal candidate for IIT undergraduates to consider it for higher studies. This opens up many career doors - in banking and finance, in government policy, in academics, in consulting etc. The Planning Unit at ISI Delhi runs one of the best graduate programs in economics in India. I encourage all IITians to consider it as an option for graduate studies.