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Principles of quantitative development

MANOJ THULASIDAS

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Preface

Times have changed. Not long ago, all that you needed for a successful career in the financial industry were good people skills, and modest arithmetic and accounting abilities. The derivatives market requiring advanced quantitative (or computing) skills used to be miniscule. Now, with the explosive growth of derivatives, those simple times are gone for good. Derivatives and structures have taken the centre stage in recent years.

The world of trading and structuring today relies heavily on mathematical models and sophisticated computational techniques. In order to stay competitive, financial institutions need quantitative talent now. They cannot expect their bankers, specialized professionals themselves, to be adept in other professional domains like computer science and applied mathematics as well. Banks, therefore, import talent from other unorthodox domains. They find a helping hand among physicists and mathematicians who can model and price complex derivatives. They also employ a small army of computer scientists and programmers to deploy the pricing models in systems and platforms that help their traders make money.

This development has created a knowledge gap between the conventional banking staff and the newcomers. Bankers and regulators do not fully understand what the quantitative professionals are up to. The professionals themselves have very little appreciation for how the business side of the financial institution works. Bridging this gap is one of my objectives in embarking on this work.

Coming from a quantitative professional's perspective, I may have tilted this book a bit in our favour. That bias notwithstanding, I feel that it is important for 'quants' (the mathematicians who develop pricing models) and 'quantitative developers' (computer scientists who deploy the models) to understand and appreciate the business aspects of trading so that our efforts may be as fruitful as possible. Once, one of our top traders pointed out that even the most intelligent pricing model is useless unless it can be deployed effęctively and in a timely manner. Effective deployment crucially depends on our appreciation of the 'Big Picture'.

Most quantitative professionals, especially at junior levels, are indifferent to the Big Picture. They think of it as a distraction from their real work of taming stochastic differential equations and writing programs. Through this book, I hope to change their mindset to some degree.

However, the scope of the book is bigger than the world of quantitative professionals. There is a flip side to our reluctance fully to appreciate the rest of the value chain. It is the inability of other business groups to realize what is possible and desirable in the quant world or in a trading system. Every business group in a bank is so specialized and requires skills and focus so specific to their duties that they all end up being distinct silos of knowledge. The professionals in other business units, especially in the middle office, will benefit from this book, in being able to formulate their requirements within the realms of feasibility. More than that, they will also gain an insight into how the quantitative work is done and how a mathematical model finally becomes profit-generating systems.

Another group of professionals who are supposed to know everything this book has to say are business analysts whose job it is to interface business needs to systems development. They usually work for technology consultancy firms and talk to their banking clients in order to come up with solutions specifically targeted to the needs of trading, financial computing and risk management. However, their existence is not confined to the technology side of the value chain. Some business associates and analysts work in financial institutions, translating internal business requirements to quantitative development objectives and rolling out new products and processes. These professionals will find this book invaluable as well.

When we change our narrow, albeit efficient, focus on the work at hand to an understanding of our role and value in the organization, we will be able to leverage off each other's work and enhance the overall productivity by leaps and bounds. This big picture view is especially relevant in the current climate (2008–2009) of financial turmoil and in our efforts to avoid or mitigate similar crises in the future. Of the many causes behind the turmoil that we see clearly with the benefit of hindsight, one that this book addresses is the general lack of a high-level understanding of the whole trading process. For instance, most quants, who are often blamed for the hole in which we find ourselves, do not fully appreciate the processes and methodology in managing the credit and market risks, or the interplay between them. Most professionals who manage credit and market risks do not quite understand the risk profiles straddling these two classes of risks that they manage independently of each other. Yet, this deficiency in understanding is neither deliberate nor premeditated. It is a natural consequence of the silo-like concentration and focus, which this book aims to change. In setting its sight at this holistic picture, this book indeed starts with an ambitious goal, but a timely one.

Manoj Thulasidas
Singapore

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Introduction

Purpose-built trading platforms have become indispensable tools for exotic trading in most modern banks. One reason for their success and prevalence is that exotics and structured products business is highly lucrative to a financial institution. One prerequisite for success in exotic business is the ability to price the products. For pricing model development and hedging or risk analysis, the financial institution can resort to its mathematicians and the quantitative models they develop.

Another vitally important prerequisite is the capability to assess and manage the associated risks. The risks arising from market movements are related to pricing and are managed through sensitivity analyses. However, in order to manage credit and operational risks, especially when the business volume grows, banks need robust trading platforms supporting and augmenting the mathematical effort.

A carefully designed and deployed trading platform can easily recuperate its development costs within a few short months of going live, and turn into an important profit centre for banks. Once they started appreciating the necessity and profitability of an in-house trading system, banks and other financial institutions began to invest resources into developing in-house trading systems.

Resource allocation attracts professionals with highly specialized skills to move into the field. However, their skills, at times, work against them. They think of quantitative development as a purely technical endeavour. Although, at its heart, trading platform development is a technical challenge, it is the myriad of business processes around it that will eventually make or break its viability. The proverbial devil is really in the details.

1.1 WHAT IS A TRADING PLATFORM?

The goal of this book is to help design a robust, durable and reliable trading platform. The first question then is: What exactly is a trading platform (or system)? For our purpose in this book, I define it as a program or a collection of programs that meets the following broad requirements.

1.1.1 Model archival

One of the problems that the quantitative analysis effort in any modern bank faces is the archival and reuse of their pricing models. A trading platform acts as a repository for the quantitative intelligence generated within the bank. A model developed for a particular product is all too often so specialized that it is difficult to deploy it to tackle another product. This lack of reusability results in duplicated effort. A well-designed trading platform can help by imposing the right quantum of structure and standards to encourage generic programming and to enforce reusability. Furthermore, it will hold all the pricing models with standardized interfaces in one place where they can be found, examined and reused.

1.1.2 Incremental deployability

A trading platform should provide means by which the new quantitative models developed or implemented in the bank can be easily integrated and deployed into the revenue generating work streams of the bank. In other words, even after the trading platform is commissioned, as new and innovative products are developed by the mathematicians and structurers, we should be in a position to augment our system to make use of the innovation. This requirement of incremental deployability drives the whole architecture and design of the trading platform, as you will see in later chapters. It also imposes the necessary rigidity in the form in which quantitative analysts deliver their pricing models, facilitating the first requirement.

1.1.3 Live data feeds

A trading platform should talk to the external world to obtain market data (either as live feeds or as snapshots at regular intervals) and archive snapshots of market conditions for bulk processing. Market data feeds reach the trading platform from several data providers who use dissimilar, and often incompatible, technologies and interfaces. For this reason, the market data handling may become another auxiliary project in its own right, providing a uniform interface to the trading platform regardless of the origin of the data provided. This market data project often has its own database back-end for data persistence.

1.1.4 Trade persistence

A trading platform should be able to save trade data into a database and manage all the associated inception and life-cycle events. The database layer of a trading platform has many stringent requirements on security, performance and record-keeping integrity. It should be capable of handling the inception events such as cancellation, cancel and amend, reissue, novation (changing the ownership) etc., consistent with the policies of the financial institution. A cancellation, for instance, is never a database operation of deleting a record, for a complete deletion would erase the necessary audit trails. In addition, the database layer may reside in geographically dispersed locations, and the trading platform may be called upon to provide data replication services that can be challenging when the trade volumes grow.

1.1.5 Regular processing

A trading platform should facilitate and mediate all aspects of regular downstream processing, such as risk management, trade transformation, settlements, etc. This requirement, although summarized in one bullet point, is very vast in its scope, as you will appreciate by the time you finish this book.

It is instructive to benchmark a vended system (such as the trading system currently in use in your bank) against these requirements. All vended systems do an admirable job in meeting the last two requirements. However, they fail miserably in the first two. In fact, the pricing models implemented in vended solutions are the principal intellectual properties that the vendors jealously guard. They have no incentive in facilitating easy deployment of in-house custom models using their trading systems.

The pricing tool that comes with this book is near the other extreme: it implements the first two requirements wonderfully. Using the pricing tool, you can define and deploy new models without even recompiling the core program. However, it has no market data feeds, not even a clear notion of a market, and it does not provide a database layer. The only data persistence it offers comes in the form of XML files that store pricing scenarios.

Most in-house trading platforms find their place in between these two extremes. They do not try to handle every aspect of trade life-cycle management, but they are far more than the prototyping or proof-of-concept pricing programs that the mathematical brains of the bank generate. Depending on the implementation strategy of a particular bank, the in-house trading platform may end up focusing on different aspects of the requirements listed above. In all cases, however, an in-house trading platform attempts to bridge the gap between quantitative pricing models and a deployed and supported system out of which the bank can generate profit. Its emergence has engendered the relatively new domain of *quantitative development*. Trading platforms are the domain of the quantitative developers (computer scientists who deploy the models) in the bank, who are distinct from the so-called 'quants' (mathematicians who develop pricing models).

1.2 QUANTS AND QUANTITATIVE DEVELOPERS

The term 'quant' is short for quantitative analyst. They are mathematicians who develop pricing models and keep abreast with the cutting edge research on stochastic calculus and quantitative finance. They transform the academic knowledge they assimilate into programs that can generate revenue and profit. Quants usually have an advanced degree in mathematics, physics or other quantitative fields. Ideally, quants have a sound knowledge of markets, business and products, as well as computer science.

The input to quants' work is research and the academia. Their outputs are pricing models, often delivered as programs or functions in a library, aptly called the quant library. They may also deliver standalone pricing programs, usually as spreadsheets and add-ins.

Quantitative developers are computing professionals who make the output from the quants widely usable, often through the in-house trading platform. Their functional duties fall in between the quant output and the programs used at trading desks. Ideally, quantitative developers would have the same skill set as the quants (mathematical aptitude, product/business knowledge and computer science), but with less emphasis on mathematics and much more focus on computing and software engineering. How separated quants and quantitative developers are in terms of job functions and organizational hierarchies depends on the human resourcing strategies of the bank.

In our discussions in this book, we will assume a clean separation between the duties of quants and quantitative developers. The developers start their work from the quant library, the fruits of the quant's labour. The end point of their work is an in-house trading platform and other maintainable quantitative tools.

1.3 NEED FOR SPEED

In today's financial markets, opportunities are transient. The skyrocketing commodity prices of early 2008, for instance, generated a strong demand for cost-effective hedging. Banks that could roll out structured products to meet customized hedging requirements reaped handsome benefits from this demand. Hedging essentially caps the customer's upside exposure while subjecting them to unlimited downside risks. Because of the dizzying fall in commodity prices (especially in energy) that soon followed during the second half of 2008, the banks that could provide the hedging structures again made even more profit. Rolling out such hedging solutions on short notice to benefit from the market fluctuations of this kind necessarily calls for the agility and flexibility that only an in-house trading system can provide.

Due to such enticing profit potential, an increasing amount of assets under management gets earmarked for exotics trading. In fact, this influx of institutional investments was at least partly to blame for the wild fluctuations in commodity prices. However, the influx also underscores the importance of exotic and structured products. Coupled with this emphasis on exotics trading is the increasing sophistication of the clients who demand customized structures reflecting their risk appetite and market views.

The net result of the changing financial market attitude is the need for more mathematical modelling and speedier deployment than ever before. The need for speed, in fact, goes beyond exotics business. In spot FX trading, the time scale of profit making opportunities is measured in seconds or milliseconds. The so-called