Quantitative Research

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1.1 Introduction

The City of London is one of the world's leading financial centres. All of the world's major investment banks have operations there. Allied industries to Investment Banking encompass Consultancies, Software Firms, Accountancies, Legal Specialists and Recruitment – the Banking and Finance industry is colossal and current estimates are that, despite the economic downturn there are around 15,000 employers and 300,000 employees within the City of London alone (tuc.org.2001). It is no surprise that the City is a huge target for Graduates and Post-Graduates seeking their first role in Finance.

London is a highly attractive place from both a career and a financial perspective. However, its very size and the complexity of its business can make the Banking and Finance sector seem a nebulous mess. Often aspiring Graduates are left confused about the nature of the careers within the City and unsure of the best approach to take to successfully gain the right job.

This guide is focussed on careers within Quantitative Research. It seeks to explain in general terms the main businesses of the City, the career paths Quantitative Researchers can take and what their jobs actually entail. The main function of the guide is to enable successful application to a first role. Therefore there are descriptions of typical quantitative backgrounds, advice on interview processes, tests, CV preparation and example CV's, market overviews and Day in the Life examples of likely work. The authors of this guide have between them twelve years recruitment experience within the City and over that time have seen the development of Quantitative Research as a necessary and value-adding resource to the functioning of the Banking & Finance Sector. Hopefully this guide will add some clarity to the rhetoric.

1. Overview Of Finance and Quantitative Research

1.2 The Structure

The purpose of Banking is either the lending or the investment of capital for a profit. This is the core around which revolves a myriad of complex terms, innovative business plans and a vast related industry of support services. It is worth remembering when embroiled in the latest paper by Myron Scholes or struggling with the concepts of object orientated programming that underlying all of this is a very simple idea of wealth generation.

However London has been a Banking centre for several hundred years and as such the industry is highly mature and developed. This also makes it difficult to understand how everything fits together. The best way to explain the structure of the City and thus within it where quantitative researchers are employed is diagrammatic – see below.
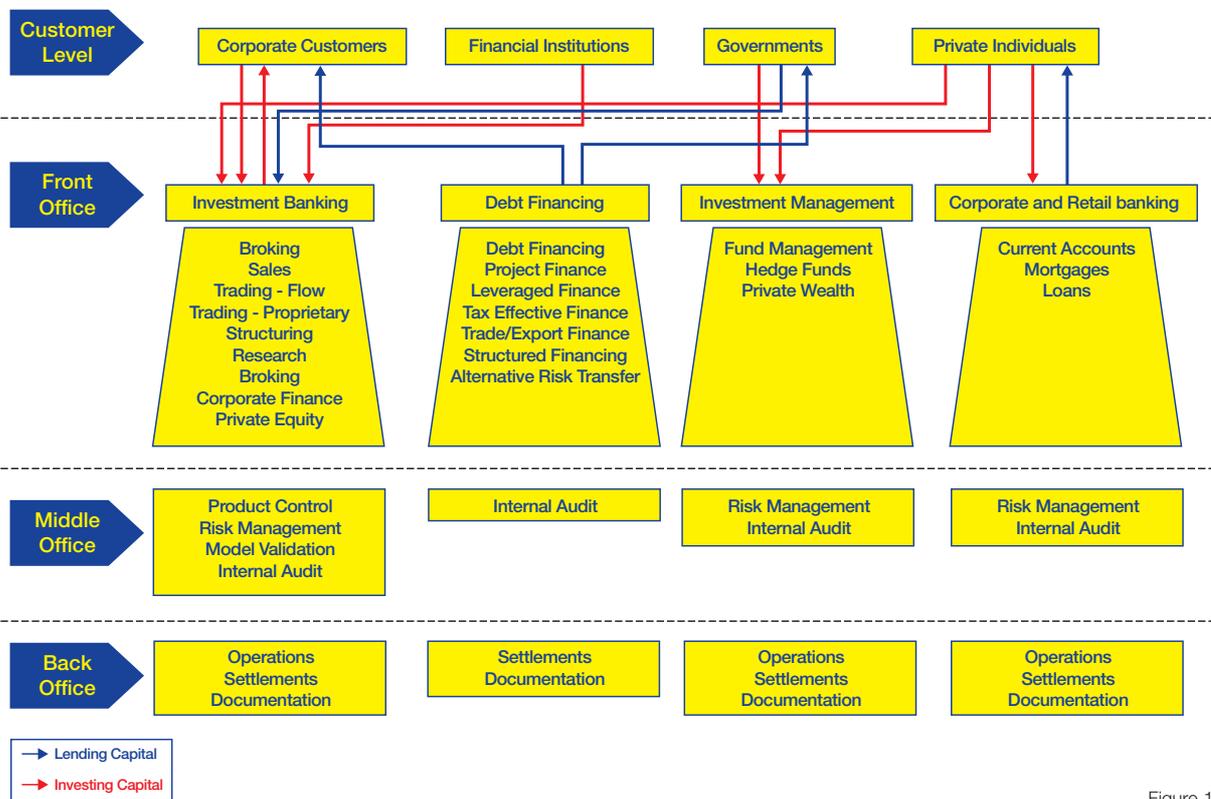
Figure 1

Within the above structure the majority of quantitative research roles are centred within the Investment Banking sphere. They generally are placed within the two major subsections of Financial Institutions namely Front and Middle office. Front Office refers to any area of a firm which is revenue generating (thus Trading or Mergers & Acquisitions) whilst Middle Office refers to those areas which support the front office in their functions but do not directly have any contact with revenue generation (Risk, Model Validation, Finance).

1. Overview Of Finance and Quantitative Research

1.3 Location – Front Office

- Within the Front Office quantitative researchers are either placed on the trading desks or on a centralised team to which all the trading and sales desks have access.

- The quantitative teams are often very product aligned but sometimes, especially within smaller environments, they cover all asset classes.

- Quantitative Researchers can also be individually placed to support other teams within the Front Office. Teams that are likely to need this kind of resource include Structuring and sometimes Broking.

Within the other spheres indicated in the diagram (Figure 1) there are a much smaller number of quantitative researchers, most of whom are found within Investment Management. Here, again, they can be individually placed on teams or structured in a centralised group. They will work directly for individual Fund Managers and their respective teams. Within the Corporate & Retail Banking there are quantitative units which are mostly centralised and responsible for all areas of the business. Debt Financing, other than within the Ratings world, does not often have the need for a dedicated quantitative resource but when it is applicable they would have individuals to supply that function on the team.

1.4 Location – Middle Office

- Within the Middle office quantitative researchers are mostly structured into a specific group which is often cross-asset and supportive of the entire front office.

- They can be placed within Product Control or Risk Management although some of the very large banks will place the team separately. Given the nature of their work (which we define later) there is exposure to the front office quantitative teams and also to other front office units.

- Depending on the view of the bank and its internal strategy there can be a greater or lessor degree of exposure allowed to the Front Office.

It should be noted that some institutions view their quantitative teams as a dynamic resource shaping the strategy of the business. There are other institutions that use quantitative teams as a secondary line of support, still adding value to the business but operating rather like a safety net. This means that there will be differing emphases and pressures on the team. The question has to be asked 'how will you know.' You can generally tell during an interview process by where the group is orientated and the kind of projects they are involved in. There are obvious questions which will reveal this and we will talk through these in the section focussed on interview processes. Hopefully we have given a little shape and structure to the Financial world. It is very important to realise that, despite the generalisations, there are no two institutions which are the same and each will structure themselves according to the needs of their individual businesses.

1. Overview Of Finance and Quantitative Research

1.5   What Do Quantitative Researchers Do?

Many graduates, as well as being confused about the structure and nature of the Banking & Finance industry are not really certain about the purpose of quantitative researchers within it. We meet many people who can perfectly well describe how to derive Black Scholes using Ito's Lemma but have great difficulty explaining why this is of any use to anyone. There seems to be an expectation that they will move into a well-paid role involving modelling and programming, they will write some recognised academic papers and perhaps will attend a few conferences where they will rub shoulders with the Professors from the major universities. Apart from some notable exceptions Banks will very rarely employ financial academics just for the purposes of funding their research. Remember banks are practical businesses whose primary goal is making money through lending and investing capital.

1.5a Front Office Quantitative Research

So what do quantitative researchers do? Within Banking quantitative researchers are employed to support trading and sales functions. At the very simple level Banks buy and sell investment products known as Stocks (Equity) and Bonds (Debt). They can gain a good idea of a fair price to charge for these because they are liquid instruments (many people are buying and selling them) and thus they are governed by the market principles of supply and demand – the lower your price the more people will buy from you, the higher your price the more people will sell through you.

Over the last 30 years a massive industry in derivative securities has developed as the risk preferences and profiles of customers have matured. The idiosyncratic, customised nature of many of these products can make them relatively illiquid and hence there are no handy market prices available. There are market prices for many more vanilla derivatives but often they are not in useable form. This is where quantitative researchers are very necessary. These products are actualised, priced and hedged by means of complex financial models, implemented as software and then embedded in front-office risk management systems. This is the function of front office quantitative researchers.

The role can be broken down into further detail by considering the nature of derivative investments. Derivatives are securities which have a payoff (investment profit/loss) linked to the behaviour of specific underlying securities. Their value is determined by the behaviour of these underlying securities and more importantly what these underlying securities are about to do. The purpose of a model is to define the manufacture of the derivative security from its underlying ingredients and then how to vary those ingredients as market conditions change so that the price of the derivative accurately maps the price of the underlying securities. The model itself is an attempted simplification of a complex reality and therefore there is no correct model for any given situation – there are only models which can give more and more accurate prices. The processes a front office quantitative researcher has to carry out in creating a model to value a derivative security are as follows;

- Obtain a description of the security's payoff in terms of the values of each of the underlying securities. Sometimes this is generic but often it is highly structured and is developed by an in house structuring team whose sole purpose is to come up with new investment ideas which are then marketed to clients.

- Specify a model for the future behaviour of these underlying securities. This has led to whole branches of maths dedicated to modelling debt and equity behaviour under all sorts of conditions and parameters. Generally knowledge of stochastic calculus, partial differential equations and numerical methods are needed.

- Obtain accurate values of model parameters (such as volatility or interest rates) that describe the behaviour of the underliers.

- Calibrate the model to these parameters so that it reproduces the known prices and assumed future behaviour of the underliers. For example many fixed income models are calibrated to the LIBOR rate which is the rate the major Banks will lend money to each other in Europe.

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- Build a computer program that incorporates all of the above. Usually this will be implemented in a centralised library to which traders and sales individuals have access. Often an interface needs to be created as models will sometimes be shown to clients. C++ is the language banks most often use for implementing models. This is to ensure a common standard across the financial world and because it is object orientated. This means that many people can use one model at the same time, putting in many different parameters and running many scenarios. It also allows for models to be highly flexible, a necessary must given the complexity of models to be coded.

To give further clarity we include the experience of a front office quantitative researcher at one of the US Banks.

"I currently work in the Product Research group of a US Investment Bank focussed on Credit Derivatives. I was educated at a British University and gained my role through a recruitment consultant. My principle responsibilities are;

- *New product development – many products in structured credit derivatives are proprietary. I provide quantitative support (modelling and coding) when new products are developed. These are normally originated by our structuring team but sometimes major projects can be originated by quantitative research.*

- *Implementation – Once new models have been developed for pricing and hedging I have to implement them in C++ into a centralised library for Credit. Sometimes I work with a systems team who are responsible for providing an interface to my work and also connection with the middle and back office systems.*

- *Models that I have delivered include one to price a a credit default swap and a first to default basket model.*

- *I am also engaged in long term projects. My current project is focussed on assessing the best form of copula to use for credit derivative pricing.*

Often I am called upon to provide quick analytics and simple tools for the traders to use to provide a quick estimate of pricing or risk exposure. The main attributes needed in this role, as well as mathematical ability are common sense and managing trader expectations."

These are the principle responsibilities of a front office quantitative research. Of course there is a massive amount of minutia accompanying these. This can range from debugging code which has corrupted in a model or having to speed up an algorithm because a simulation is taking too long to run. Most people are attracted to this type of role because of the complex mathematics involved combined with the opportunity to be creative – allied to the fact that it also pays well. However because it is in the front office it is a highly pressurised position. There are often large amounts of money riding on model outputs and quantitative analysts will have to deliver solutions in a short time periods. Some traders will disregard their quant teams altogether and treat them as a necessary nuisance. When the relationship works well quantitative researchers are a very valuable asset to a business and are compensated as such.

1.5b Middle Office Quantitative Research

Within the revenue generating areas of a Bank there will be wildly divergent pools of interest. Most traders will be concerned with personal gain and will not often give thought to the wider strategy of the bank.

Therefore, to satisfy their own vantage points firms have developed quantitative groups to provide an independent view on whether the models and the prices they emit are correct and are in the firm's best interest. It is no good entering into a trade where the potential upside is colossal but there is a 99% chance of losing all your initial investment. In addition to this, there have been enough cases of high profile financial institutions collapsing to persuade the Regulators in all the major financial centres to enshrine in law that "for any firm to operate as a bank it must put in place an independent quantitative team to provide an alternative view on the models and strategies".

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These teams are typically referred to as Model Validation but can be called Model Risk, Models & Methodology or Quantitative Risk Management. Essentially they all perform the same function of price and model verification. This is the role of the middle office quantitative analyst. Once again it is worth looking a little closer at the traded products to understand the function of the role. For illiquid derivatives it is very easy to check a price by observing external market data. For illiquid securities one must test the payoff description, the plausibility of the inputs and the reasonability of the model itself. The computer programs which incorporate the models must also be tested. A detailed overview of the responsibilities follows explaining what is involved in performing this testing.

- Model Validation & Model Assignment Documentation. All new models, especially those responsible for the greatest sensitivity of any given portfolio should be tested and certified by someone other than the developer. A report demonstrating that the model captures the relevant features of both the market and the product should be produced. This should also cover the numerical accuracy and reliability of the algorithms and software and should emphasise areas where approximations appear unacceptably large.

- Input Tests. A quick and dirty method of checking reliability is by comparing the extent of the correspondence between the input values in the traded models and the same parameters obtained from external market sources. There are hidden complexities. Some parameters are not single numbers but such things as one-dimensional curves and for some there is not even reliable external market data.

- Comprehensive Validation & Verification. The more forward thinking firms adopt a completely holistic approach to validation. A person independent from any trading desk who is knowledgeable in the markets should begin with the confirmed trade details of a product and should build an independent model from first principles. They should describe the product and the market, then calibrate the model and finally provide an estimate of value and hedge ratio. Very often the firm will develop a central model library which is available to the Trading and Sales desks as a resource and which is developed independently by the Model Validation team.

- Periodic Review. As markets mature new eventualities and inaccuracies arise that early pricing models do not cater for. It is advisable to revisit entire derivatives markets and models to develop new approaches where necessary. One of the major problems in recent years has been how to effectively model skew (where market sentiment means that a product trades at a higher or level level than its pricing model indicates). In some liquid products where the data is in the public domain skew is easy to observe. In the swaptions market for example accurate information on the skew is much more difficult to obtain.

To give a first-hand insight into this function we have included a brief overview from a middle office quantitative researcher at one of the European houses;

"I work in the Product Analysis and Market Risk Modelling team as a credit and interest rate derivatives quant. I was hired via a recruitment consultant. I mainly work on three kinds of projects:

- *When a new model, or an improvement over a previous model, or a new calibration methodology is proposed by the Front Office, my role is to test and validate it before it can be used by the traders.*

- *Before a new structured or exotic product is traded, I am have to analyse it, quantify the risk involved in the transaction, and assess the efficiency of the hedging strategy.*

- *I am also involved in specific deals, which generally means measuring the risks involved in a complex one-off transaction.*

1. Overview Of Finance and Quantitative Research

On a daily basis, I use a broad variety of mathematical tools such as stochastic calculus and numerical analysis, statistics, and a bit of C++ to implement my tests. But common sense is more important than everything else. I need to take into account what data is available, and to constantly keep in mind that models should not be trusted too much. In fact, model risk is one of my main preoccupations. And because I want to test a hedging portfolio in the real world and not just within a model, I build my stress test scenarios regardless of the mathematics.

Currently, my projects include calibration strategies of interest rate models and robustness of hedging strategies for multi-name credit derivatives."

It can be seen that the function of Middle Office Research is highly necessary and also that it shares much of the same responsibilities and skills that the Front Office demands. The leading houses will treat their Middle Office teams as reviewers as opposed to validation or verification. Validation suggests performing a check after the deal is closed. It is no good being able just to accurately define a large loss after it has happened. The point of an effective Model Validation team is to ensure that such risks and pitfalls are avoided whilst profit is maximised. This, by definition, needs to be carried out independently from the Front Office.

Middle Office Quantitative teams have different levels of power across the financial world. The best Financial Institutions will view these teams as a highly valuable resource preventing them from losing millions of pounds on pointless risky transactions.

Quite often banks will use these teams as breeding grounds for their Front Office as it gives a candidates a good chance to develop their quantitative skills in a secure, less pressurised environment before exposing them to the full pressure of the trading floor. It also allows for involvement with long term projects. Banks have been known to develop new trading teams and desks and to have asked the Middle Office quant team to perform all the start up development needed. On the other hand, as with various Front Office teams, there are institutions who regard these teams as a safety-net. It should be noted that given the long term bear market climate this point of view is not such a bad thing. When Banks and Financial institutions have been made horribly aware of the consequences of major losses any team that exists to prevent these is considered highly important. In that sense the bear market has led to significant appreciation for and involvement of quantitative resources.

2. Profiles

Thus far we have tried to paint a clearer picture of the Banking and Finance Sector and within that where quantitative researchers are employed. We have also attempted to break down and define what it is quantitative researchers actually do. But why do people choose to follow this career path? Why do people chose to leave highly academic careers and often high profile research posts to move into this world? The answers are varied. In the following section we will attempt to outline what motivates people to move into a quantitative research role and what kind of profile and skillset is successful in making that move.

2.1 Why choose this type of career?

- The primary reason this move is made is that the skills and techniques needed to cope and succeed in a quantitative research role are highly similar to those demanded by MSc and PhD courses at the major universities. Graduates feel that they can carry on performing the models and techniques but shift their environment into the business world. As part of a Theoretical Physics course someone may have utilised numerical methods to solve complex differential equations defining such things as the appearance of sun spots or chaos theory. Equally in a quantitative environment monte carlo simulations will be run to gain an optimal price for an interest rate derivative given infinite future movements of interest rates over the next ten years.

- Models are coded in object orientated environments for other people to view. In the academic world the languages are usually Mathematica or Fortran whilst in the Financial world the languages are C++ and Visual Basic – but the concepts are the same. In the same way that Post Docterate academics will continue to produce research papers and books financial researchers will often do the same. There are a number of high-profile quantitative researchers, for instance, who publish new developments within 'Risk Magazine' on a monthly basis. Some banks even view publishing as a good way of advertising their derivative capabilities.

- The secondary reason is usually a lifestyle issue. Quantitative researchers are usually committed to an academic career but become tired of the lack of serious funding available in British and European Universities. A post doctorate at University will not always equate with raising a family, purchasing a house or taking regular holidays abroad. There are a large number of quantitive researchers who would admit that if the academic research world paid a little higher then they would prefer to stay in that environment (See appendices for salary overviews).

- People are also motivated by the applied nature of the business world. Quite often academics become tired of working in an esoteric environment which has little application in the real world. In contrast, in a quantitative career they will be using the same skills but applying them to real world situations and operating within a highly goal-orientated environment. Models have to be delivered on time and with definable outputs. The work is highly practical and relevant. Some of the more obscure areas of deep-space research can be hard to relate to where as people will always wish to lend or invest money and will look for ever more complex ways to do so as they attempt to beat the market benchmarks.

- Some people have directed their academic studies towards Financial Mathematics purely for academic reasons – this is where their interest lies from an early age. It is a natural progression to move from here to a banking role in the way that someone who has pursued a degree in Aeronautics will probably aim to be a pilot.

These are the general motivations that candidates have expressed to us, as recruiters, when we posed the question 'why do you wish to follow this career path?' Over the last few years Quantitative Research within Banking and Finance has become much more highly sought after among the graduate community. There are tailored academic courses designed to train people for entry to the types of roles we have discussed above. People are aware of the benefits and upsides in such a career. There is a larger group of applicants in an increasingly global market. This does not mean that the jobs are any easier to obtain.

2. Profiles

Many banks have developed their quantitative teams in a parallel fashion to the development of the derivative markets. This has led to increased growth over the last 5 to 10 years in numbers of personnel. However now that the markets have matured banks are close to capacity meaning that for a new role to appear either someone has to leave a team (via promotion or resignation) or there has to be significant growth in one particular area of the business. In these depressed times significant growth is unlikely and investment in a new area of business even less so.

When an entry level role does arise there will be very heavy competition. Typical statistics from one client in particular for a junior role was in the region of 100 CV's received, 10 of whom were interviewed, 2 were shortlisted and 1 one was successful. It is worth questioning ones personal motivations and skillsets to see if they are the right ones. Someone who is bright compared to their peer group and is motivated in a similar style to those mentioned above will eventually be successful in gaining their intended role. One should not be drawn to the role simply for money (interviewers will pick up on this) or image. The image of quantitative researchers is, as with many careers, vastly different to the reality. Quite often there will be long hours, much pressure, irrational behaviour from colleagues, market volatility and tedious tasks to contend with. So what type of profile do employers look for in the quantitative world?

2.2 Typical backgrounds of Quantitative Researchers

A quick search on the internet of various job boards will soon indicate a generic profile for a quantitative researcher punctuated with various soundbites. Indeed many of them read like estate agents boards. The aim here is to decipher some of the common jargon and explain why various skills and academic achievements are typically demanded.

Academic Level

No two candidates are ever the same. However, quantitative research roles do demand a high level of academic achievement. Typically in the UK candidates will have A's and B's at A level and a strong 2:1 or a 1st in the undergraduate degree. European candidates will have a similar level in their respective qualifications. Partly this is necessary because there are basic skills and competencies which high grades will demonstrate (such as quickness of thought, accuracy and the like). Partly employers themselves generally have a high level of academic achievement and wish to employ similar profiles to themselves.

PhD/MSc

Nearly all entry level quantitative roles demand either an MSc or a PhD as a requirement of entry. The natural question often asked is how relevant that requirement is. As a benchmark of entry the relevance lies in both the technical and the intellectual skills such a qualification cultivates in successful graduates. There are minimum mathematical and modelling skills that applicants to these roles will need. The majority of undergraduate degrees will not cover in depth solving of partial differential equations, term-structure modelling or higher order stochastic calculus. The current methods used to price complex interest rate derivatives (eg Rainbow or Bermudan) demand the use of term structure modelling (the models are in continuous time) and stochastic processes (especially entailed within yield curve modelling).

However, these qualifications are also important because of the way they nurture wider related skills. The way one approaches a problem and solves it matures under the study of a further degree. Once the tuition moves from a teacher/pupil relationship to a more independent researcher/supervisor style students become much more independent in their thinking and it is this the ability that employers are looking for. Quite often there will be projects which a quantitative researcher will have to complete without guidance from management. The resources will be available to use, such as relevant textbooks, data warehouses, systems specialists and the like, but how these are deployed will be solely up to the researcher. In addition, at the entry level there is rarely a graduate program for quantitative researchers, largely because it is a unique function with a small number of personnel in relation to trading or finance. Therefore new entrants will be expected to pick up the necessary skills and techniques with perhaps only a little mentoring.

2. Profiles

Science Or Maths

The fixed income quantitative research unit at one of the US Investment Banks is known to prefer candidates with a Physics background because, in their view, 'mathematicians develop models whereas scientists develop solutions.' This is not a shared view across the market, thankfully. Different banks will have varying views. Those that orientate their quantitative teams towards developing new models and ideas generally prefer theoretically focussed degrees such as Pure Mathematics or Theoretical Chemistry. These teams will be looking for the ability to pursue an abstract idea before applying it to relevant situations.

Banks who position their quantitative teams as fixers and implementers closely allied to the desk generally prefer people with very applied backgrounds such as Astrophysics, Geometric Mathematics or Engineering. There is no particular view on whether a Science background or Mathematics background is stronger. However, quantitative research groups will rarely, if ever, hire people from outside of these fields.

Internships

An internship will add much weight to a CV and more so are they becoming a criteria for selection. It is true that some banks and groups within banks prefer candidates without internships because they feel that these candidates will be untainted with other people's views and are likely to be more receptive to new ideas and tuition.

On the other hand, a relevant internship gives candidates a practical impression of what is actually entailed in a quantitative role. It also speaks volumes about a candidate's enthusiasm for their intended role. If they have invested the time, effort and sometime money to gain and pursue an internship then they are very likely to be more committed to a new job. This has been clearly recognised by the major French Universities so that an on-site internship is a necessary part of finishing a post-graduate degree. In the current depressed markets many employers are looking for experience and an internship will allow a graduate to develop a firm amount of experience before being exposed to the employment market.

Programming Skills

More and more so are these becoming necessary in the banking environment. Models, once designed, have to be implemented into banking systems by code to be used by others. Often businesses will require small tools for one-off trades and unique situations which have to be coded up quickly. Programming code is the way that models move from theory and paper into practical usage. The most commonly used languages in the quantitative world are C++ and Visual Basic. The foremost reason is so that there is a common standard across the industry with which models are developed and implemented ensuring fair competition on pricing issues. Secondly, C++ is an object-orientated language allowing many users to link to a single model at the same time for differing purposes. Visual Basic is then used to design the interfaces that internal customers (the traders and sales force) and external customers (institutional client base) will use. Some banks, even prior to an interview process, will ask candidates to sit a C++ test and have benchmarked levels at which they will interview applicants.

It is worth investing time and effort in learning these languages if they are not an integral part of a degree course. Often academics use languages (Mathematica and Fortran) which are not used within banking. Certainly they will give students an appreciation of programming as a whole. However, it is not direct logic that just because one language has been mastered another will be just as easy. C++ is difficult and complex. It is generally considered to take around six months to pick up an effective level. It should be remembered that programming skills within the quantitative world are an effective tool,a means to an end but should not be considered an end in themselves unless one wants to work as a pure programmer.

3. Job Search and Interview Process

3.1 How To Go About Looking For A Role

For first degree and masters level graduates, the recruitment process is clearly demarcated. From October through to March, the majority of the larger banks and investment houses conduct a recruitment campaign on campus at the top Universities and MBA schools. Most smaller houses will also offer a structured recruitment process, albeit less wide ranging and often involving no interviews on campus. These campaigns are run by in-house recruitment specialists whose success is judged by filling the vacancies available in any year. Of course, the number of vacancies varies hugely with the cyclical stage of growth in the economy.

These schemes invariably offer one or two start dates annually, traditionally in early autumn and the New Year and entrants typically will undergo a rigorous training course involving lectures on a wide variety of relevant topics before embarking on up to two years of rotation across various areas of the business. After that time, most will then embark on a career in an area of preference (to both themselves and the Managers of that area).

Unfortunately, things are far less clear-cut when one looks at recruitment into quantitative positions. One of the reasons that the graduate campus recruitment campaigns work so well is they are effective and timely. Banks are looking for intellectual prowess, personality, strong work ethics and drive. In the UK and across most Western countries, university entry is a competitive process and certain institutions attract higher calibre individuals. Therefore a bank can go to a small number of universities and meet a disproportionately large number of the type of candidate they wish to hire. Quantitative recruitment is not so simple. Firstly, there is far less certainty of finding the right person at a certain university. Postgraduates have to be more practical and gravitate to funding and a professor who specialises in the field they wish to pursue their PhD in. Secondly, there are no guarantees a PhD student is going to leave academia regardless of how suitable he may be for a quantitative opportunity. This makes it less attractive to recruit such people as part of a large scale process. There are also far less hires into this area than, say, sales or trading as a quant can support a number of these individuals. Finally, PhDs finish their thesis at all points of the year, and they do not therefore easily fit into a set joining date. For banks seeking to recruit quants, a standard graduate entry level scheme is not an efficient process.

Therefore, the banks seek to source these types of candidate through other methods. For a PhD seeking entry into quant roles, it is crucial to identify these methods and to utilise them fully.

3.2 Recruitment Consultancies

A large proportion of vacancies are filled through recruitment consultancies putting forward registered candidates for interview. There are several specialist consultancies within this field with varying levels of access to vacancies. There are also several consultancies who are not specialists but who will occasionally advertise a quantitative vacancy. These latter firms tend neither to fully understand the position/market, nor to fully understand what would make a good potential candidate. It takes some effort to identify suitable consultancies to work with. One should research the relevant websites to find out how much work companies do in the field. It is also worth speaking to contacts in the industry and by making initial calls on an information-gathering basis.

Any reputable consultancy will look to meet you face to face before putting you forward to a vacancy. Remember that you are representing them to the bank as well as yourself. An initial meeting should give you an opportunity to find out more about the market, but also to get an honest assessment as to the strength of your candidature. Of course, it is not always possible to meet face to face, but at the least one should expect a lengthy telephone interview.

Following this meeting the consultant may recommend you to do further preparation before starting to apply for and interview at the appropriate vacancies, or they will accept you as a registered candidate who will be considered for any relevant positions.

3. Job Search and Interview Process

In certain market conditions, and for certain candidates, this can be a quick, rewarding and exciting process. At other times it can seem slow and frustrating. In these times you should look for a consultant who is able to give you honest, open feedback on your process – is it just the market or is your CV in some way not good enough? Establishing a good relationship with a consultant can be highly rewarding and they can end up managing a number of external career moves for you over the coming years.

Whilst consultants can occasionally be more proactive and market your CV to relevant clients, this requires both a strong relationship with the client and also a firm belief that you are a fit for that clients business. It is far more likely that a consultant will fit you to a specific need and therefore there are other approaches one can take to augment their service.

3.3 Industry Contacts

Industry contacts can take a wide ranging form – alumni, former colleagues, friends of ones professor. The quantitative finance world is a network of individuals working both in banking but also in academia and is far more collaborative than many areas in finance.

There is not an exact science to using this network, but one needs to approach the exercise with determination and also persistence. In some cases managers of research teams will actively seek applicants to contact them from the academic world, and will utilise their own contacts in these fields to source people. It is obvious that professors in quantitative finance will have industry contacts, but equally others will have seen former students move into the field.

This method can not only lead to interviews for roles that are not actively being sourced yet (and thus get ahead of the competition), but can also lead to making some excellent contacts in the industry.

3.4 The Internet

Banks are increasingly looking to source candidates direct via their websites and the internet is already a major strategic tool used by the recruitment industry.

Some institutions have well run and effective internal recruitment websites where managers are able to access good candidates effectively, however many others are not currently well run or vetted and one's CV can disappear into a database void. The biggest issue for institutions is coping with the volume of applicants and finding the good candidates when they only have a paper CV to go on. A CV, in contrast, received from a recruitment consultant and has been screened twice – once for its written content and once for the person behind the CV. Therefore one should be careful in one's reliance on applications via the internet, whilst appreciating it can be a useful augmentation to other job-searching methods.

3.5 What Are The Typical Processes?

The first thing to note is that there is no typical process. However any process is likely to involve at least two and as many as six visits to the institution, though for a junior hire, three is about normal. There are a number of tools that interviewers use in combination to determine the suitability of a candidate. Some are general interview techniques and methods, some are specific to the quantitative recruitment arena (These will be addressed more fully in section 4).

3. Job Search and Interview Process

3.6 How The Market Has Fared In The Last Three Years

There are two main factors behind the levels and areas of recruitment. One is product specific development, the second is the external environment – mainly economic and regulatory.

3.6a Product Specific Development

The derivatives world is becoming ever more complex. Now that OTC structured products are becoming common place and even exchange traded, the emphasis has been on creating new client solutions where a bank is able to offer a unique package, which they can maintain large margins on. Recruitment trends mirror the market, and therefore there has been an increasing demand in areas of new development. Three years ago, credit derivative quantitative research was the biggest growth area. Now there is growth in areas such as exotic FX, IRD/FX, IRD/Credit and EQD hybrid products.

Recruitment is also still occurring as a result of turnover of staff and even in areas such as Fixed Income which is very mature with many quantitative personnel.

3.6b External Environment

The general economic climate has been poor since the start of 2001 when the dotcom bubble burst and this has placed pressure on recruitment across the whole City. In many instances, a quantitative research team has needed to hire, but has been unable to do so because of firmwide recruitment freezes. One must be resigned to these periods, and remember that such conditions are cyclical. For the top quality candidate, the difference is perhaps in receiving one offer not four, for some less gifted people, it can be the difference between a banking career and no job at all. The market has turned in favour of the client, and there is tough competition for every vacancy.

The regulatory environment has influenced quantitative recruitment particularly in model validation areas where increased concerns over accurate pricing of complex trades and of the credit risk issues of traded products have meant banks have been forced to invest more heavily in developing strong teams. The Basle 2 accord, a centralised pan-European agreement across banking will increase regulation of financial institutions in terms of measuring credit risk. The underlying models to do this need to be developed by quantitative teams.

In summary, quantitative recruitment is less buoyant than 3 years ago, but has suffered far less than other areas of banking. This is largely because the teams are relatively lean compared to revenue generating groups, because the market is trading ever more complex products and also, as indicated above, because of external regulatory drivers.

That having been said there are less roles than applicants and now more than ever it is important to perform to the best of one's abilities at interview. In the the following section we have broken the interview process down into component parts and addressed the issue of how to prepare for each test, be it knowing the Company through to handling logic problems.

4. Preparing for Interview

It is vital that you approach interviews in the right way. Whether you are doing this via a recruitment consultancy or independently it will be evident very quickly to any interviewer and thus potential employer if you have not done sufficient preparation. There are a number of questions that need to be thought through to ensure thorough and complete preparation;

- **The Company** – Who am I applying to work for?

- **The Interviewer(s)** – Who are you meeting?

- **The Role** – What is it that you are applying for?

- **Key Attributes** – What skillset is the client asking for and how do these compare with your strengths and weaknesses?

- **Competitive Advantage** – How can I distinguish yourself from other candidates that they are likely to be meeting?

These questions may appear explicitly obvious but it is remarkable how often the smallest details are overlooked. It is worth being logical in your approach. Let's consider each in turn;

4.1 The Company

Clients will expect you to be as up to date as possible regarding the latest market and business developments. To achieve this you are recommended to spend time researching the company's website and corporate news releases.

In the past candidates have come unstuck in interviews by not knowing such facts as the company share price or latest merger developments. Of course you will not be expected to know everything but with very little effort it is easy to gain sufficient knowledge to prove to an interviewer that you've taken a specific interest in their company and have taken time and trouble to do some research. You will be surprised how informative websites can be!

4.2 The Interviewer(s)

If you are being represented by a recruitment company then it should be easy to enter an interview knowing at least a little about the background of the people you are meeting. The more you know the easier it will be to find common ground and establish empathy. You should try and be aware of the following;

- What is the person's level of seniority? i.e. what title do they hold?; how long have they been with the bank?; how have they progressed in their time with the organisation?

- What are they responsible for? i.e. do they manage a team?; how does their business interact with other areas of the business?

- What is their background? i.e. what is their level of education, what and where did they study? Knowing this information in one of the easiest ways of breaking the ice and establishing credibility with your interviewer.

- Will the interview be structured in a particular way? i.e. does the interviewer have a particular style or like to ask particular questions? (see Common Interview Questions)

4. Preparing for Interview

4.3 The Role

If a job specification has been provided then make sure that you have read it thoroughly. Often though a client will be seeking a particular profile and will not formalise their requirements on paper. In this situation if you do sufficient research into the people that you are meeting then by default you will have gained a suitable understanding of what the role will entail. Any additional information can be gained through the use of sensible questions (see Competitive Advantage)

4.4 Key Attributes

It is important to understand what the client is looking for – it will make it far easier to sell yourself effectively. The more you understand about the particular preferences of the client the better you can make your preparation and the focus of your answers at interview. Ultimately, this will allow you to come across more effectively.

Different companies approach issues in different ways and it is important to recognise this, e.g. one company may approach EQD pricing via use of Martingale methods and Stochastic Calculus, another bank may do it using historical pricing methods. Alternatively, one company may use VBA extensively to code, another C++. Understanding this would be fundamental to your suitability and would allow you to concentrate on selling your skills in this area.

4.5 Competitive Advantage

Currently, the market is very competitive. Clients are being extremely stringent regarding the attributes that candidates need to possess in order to enter the recruitment process. This starts with your CV but once you are invited to the interview you can definitely improve your chances of passing with some self-preparation

If clients are seeking a particular profile or specific skillset then it is sensible to assume that all the candidates that they will be meeting will share similar backgrounds. Thus over and above the areas that we have discussed, preparation should be geared towards distinguishing yourself from the competition. There are areas where the best candidates will be very prepared and these are indicated as follows;

4.5a Suggested Reading

Do background reading. You will gain an interview on the strength of your academic background but it is worth augmenting this with additional reading. There are several recognised texts whose content clients will generally focus on.

Options, Futures, and Other Derivatives
by John C. Hull
This text shows how academia and real-world practice have come together with a common respect and focus of theory and practice, and provides a unifying approach to the valuation of all derivatives. It assumes basic knowledge of finance, probability and statistics. This book bridges the gap between the theory and practice of derivatives. It provides a unifying approach to the valuation of all derivatives not just futures and options. It assumes that the reader has some knowledge of finance, probability and statistics.

Paul Wilmott on Quantitative Finance
by Paul Wilmott
Paul Wilmott on Quantitative Finance is an extensively updated and expanded edition of his earlier Derivatives: The Theory and Practice of Financial Engineering. The first third of this volume introduces classic financial and mathematical concepts, with the remaining two-thirds has recently been updated extensively.

4. Preparing for Interview

Introduction to Mathematics of Financial Derivatives
by Salih Neftci

Using an intuitive, systematic approach to the material, Salih Neftci introduces the mathematics underlying the pricing of derivatives. The interest in dynamic pricing models is increasing due to their applicability to practical situations. With the freeing of exchange, interest rates, and capital controls, the markets for derivative products have matured, and pricing models have become more accurate. An Introduction to the Mathematics of Financial Derivatives fills the needs of professionals PhD students, and advanced MBA students who are specifically interested in these financial products.

Interest Rate Option Models
Understanding, Analysing and Using Models from Exotic Interest-Rate Options
by Ricardo Rebonato

Interest Rate Option Models presents in a unified way the theoretical and practical issues involved in the use of models for pricing of exotic interest rate options. Despite the fact that relatively complex mathematical concepts are introduced and used in the book, financial intuition rather than mathematical rigour is emphasised throughout.

Pricing and Hedging Swaps
by Paul Miron and Philip Swannall

This book explains both the basic and advanced principles of pricing swaps and their hedge applications. Chapters describe pricing methods, swap valuation, dealing with interest rate exposure, developing trading strategies and their application in portfolio management.

Option Pricing, Interest Rates and Risk Management
by Elyes Jouini, Jaksa Cvitanic and Marek Musiela

This handbook presents the contemporary state of practice, method and understanding in the field of mathematical finance. The primary audiences for the book are doctoral students, researchers and practitioners who already have some basic knowledge of mathematical finance.

Financial Calculus
An Introduction to Derivative Pricing
by Martin Baxter and Andrew Rennie

This book is considered by many to be the first rigorous and accessible account of the mathematics behind the pricing, construction and hedging of derivative securities. Key concepts such as martingales, change of measure, and the Heath-Jarrow-Morton model are described with mathematical precision in a style tailored for market practitioners. Starting from discrete-time hedging on binary trees, continuous-time stock models (including the Black-Scholes) are developed. Practicalities are stressed, including examples from stock, currency and interest rate markets, all accompanied by graphical illustrations with realistic data.

Option Pricing
Black-Scholes Made Easy
by Jerry Marlow

In 1997, the Nobel Prize in Economics was awarded for the work that led to the development of Black-Scholes Options Pricing theory. Black-Scholes has become the dominant way of understanding and exploiting relationships among option prices, stock forecasts, and expected stock market volatility. Option Pricing: Black-Scholes Made Easy teaches you the fundamentals of option valuation and dramatically shortens the learning curve for mastering and applying the theory and its analytic capabilities. Here is a sophisticated way of thinking made available to those who do not have the background necessary to do Nobel Prize – winning mathematics.

4. Preparing for Interview

4.5b Questions

One of the easiest and most effective ways in which you are able to distinguish yourself quickly and at times effortlessly is in the quantity, and more importantly, quality of questions that you ask. It is very rare for an interview to finish without you being invited to ask questions – it is highly recommended that you have some!

In asking appropriate questions you prove to a potential employer that you;

• Have considered the role and function carefully

• Have a genuine interest in the opportunity

• Can digest and interpret information suitably

• Can communicate your thoughts effectively. One of the major attributes of any Middle or Front Office role is the ability to liaise effectively with senior management, trading staff etc. An interview process provides the first and decisive opportunity for you to prove this.

4.5c Presentation

Although most financial services companies have adopted and retained a "dress-down" policy it would be our strong recommendation that you wear a suit (dark – black or navy), shirt (white) and tie (smart and understated).

You should announce yourself to reception five minutes before the scheduled start of your interview. Small details can make a big difference, so be sure to stand to greet your interviewer(s) and introduce yourself confidently and with a firm handshake.

4.5d Handling Questions

Interviews for quantitative roles will be testing and are designed to be so. Interviews are designed to take you out of your comfort zone and to explore the boundaries of your knowledge – if it was simply a case of covering subjects you know intimately then neither party would learn anything.

You should therefore consider carefully the questions that are posed to you. There is no reason why answers should be instantaneous and interviewers will be surprised if this is the case. Take your time. Employers are often looking for more than the ability to regurgitate formula and proofs. They are generally searching for practical application of knowledge to new situations. One of the European Banks, when interviewing entry level quantitative researchers is known to like to introduce a technical idea that the applicant will not have covered before, such as an obscure type of derivative product. They will then develop the idea through the space of the interview and expect the applicant to take the lead in this thought experiment. Here they are looking for logical thought, the ability to progress an idea under pressure but most importantly the capacity to apply rules, theories and models to a completely unknown field. Successful applicants have been able to develop the idea and engage with the interviewer. In this situation being accurately able to regurgitate formulas was not going to be of much help.

More often than not getting the right answer is not the important thing. You are not expected to know everything (although a certain level of knowledge will be assumed). What clients are specifically interested in is how you go about solving problems. Many institutions like to introduce logic problems to observe this. Examples of these are included below. It is useful to have a pencil and paper in the pocket for this situation.

Sometimes people will be asked a question only to have the answer attacked and put under pressure. Here employers are looking for strength of character. Can you disagree with someone in an interview situation and explain why? Often on the trading floor quantitative researchers will have to explain why a deal is too risky or why it is going to take a loss in the face of much opposition from traders and salespeople. It is important to be able to stand by an opinion.

4. Preparing for Interview

4.5e Tests

Most interview processes will involve some form of testing. What you are tested on very much depends on the specific requirements of the job but will usually fall into 3 distinct catagories; namely systems, mathematical finance and logical reasoning.

Systems

A certain level of systems ability will be assumed of all candidates. In some cases VBA remains the prominent package, but progressively in model risk functions and certainly in front office functions C++ is used extensively.

Nearly all PhD graduates and most MSc graduates claim some level of proficiency in C++ but the difference between candidates can be broad and often clients find it better to set a competency test.

Regardless of how well you think you know the language, it is recommended that you revise your knowledge at least a little. You may find the following books and websites useful:

- C++ The Core Language
  Gregory Satir and Doug Brown
  O'Reilly & Associates (1995)

- Problem Solving with C++ – 4th Ed
  Addison Wesley
  WalterSavitch(2002)

- Big Java – Programming and Practices 1st Ed
  Cay Horstmann
  John Wiley & Sons

- http://msdn.microsoft.com/visualc/

- http://www.linuxselfhelp.com/HOWTO/C++Programming – HOWTO.html

Mathematical Finance

There are probably five keys areas in which clients will expect some understanding:

- General Mathematical Knowledge

- Applied Probability and Statistics

- Stochastic Processes and Martingales

- Financial Mathematics

- Numerical Analysis

These shouldn't be new topics to you but clearly individual candidates differ in their abilities. Some sample questions of the type that you may expect are listed below:

4. Preparing for Interview

Sample Questions

1. Briefly explain what you understand about the volatility smile and/or skew.

2. Why would you expect government bonds to have a lower yield to maturity than corporate bonds.

3. Briefly explain what you understand by the following terms as description of options

    (i) Asian
    (ii) Convertible
    (iii) Barrier
    (iv) Bermudan
    (v) Basket

4. Prove that the sum of the series $1, 2, ..., N$ is $\frac{1}{2} N (N + 1)$

5. A lighthouse is 1 mile from an infinitely long straight beach. The light beam rotates at 1 revolution per minute. With what speed does the beam move along the beach at a point on the beach three miles from the lighthouse.

6. Prove that $\sqrt{7}$ is irrational

7. A child rolls 2 dice, one at a time. What is the probability that he rolls two fives, given at least one of them is a five?

8. X is a normally distributed random variable with mean μ and variance σ^2. Evaluate $E(\exp(tX))$ where t is a constant.

9. State:
    (i) The cental limit theorem
    (ii) The law of large numbers

10. W is a standard Brownian Motion. Using Ito's Lemma find dX_t where X is defined as $X_t = \exp(W_t)$

11. Solve the following SDEs
    (i) $dX_t = \mu X_t dt + \sigma X_t d W_t$
    (ii) $dX_t = (\alpha - \beta X_t) d_t + \sigma dW_t$ [hint: consider $Y_t = \exp(\beta t) . X_t$]
    In each case find the mean an variance of Xt.

12. State, and briefly explain the importance of:
    (i) Girsanov Theorem
    (ii) The Martingale Representation theorem

13. Consider the one step binomial tree below:
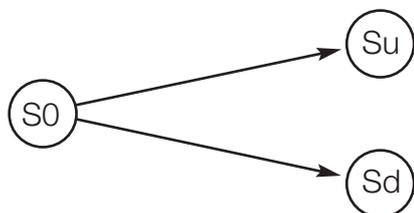
    Price a call option with strike K using this tree. The risk free interest rate on the money market account is r (continuously compounded).

    Please state all your assumptions and justify all the major steps in your argument.

4. Preparing for Interview

14. State the Black Scholes formula for the price of an American Call option on a non-dividend paying stock.

15. The implied volatility of a 1 year option is 20% and the implied volatility of a 2 year option on the same underlying is trading at 10%. Estimate the implied volatility of a one year option forward starting in 1 year.

    What would happen if the one year implied volatility jumped to 25%, but the two year implied volatilty stayed the same?

16. You are asked to implement one of two convertible bond models. Both are two factor models, one of them has a stochastic interest rate in addition to a stochastic equity price, and the other has a stochastic credit spread in addition to a stochastic equity price. Which model do you prefer to use and why?

17. You are asked to solve the generalised Black Scholes PDE by a finite difference method. Write down the finite difference approximations you would use for each of the partial derivatives, in the case of

    (i) An explicit method

    (ii) An implicit method

    Briefly describe which method you prefer and why.

18. Briefly explain what you understand by the following in relation to Monte Carlo simulation:

    (i) Antithetic Paths

    (ii) Control Variates

    (iii) Moment Matching

    (iv) Importance Sampling

19. Outline the general methodology used in the Gaussian Quadrature.

20. Briefly explain what you know about Quasi-Random sequences.

Sample Logic Questions

Often employers are looking for a combination of mathematical ability and logical, practical thought. Thus many interviewers will ask logic based questions to assess how you go about tackling different scenarios. Some popular examples are the following:

1. You are in a rowing boat on a lake. A large heavy rock is also in the boat. You heave the rock overboard. It sinks to the bottom of the lake. What happens to the water level in the lake? Does it rise, fall or stay the same?

2. You are playing a game on a large circular table. The game is played by two players, each in turn places a coin onto the table. The winner is the last person who is able to place a coin on the table (i.e. so one side of the coin touches the surface of the table entirely with no overlapping coins).

    You are given the choice to play first or second. Which do you choose? Why? What is your strategy to win the game? Do you think this strategy will be successful.

3. Estimate the number of lightbulbs in Greater London.

4. Two people play a game. In turn, each player says a number between 1 and 10 (inclusive). The accumulative score is recorded. The aim of the game is force your opponent to make the total equal to or above 60. As the player going first, what strategy should you adopt to enable you to guarantee a victory?

4. Preparing for Interview

5.   Two trains enter a tunnel 30 miles long travelling at 100 mph at the same time from opposite directions. As soon as they enter the tunnel a fly flying at 180 mph starts from one train and heads toward the other one. As soon as it reaches the other one it turns around and heads back toward the first, going back and forth between the trains until the trains pass in the middle of the tunnel. How far did the fly travel?

6.   You are provided 2 unequal lengths of rope and told that both take exactly 1 hour to burn from end to end, although they don't necessarily do so in a uniform fashion. How would you go about measuring an exact 15 minute period?

5. Conclusion

The Banking industry is an ever evolving, exciting environment within which to work. As Companies strive to grow market share and customer base new products and ideas are continually being tested and developed. Quantitative research lies close to the very heart of the industry, constructing, implementing, researching and testing the models and infrastructure which control and facilitate the business of banking. This is why it offers a stimulating career full of possibilities. It shares the best of the academic and business world – a truly intellectual role with a practical, business application.

In this guide we set out to apply some structure to the Banking industry and in particular quantitative research groups within it. We then attempted to define the variety of responsibilities such groups perform, how best to approach applying for such a career and how best to groom oneself for interview. However, there is no exact science or formula to gaining a job. Often a large amount of luck is involved. Interview processes can be completely fair and logical or entirely arbitrary. Equally the recruitment environment is as volatile as the traded markets as perceptions oscillate between the bullish and the bearish.

The very best we can hope to achieve from this guide is to allow you, the applicant, to gain a greater clarity of the quantitative world and as a result of following the advice herein to manipulate the odds in your favour in any interview situation.

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Appendices

1. Sample CV's

Below are enclosed fictional examples of how to lay out a CV to best present the relevant skills and background to potential employers. In the quantitative world CV's should be constructed to focus on specific areas that perhaps other banking roles would not require. Employers want to see examples of modelling skills, research papers that have been published, extra background reading in relevant areas and programming skills that have been fully mastered.

Curriculum Vitae 1

Name: Insert Name

Date of Birth: 3rd September 1977

Status: Single

Nationality: British

Residence: Oxford

Relocate: Yes, London and New York

Education: **1999-2003**
                      British University
                      PhD Theoretical Physics
                      Thesis; Enter Title

                      1995-1999
                      British University
                      MSc Physics – 1st
                      Project; Designed and built a laser system (for example).

                      1988-1995
                      Grammar School
                      4 A Levels
                      Physics   A
                      Mathematics   A
                      Further Mathematics   A
                      Greek   A

Current Employer: Post-Graduate – British University

Computer Skills: C/C++ (4yrs experience), Visual Basic (6 yrs experience), Fortran, Mathematica, Microsoft Applix

Appendices

Work Experience:

June-August 2000
Funded by the Royal Society of Physicists to write a paper.

June – August 1999
Funded by the Wellcome Trust to create an improved electronic detection system for ion traps.

Recent Publications

- Title of publication I, authors, journal published in and date published

- Title of publication II, authors, journal published in and date published

- Title of publication III, authors, journal published in and date published

Relevant Experience & Skillsets

- Programming experience in C++ (object orientated) and Visual Basic (for applications and interface design)
- Familiarity with MAC/NT/Linux Operating Systems

- Basic understanding of OTC Derivatives: Pricing methodologies, Black-Scholes, Trade Operations (FO/MO/BO functions)

Reading

- Options, Futures & Other Derivatives – J.Hull

- Financial Calculus; An Introduction To Derivative Pricing – M. Baxter & A.Rennie

- Arbitrage Theory In Continuous Time – T.Bjork

Commentary

This is a strong CV for a position within a model validation group and possibly even for a front office position. The candidate has a high level of academic achievement and has clearly been respected in their field with a number of publications and research sponsored by the Royal Society. If their summers had not been spent on research projects We would expect to see either internship experience or some other relevant from of work experience. Their academic ability is complimented by practical programming skills and they show their interest in the financial world by the kind of background reading they have done. It is worth noting that reading should only be included if one can answer specific questions on it such as 'can you derive Black Scholes from first principles' or 'what are Baxter' & Rennie's views on term structure modelling.' Some front office groups would be interested in this profile. However others would want either a further degree in Financial Mathematics (probably a Masters) or relevant banking internship experience on a trading desk.

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Curriculum Vitae 2

Name: Insert Name

Date of Birth: 3rd September 1977

Status: Single

Nationality: French

Residence: Paris

Relocate: Yes, London, Amsterdam

Education: **2001-2002**
French University
DEA Probabilities & Finance – with Honours
Thesis; Study of markov functional models (for example).
Internship French Bank

1998-2001
French Engineering School
MSc Mathematical & Mechanical
Modelling
License & Maitrise in Applied
Mathematics
Internship French Bank

1995-1998
Classes Preparatoires aux Grandes Ecoles
Major in Mathematics & Physics

Computer Skills: Windows NT, Unix, C#, C, C++, Fortran, VBA, Matlab, LaTex, Excel,

Work Experience

April-September 2002   **French Bank**

Fixed Income Research Team

Main area of research focussed on the study of Markov Functional Models. Other responsibilities included;

- Implementation of Libor and Swap Models,

- Application to Flexible Caps/Floors and Bermudan Swaptions,

- Forward Volatility Analysis

- Financial Modelling – Stochastic Calculus

- Numerical Methods (Tree and Finite Differences)

Appendices

February-August 2001   **French Bank**

Fixed Income Research & Strategy Team

Study of Heston's Stochastic Volatility Model

- Analysis of resulting PDE,

- Implementation of a PDE solver using C++

- Analysis of algebra template libraries. PDE Analysis – 2D Finite Difference Method

- Mesh Analysis – C++

June-October 2000   **International Energy Firm**

Research & Development Team

Study of Numerical Error Propagation in a CFD code

Commentary

This CV would be more orientated towards an entry level position within the front office. The candidate has geared their education towards applied and financial mathematics. As part of this they have gained two internships based on trading desks learning the kind of models they use and the necessary practical tools that need to be developed and coded. They clearly have good programming skills to support their mathematical ability and have implemented models in code not just in banks but also within industry.

Appendices

Salary Survey

The following table outlines the average salaries and bonuses paid at all levels of seniority within quantitative research. There will of course be exceptions and at the senior level it is worth remembering that compensation is heavily linked to performance. These are only guidelines.

	Front Office Research		Middle Office Research	
Level Of Seniority	Basic Salary (£ 000)	Bonus %	Basic Salary (£ 000)	Bonus %
Entry Level	35-60	30-50	30-40	20-30
2 yrs Experience	45-75	50-100	35-50	30-40
3-5 yrs Experience	60-100	75-150	50-80	40-80
5 yrs +	100+	100-1000	80+	60-100

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