

ON BECOMING A QUANT

MARK JOSHI

1. WHAT DOES A QUANT DO?

A quant designs and implements mathematical models for the pricing of derivatives, assessment of risk, or predicting market movements.

2. WHAT SORTS OF QUANT ARE THERE?

- (1) Front office/desk quant
- (2) Model validating quant
- (3) Research quant
- (4) Quant developer
- (5) Statistical arbitrage quant
- (6) Capital quant

A desk quant implements pricing models directly used by traders. Main plusses close to the money and opportunities to move into trading. Minuses can be stressful and depending on the outfit may not involve much research.

A model validation quant independently implements pricing models in order to check that front office models are correct. Plusses more relaxed, less stressful. Minusses model validation teams can be uninspired and far from the money.

Research quant tries to invent new pricing approaches and sometimes carries out blue-sky research. Plusses it's interesting and you learn a lot more. Minusses sometimes hard to justify your existence.

Quant developer – a glorified programmer but well-paid and easier to find a job. This sort of job can vary a lot. It could be coding scripts quickly all the time, or working on a large system debugging someone else's code.

Statistical arbitrage quant, works on finding patterns in data to suggest automated trades. The techniques are quite different from those in

Date: January 3, 2007.

derivatives pricing. This sort of job is most commonly found in hedge funds. The return on this type of position is highly volatile!

A capital quant works on modelling the bank's credit exposures and capital requirements. This is less sexy than derivatives pricing but is becoming more and more important with the advent of the Basel II banking accord. You can expect decent (but not great) pay, less stress and more sensible hours. There is currently a drive to mathematically model the chance of operational losses through fraud etc, with mixed degrees of success.

People do banking for the money, and you tend to get paid more the closer you are to where the money is being made. This translates into a sort of snobbery where those close to the money look down on those who aren't. As a general rule, moving closer to the money is easy, moving towards it is hard.

3. AREAS OF DERIVATIVES

- FX
- Equities
- Fixed income
- Credit derivatives
- Commodities
- Hybrids

FX is short for foreign exchange. Contracts tend to be short-dated with high volume and simple specifications. Emphasis is therefore on speed and smile modelling.

Equities means options on stocks and indices. Techniques tend to be PDE based with the local vol model being popular. A typical contract is a note paying some function of the stock price path. Not a particularly big market.

Fixed income means interest rate derivatives. This is probably the biggest area by value. The maths is more complex because the underlying is multi-dimensional. Martingale techniques are used a lot. It's well paid.

Credit derivatives are derivatives that pay-off according to the defaults of corporate entities. This is currently a big growth area with lots of demand translating into very high pay. It displays some bubble-like characteristics, however.

Commodities, this is also a big growth area with the general rally in commodity prices in recent years.

Hybrids are derivatives that pay off according to behaviours in more than one market – this is typically interest rates plus something else. The main advantage of working on such products is ability to learn multiple areas. These are also very trendy currently.

4. SORTS OF EMPLOYERS

We can roughly divide employers into

- Commercial banks, e.g., RBS, HSBC
- Investment banks, e.g., Goldman Sachs, Lehman Brothers
- Hedge funds, e.g., the Citadel Group
- Accountancy firms
- Software companies

Commercial banks ask less of you, and pay less. Better job security.

Investment banks tend to demand long hours but pay well. Not so good job security.

Hedge funds tend to demand a lot of work. They are very volatile and a big growth industry currently. There is the potential to make a huge amount of money, but also the potential to be unemployed after a few months.

In general, American banks pay better but demand longer hours than European banks.

The big accountancy firms have quant teams for consulting. Some places, particularly D-fine, send their employees on the Oxford Masters course. The main disadvantage is that you are far from the action, and high quality individuals tend to work in banks so it may be hard to find someone to learn from.

There is becoming more of a tendency to outsource quant modelling and buy in software models. One option is therefore to work for the software company instead. The issues are similar to those with working for accountancy firms.

5. STUDY

What should one learn? There is by now a huge number of books available. Standard books are

- Hull - Options future and other derivatives – this is sometimes called the “bible book.” Main downside is that it is oriented towards MBAs rather than quantitative PhDs.
- Baxter and Rennie – accessible introduction to martingale approach but oriented towards theory rather than practicalities
- Wilmott (Derivatives) – good on the PDE approach but not so good on other approaches.

Like any author I recommend my own books:

- The concepts and practice of mathematical finance, CUP 2003, my objective here was to cover what a good quant ought to know. It includes programming projects that I strongly advise you to do before applying for jobs.
- C++ design patterns and derivatives, CUP 2004, this is a second book on C++, the objective was to teach the reader how to use the language properly.

Stochastic calculus is useful, but not as important as it at first appears. It is hard to find the time to pick it up on the job so it's worth learning in advance. It's also worth spending some time going over basic probability theory – eg Chung's books. Some books on stochastic calculus and martingales which I like are

- Williams, Probability with martingales, a remarkably easy to read rigorous account of discrete time martingale theory. (You need to know the discrete time stuff to learn the continuous case.)
- Rogers and Williams, particularly Volume 1.
- Chung and Williams, you need to know continuous time martingales first, but if you do it is a nice read.

I keep a much more detailed list at

<http://www.markjoshi.com/RecommendedBooks.html>

6. HOW MUCH DO I NEED TO KNOW?

The amount you must study before getting a job varies a lot from place to place. It goes up every year as it becomes more standard to do financial mathematics degrees. At the time of writing, I would advise knowing the contents of both my books well. A lot of candidates go wrong by reading books instead of studying them. Pick a couple

of books and pretend that you have to do an exam on them (this is essentially what happens in an interview,) if you aren't confident that you'd get an A in that sort of exam, don't apply for jobs.

Interviewers tend to care more about understanding the basics well than on knowing a lot. It's also important to demonstrate genuine interest in the field. Read the Economist and the FT or Wall Street Journal comprehensively. It's not unusual to ask basic calculus or analysis questions e.g. what is the integral of $\log x$. Asking for a derivation of the Black-Scholes equation is very common too. They always ask you to explain your thesis so be prepared to be able to do this. Have a prepared 60 second speech on every phrase on your cv.

The interview is also a chance for you to judge them. What are they like as people? (You will be spending most of your waking life with them so this is important.) What do they care about, as evidenced by what they ask you? If most of the questions are about the minutiae of C++ syntax then be wary unless that's the sort of job you want.

Generally, a PhD (or almost a PhD) is a necessity to get a quant job. I would advise against starting before it's awarded as it tends to be hard to get it done whilst doing a busy job.

Having a masters degree in Financial mathematics but no PhD tends to lead into jobs in banking in risk or trading support but not straight quant jobs. Banking is becoming progressively more mathematical so the knowledge is useful in many areas in banks. Some people then manage to move into quant later on.

In the US, it seems to be becoming more and more common to do a masters after a PhD. This still seems to be less the case in the UK. There is a general move towards more routine work and less research in banks making the job less interesting. This seems to be particularly the case in the US. One head quant recently told me that he regards research as something "to be contracted out to universities."

7. FOR PURE MATHEMATICIANS

The main challenge for a pure mathematician is to be able to get one's hands dirty and learning to be more focussed on getting numeric results than on fancy theories. The main way to do this is to implement pricing models for practice. If this doesn't appeal you aren't suited to being a quant. There are quite a few ex-pure mathematicians working in the city so it can certainly be done but there is some prejudice in

favour of applied maths and physics people. Generally, people tend to hire people who are like them so if you can find anyone with a similar background working in the city, apply to them.

I sometimes get asked by people whether they should do a pure maths PhD or a financial maths one. If you are absolutely sure you want to do derivatives pricing then you should do it in financial maths. (Yes, I am taking PhD students.) If you aren't sure then don't. A good compromise is to do stochastic calculus, this is a hard area which will give plenty of intellectual stimulation and leave you very well placed for working in derivatives if you ever want to make the switch.

8. CODING

All forms of quants spend a large amount (i.e. more than half) their time programming. However, implementing new models can be interesting in itself. The standard programming approach is object-oriented C++. A wannabe quant must learn C++. ¹ Some places use MatLab and that is also a useful skill, but less important. VBA is also used a lot, but there is a general attitude that you can pick it up on the job.

9. APPLYING FOR A JOB

All of the finance forums have their own jobs advertising boards. A lot of adverts are from recruitment consultants rather than from banks. It is important to realize that the job may not even exist – the consultant wants to get decent candidates that he can then try to place them in banks. The consultant gets a commission from the bank if he can place you. They tend to have short attention spans; ² if you do well at the first couple of interviews then they will work hard to get you a good job but if you don't they will quickly lose interest. Also, be aware their agenda is to get a good commission rather than to help you so they will push you at jobs on that basis. (A typical cut is 25% of your first year's package so whether you say "yes" to a job makes a difference of ten thousand pounds to them.) If you want to understand them, think of estate agents.

¹I have no opinion on whether this should be the correct language for implementing; it is merely the correct language for getting a job.

²To any headhunters reading this, sorry but it's true.

In fact, going via a recruitment consultant is the standard way to get a job. Quants are generally not hired as a part of the on campus recruitment process but instead hired as they are needed by the team. That said it is worthwhile to go to presentations and to meet the people, and get their contact details for later. Because of this it is not a great idea to start applying a long time before you want to start. Banks tend not to be into paying expenses for interviews. One therefore needs to go to London or New York and attempt to get as many interviews as possible as quickly as possible.

If you have personal contacts, you should use them. Employers prefer not to use headhunters if they can avoid it. If you are finishing a maths or physics PhD from a top university you will be a hot property. Employers will be keen to get you before someone else grabs you so make use of this.

Recruitment agencies vary tremendously and are discussed at great length on all the online forums. Two which seem to know what they are doing more than most, and which have their own much more extensive guides are Michael Page and paulanddominic.

If you get offered a job that is not in your ideal area do not be too worried. It is the first job that is hard to get. You can move on. The main thing is not to spend more than a couple of years in an area where you do not want to be. Quants are most employable with 18 months to 2 years experience. With more than that they tend to be too well paid and get pigeon-holed.

From time to time, I hear of someone being offered a job and being told they must accept immediately or within 24 hours. This is unreasonable and you should question why they are doing this, and do you want to work with someone who treats you this way? Possible responses are

- “Why?”
- Does that mean the offer will go away if I don’t accept immediately?
- “Oh I get it, you are testing my naivety” and laugh.
- Mark Joshi’s guide says never to accept an offer made under such circumstances.

If you are interviewing with other places, call them first and tell them the circumstances, they will find this less annoying than you telling them you accepted a job under pressure.

10. PAY

How much does a quant earn? A quant with no experience will generally get between 35 and 50k pounds. The lowest I have heard of is 25k and the highest is 60 plus a signing on bonus. If the pay is outside the standard range, you should ask yourself why? Pay will generally go up fairly rapidly. Bonuses are generally a large component of total salary, and should be taken into account when negotiating pay. E.g. you may be able to get a guaranteed bonus if the base is lower.

Do not get too focussed on what the starting salary is. Instead examine what the job opportunities will be, and what the learning experience is likely to be. How much turnover is there in the team? and where do the people go?

11. HOURS

How hard does a quant work? This varies a lot. At RBS we got in between 8.30 and 9 and went home around 6pm. The pressure varied. Some of the American banks expect much longer hours. Wall St tends to be more demanding than the City. In London 5 to 6 weeks holidays is standard. In the US 2 to 3 is standard.

12. INTERVIEWING

Here are some do's and don'ts that will reduce your chance of messing up unnecessarily.

- Don't be late.
- Don't be early; this annoys the interviewer. Get there early, go to a cafe and have a lemonade and turn up dead on time.
- Do eat a good meal beforehand; sugar lows destroy thinking power.
- Don't argue with the interviewer about why they've asked you something. They've asked you it because they want to know whether you can do it.
- Do appear enthusiastic.
- Do wear a suit.
- Do be eager to please. They want someone who'll do what they want, you must give the appearance of being obliging rather than difficult.

- Don't be too relaxed; they may well conclude that you aren't hungry enough for success to work hard.
- Don't tell them they shouldn't use C++ because *my niche language* is better.
- Do demonstrate an interest in financial news.
- Do be able to talk about everything on your cv (resume in American). Have a prepared 2 minute response on every phrase on it.
- Do bring copies of your CV.
- Don't expect the interviewer to be familiar with your CV.
- Don't say you've read a book unless you can discuss its contents; particularly, if they've written it.
- Do be polite.
- Do ask for feedback and don't argue about it. Even if it's wrong try to understand what made the interviewer think that.
- Don't say you want to work in banking for the money; of course, you do but it's bad form to say so.
- Do say you want to work closely with other people rather than solo.
- Don't say that you think that bankers are reasonable people – they aren't.
- Do take a break from interviewing and do more prep if more than a couple of interviews go badly.
- Don't use a mobile for a phone interview.
- Do be able to explain your thesis – work out explanations for different sorts of people in advance.
- Don't expect banks in the UK to pay for interview expenses. If they do agree to pay, make sure they are willing to pay what your ticket will cost. eg don't get an expensive ticket if they say they'll pay for a cheapo airline.
- Do ask about the group, you'll be working in. e.g. turnover, where people go when they leave, how many, when can you meet the rest of the group (only if an offer appears imminent), how old the group is, what's the team's *raison d'être*, is it expanding or contracting. What would a typical working day be?
- Don't get on to the topic of money early in the process.

A general comment is that quant has the reputation of being a hard area to get into, but if you talk to any hiring manager they'll tell you that they interview lots of candidates and most are terrible. It's rare to be forced to choose between two good candidates; it's much more common to be relieved that you've finally found one who's good

enough. The moral is that most candidates are failing to reach the required level. If you are good at maths and do your preparation, you can be at that level and get a job.

13. OTHER RESOURCES

There are by now a large number of online forums where these sort of questions are discussed to death. I keep an up to date list on www.markjoshi.com

14. WAR STORIES

I would like to make this guide more dynamic by including the latest gossip and stories of job applicants. So send me, mark@markjoshi.com, your experiences, including info such as

- how many different firms?
- how many interviews per firm?
- what you thought of headhunters.
- how you got the job you took?
- which books were helpful?
- what you wish someone had told you before you started.

15. ADVERTISING

Various recruitment agencies have asked for plugs. If you would like to advertise in this guide, e-mail mark@markjoshi.com .