TopQuants Newsletter

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Editorial

Dear Reader,

The TopQuants team is pleased to present the first issue of our newsletter. We intend to publish the newsletter semi-annually from now onwards. As with all our efforts, it is intended to serve the quant community in the Netherlands. We would like to stay in touch with you, keep you posted between our two events, namely the spring keynote and the autumn/ winter workshops.

In the newsletter, you can expect to find news relevant to the quant community, technical articles, and additional information on recent events as well as announcements of future events. We hope that this matches with your interests. But the newsletter is also what you make of it! We are open to your suggestions, and are looking forward to receiving your comments and contributions. If there is a topic you would like to bring to the attention of your fellow quants in this country, why not write an article about it for this newsletter? Please contact us to discuss how it may be done.

This issue of the newsletter starts with an interview we have recently conducted with SNS, the main sponsor of our upcoming keynote event in May 2013. A "save-the-date" email for this event will follow soon. The newsletter also includes summaries of all the parallel sessions held at the 2012 TopQuants autumn workshop – handy if you want to refresh your memory of the session you have attended or find out about all those interesting sessions you could not attend personally. Note that in some summaries we have also included updates, i.e. recent research developments from the speaker after the event.

This issue also features two technical articles. In the first article, Cyril Schmidt from the Quantitative Trading Risk Analytics Group in ABN AMRO discusses the personal experiences of his team with GPU programming, its benefits and the issues they encountered. In another joint article, Eric Beutner, Antoon Pelsser and Janina Schweizer from the Department of Quantitative Economics, Maastricht University, present a novel analytical framework for statically replicating contingent claims through orthonormal basis functions, in the context of insurance liabilities. Antoon is of course well-known to regular attendees of TopQuants events as the key note speaker of 2012.

We hope you will enjoy reading this newsletter and we look forward to seeing you at the upcoming TopQuants event(s).

Aneesh Venkatraman

(on behalf of TopQuants)

TopQuants interview with SNS REAAL

The upcoming TopQuants keynote event in May 2013 will be sponsored by SNS, a Dutch financial institution in insurance and banking. What is the motivation for SNS to sponsor our event ? What are the modelling questions currently ranging highest on the priority list of SNS? What opportunities does SNS provide to Quants as a potential employer? TopQuants have conducted an interview with Pim Poppe (Director Group Risk Management) and Ronald Lukassen (Head of Insurance Risk Management) at the SNS headquarters to find out.

TQ: SNS has been advertising several vacancies for quantitative professionals recently. Why does the company have such an appetite for quants?

PP: As a combination of insurer and bank, we are subject to Solvency II as well as Basel II and Basel III. The workload is increasing and it is also fair to say that we had accumulated somewhat of a backlog in modelling due to cost cutting over recent years. Moreover, the focus of the Dutch Central Bank

(DNB) around governance surrounding the modelling and data for insurance companies is subject to increase in the future which puts SNS higher on their radar.

TQ: This seems to indicate that your modelling efforts are largely driven by regulatory demands.

PP: No, that is not the case. In several areas, our model advances are clearly not driven by regulatory requirements, but go way beyond the minimum required by the regulator. Examples for this are our Economic Capital methodologies, how we model the impact of interest rates on insurance products, and the sophistication of our ALM approaches.

TQ: How is quant work organized at SNS?

PP: We have two main quant teams within our organization. There is a centralized Model development team which serves both the Business and the Group Risk Management. We additionally have a Model Validation team.

TQ: Does this not lead to conflicts of interests or priorities, if the Modelling team serves two masters?

PP (smiling): Such clashes of interest are not always avoidable. But when they occur, the departments involved can usually agree on prioritizing the conflicting requests. On the whole, our experiences with organizing this Modelling team as a service center embedded within Group Risk Management are very positive. Prior to that, there were several modelling teams having just one or two quants. This led to quant knowledge and expertise being quite fragmented throughout the organization. Bundling the efforts in a centralized modelling unit provides continuity, facilitates knowledge transfer and leads to economies of scale. For instance, scenario generators can be applied in different contexts, computational challenges often being similar for various applications can now be dealt with only once.

TQ: What modelling challenges are high on your priority list at present?

RL: I see a continuously increasing demand for fast, auditable information in financial companies, but in particular in insurance. We have made important advances on this by utilizing analytical solutions in the valuation of embedded options. Many of our insurance products contain such embedded options.

PP: The embedded options can also serve as an illustrative example for the specific skill set our quants need to have. They should be familiar with advanced option pricing theory but also with our insurance product portfolio. This combination is difficult to find in the market. Hiring juniors fresh from university and training them internally is an integral part of our HR strategy.

TQ: A significant part of the quant community in the Netherlands consists of expats. Among these, SNS has the reputation to be a fairly Dutch organization with language of communication being mostly Dutch. Has this been a hindrance in hiring?

PP: There is some truth in that. Our language of communication, both spoken and written, is indeed Dutch. The language is thus an important criterion for us when talking to applicants. We have recently had two international joiners (China and Norway), but they are already quite familiar with the Dutch language and we provide them with the opportunity to enhance it. I estimate our expat percentage at below 5%.

TQ: Let us come back to the modelling challenges. At the first TopQuants event, our key note speaker Jan Sijbrands emphasized that the different risk types should not be confined to separate silos within an organization, but that they should be looked at in combination. Another recent speaker, Antoon Pelsser, focussed on long maturities and related uncertainties in discounting. Does SNS subscribe to the silo view or does it follow a more integral approach?

PP: Some risk types are in more obvious need for a combined approach than others. In ALM, we look at credit risk and interest rate risk, including spread risk, in an integral manner. Longevity and interest rate risk in combination are key to a sound risk management of several insurance products. The interplay between credit risk and refinancing risk is important in property finance. In general, I believe that one often achieves good oversight by strategically bundling certain risk types and monitoring them separately on a daily basis.

RL: Yes, in particular low interest rate levels in combination with longevity are challenging to capture properly in insurance modelling. Often we have to admit to ourselves that our models are subject to significant uncertainties in particular scenarios. But even if such scenarios are hard to model, they must be on the radar of risk management! Models must not be used blindly, but in combination with common sense. The introduction of Solvency II, capital requirements and the market valuation of liabilities introduce sensitivities and interaction between risks that are far more difficult to follow for the senior board than it used to be.

TQ: What is your view on the Fundamental Review of the Trading book?

PP: This is of only limited relevance

for the type of business that we are running at SNS.

TQ: What is high on your agenda then?

PP: Certainly the accessibility and transparency of models and model output to the non-quant, in particular to senior management. Exaggerating a bit, you could say that there is a conflict of interest between the increasing sophistication of models on the one hand and the need to make the model results intelligible to higher management. One example is the increasing volatility of capital requirements, resulting from more volatility in the input market data but also from the more dynamic character of our present models. If you report such volatile results to management, you need to be able to explain them very well, also in an intuitive way.

TQ: What do you do to achieve this at SNS and what is the feedback from the senior management?

PP: We accompany every model proposal or documentation with a two-page, leaflet-style summary for senior management. We call this the *financiele bijsluiter* or package insert. This is deliberately the same term as used in the Netherlands for the leaflet accompanying any financial product marketed to the private consumer, informing him in layman's terms about the specifications and risks. We do our best to write accessible summaries free of quant jargon. This is well received by senior management, although they sometimes reply that it's still too technical.

RL: We have also made positive experiences with tailor-made training sessions for management, for instance on topics such as scenario generators and credit risk. Managers do not have to become model experts, but nowadays they want to understand at least to some extent what happens under the car's bonnet.

TQ: How about liquidity risk?

PP: This is one of the most challenging risk types to model. Back-testing your liquidity models is even more difficult, although recent events provided us at SNS with this unusual opportunity. Even if you do not have the perfect model, you should reflect in your modelling some common sense facts. For instance, deposits above 100k definitely require a higher liquidity buffer due to the threshold in the Dutch guarantee scheme, but quantifying this is far from easy.

TQ: We acknowledge your willingness to sponsor the TopQuants event. What would be your main interest in this?

PP: We would like to convey the presence of SNS with regard to the labor market for TopQuants. Also, we would like to contribute to an event for the quant community in the Netherlands, from which also our quants at SNS can benefit.

TQ: How has the recent change of ownership affected the modelling work at SNS?

PP: Content-wise not much. At least there is some clarity now, which has made the hiring somewhat easier. Also, I think that after the very hectic past year with a lot of focus on urgent, short-term efforts, we now have more capacity to work on more long-term topics. More balance between the urgent and the important will be appreciated by those quants who enjoy delving deep into models.

TQ: Are there any other topics you feel we should have touched on in our conversation?

PP: Let me emphasize again that we need to find the right balance between the quantifiable and the unquantifiable. Quants do and should love their models, but they should also be humble about their limitations. I am looking forward to the TopQuants event and hope it will provide a stimulating input not only for our SNS colleagues joining it, but for all participants.

TQ: We thank you for this interview.

The interview was conducted by Diederik Fokkema, Aneesh Venkatraman, and Tim Mexner for TopQuants.

Disclaimer

Analytical Credit VAR

- based on talk by Mikhail Voropaev (ING)

Credit Economic Capital (EC) calculation and allocation by use of industry standard Monte-Carlo simulation tools can be computationally intensive and time consuming. In this regard, the main focus of the speaker, Mikhail Voropaev, was to present an analytical framework that allows for fast and accurate computations for multi-factor structural credit portfolio models. The techniques will be of interest to financial institutions that use these models for internal capital adequacy assessment, external reporting, risk-based pricing, performance management, acquisition/divestiture analyses, stress-testing, scenario analysis, etc. Most importantly, the framework serves as a viable alternative to Monte-Carlo simulations. According to the speaker, an important modelling challenge faced by financial institutions is in the area of risk-based real-time loan pricing and fast calculations are important in the current market because of the ever increasing regulations. It was also acknowledged by the speaker that it can lead to a competitive advantage. Further, the complex structure of the credit portfolio models can lead to difficulty in understanding by end users and thereby affect their acceptance within the organization. The speaker highlighted the background and the main mathematical features governing his so-called *KISS (Keep it Simple and Straightforward) VAR model* for credit portfolio modelling which is fast, relatively simple and robust. The speaker has a working paper "*KISS Approach to Credit Portfolio Modeling*" which describes the analytical technique in detail and demonstrates the accuracy of the technique by benchmarking against Monte Carlo simulation method. The personal findings by the speaker are that, Monte-Carlo simulations are rather slow in comparison to his proposed analytical tool which is robust, simpler and has a reasonable accuracy level that is sufficient for many practical purposes.

The talk was followed by several interesting questions from the audience. Firstly, the possibility of applying the proposed analytical VAR framework for Expected Shortfall was asked to which the speaker answered in positive. In this respect, a related paper "*An analytical framework for credit portfolio risk measures*", published by the speaker in the Risk Magazine can be referred which describes the building of an analytical framework for calculating VAR and expected shortfall for credit-risk portfolios. The analytical model assumes a normal distribution while a possible extension for non-normal distributions was asked to which the speaker's opinion was that it will not work.

The talk was very interesting and the speaker enjoyed explaining the mathematical details to the audience who were equally enthusiastic in their participation and had challenged the speaker's assumptions during the talk. The speaker indicated that he has done most of this research as an aside from his job and had it been a PhD study he would have run more tests! Upon asking whether ING is planning to use the proposed technique, the prompt reply from the speaker was that he would indeed employ the model had he been in charge of credit EC modeling.

— summarized by

Aneesh Venkatraman

"Monte-Carlo simulations are rather slow in comparison to the KISS VAR model tool which is robust, simpler and has a reasonable accuracy level that is sufficient for many practical purposes."

— Mikhail Voropaev

Market impressions on counterparty credit risk: from CVA over IMM to FVA

- based on talk by Frank de Jonghe & Siobhan Tipping (Ernst & Young)

Determining the fair value of derivative contracts has become one of the key issues in the banking industry following the financial crisis in 2008, where assumptions that were assumed to be true in the pre-crisis period are now losing their validity. Fur-

ther, the new valuation adjustment based charges under Basel-iii and stricter accounting standards by IFRS on fair value measurement puts additional pressure on banks to reconsider their approach for managing counterparty risk on their trading book. With regard to this, Ernst & Young had recently conducted a survey amongst 19 of the most sophisticated dealing houses applying either IFRS or US GAAP standards on the usage of CVA (Credit Value Adjustment), DVA (Debit Value Adjustment, OIS curves and FVA (Funding Value Adjustment**).** The speakers, Frank de Jonghe and Siobhan Tipping presented the results of this study by E&Y in their talk.

The speakers covered a wide spectrum of topics which included, recording of CVA, DVA and OCA by banks and the use of market vs historical credit spread data for computing default probabilities, methods to compute loss given default, contingent vs non-contingent approach for calculating credit/debit adjustments, collateral calculations, treatment of wrong-way risk and break clauses, accounting vs regulatory treatment of CVA vs DVA, FVA for uncollateralized deals, hedging of CVA/DVA and associated risks, governance around CVA desks in banks etc. The talk highlighted the differences in the approach and understanding by banks with regard to valuation of their derivative contracts and the bank's reasoning for adopting those particular choices. For e.g. CVA is used by all 19 banks in the survey, DVA by 13 banks. The remaining 6 banks do not use DVA because of various reasons including the difficulty in monetizing DVA, because it is viewed as conceptually counterintuitive, or because of objections to using specific market data. The speakers stressed on the relevance of the topic as the new Basel regulations demand DVA calculations to be made explicit in order to correct regulatory capital (currently estimated to be relevant as of Jan 2014 due to the delay in CRD IV).

The talk was lively, well presented and a good interaction followed with the audience. An interesting discussion was around the difficulties faced by banks in hedging DVA as it would, in principle, involve executing CDS in their own names which is tricky. This essentially would imply using proxies or indices that might lead to increased systemic risk across the banking system. Some key issues were identified from the talk like different banks having a different understanding of the cost of capital and this depends on how they are engineering the position. The results of the survey was depicted using illustrative graphs and a handout/ brochure was provided for all the attendees.

— summarized by

Aneesh Venkatraman

"Funding costs do not impact the valuation of derivatives in a Black Scholes framework under the elastic funding assumption"

—- Bert-Jan Nauta

Funding Value Adjustment: Real or Imaginary ??

- based on talk by Bert-Jan Nauta (Double Effect)

The concept of Funding Value Adjustment (FVA) with regard to Derivative Pricing has become a heated debate since the start of the Financial crisis in 2008 as many banks could no longer borrow at the risk-free rate. The speaker, Bert-Jan Nauta, presents two contrasting assumptions on the bank's funding costs which would eventually lead to either the inclusion or exclusion of FVA in the valuation of derivatives. The talk was aimed at understanding both the assumptions and providing pros and cons for both.

The speaker began the talk by showing an interesting poll that was conducted on the Risk magazine website, which revealed an opinion split on FVA with the practitioners being in favor of inclusion of FVA in derivative pricing and academicians (mostly) arguing against it. FVA is an adjustment to the value of derivatives that comes from the observation that a (typical) bank cannot borrow unsecured at the risk free rate. Therefore the valuation of a derivative, which involves discounting the cash flows, should include the funding costs of

these cash flows. In the literature, it is usually assumed that the bank's funding costs are fixed which is referred as the inelastic funding assumption. However a different assumption, that the funding costs react to the quality of assets in the banking book seems more realistic. A strong version of the latter is the elastic funding assumption where funding costs immediately react to changes in the asset composition in the balance sheet. The speaker showed by novel arguments that FVA does not impact the valuation of derivatives in a Black Scholes framework under the elastic funding assumption.

The talk was well received by the audience and there was a lively discussion with questions during and after the presentation. One view point was that, the elastic funding assumption would provide better incentives for trading as it leads to no FVA. However, the assumption was also challenged on certain aspects like the continuous adjustment of the bank's funding costs based on the riskiness of assets in the balance sheet, which may not happen in practice as the investor would have to be aware of every new risky asset and a bank's funding costs eventually depends on the investor's perception of the risk carried by the bank. Another topic of discussion was the implications of these assumptions for collateralized trades. The speaker provided convincing answers to all the questions and the general consensus was that reality lies somewhere in between the extremes of elastic and inelastic funding assumptions.

The technical details of the presentation can be found in the paper, "On funding costs and valuation of derivatives" by the speaker. Some of the discussions during the workshop have inspired parts of a new paper by the speaker, "Liquidity Risk, instead of Funding Costs, leads to a valuation adjustment for Derivatives and other Assets" on the subject of funding costs. The presentation ended with an open voting from the audience with regard to FVA. The majority were in favor of not having an FVA which was also the opinion of the speaker.

— summarized by Bert-Jan Nauta and Aneesh Venkatraman

"Our recently obtained constructions of no-arbitrage term structures yield rate dynamics of Vasicek-type. The rates thus constructed keep their tractability but avoid the failures of the latter model in complying with stylized facts such as mean-reversion and positivity"
— M.H.G. Schroeder

Mechanisms for no-arbitrage term-structure modelling, with applications to interest-rates and realized variance

- based on talk by M.H.G. Schroeder (LSE)

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

A sudden reversal of ECB policy could have a potential impact on the positions of banks and if there is a continued rise in volatility caused due to this, it becomes a challenging aspect to quantify the same. In this regard, the speaker, Michael H.G. Schroeder, discusses a novel way to model market volatility for interest rates via mechanisms for no-arbitrage term-structure modelization.

The presentation was very well structured and particularly appealing to the hard-core quant audience. The speaker followed a phased approach, beginning from no-arbitrage dynamics for forward rates, thereby passing on to instantaneous rates modelization and finally delving into derivatives valuation. The proposed instantaneous rate model is based on a couple of stylized features, the most important ones being the finite time-horizon mean reversion, the positivity and the incorporation of a rising or falling scenario. The speaker recalled how these stylized facts spectacularly fail in the Vasicek model. His first point was that there is a model class which satisfies the stylized facts and preserves the tractability of the Vasicek model, that this class is in fact obtained by keeping the overall form of the Vasicek model on just replacing the driver of its dynamics by a more general driver, and that Levy process drivers suffice for this. Methods for working in and with these models were then demonstrated; reduction series in terms of the moments of the drivers as developed by the speaker. He pointed out that these exact methods also permit

to handle institutional discreteness's, as eg those brought about by the 6 liquid strikes and 10 liquid maturities with which options and (mutatis mutandis) variance swaps are traded in FX, or those arising from the mechanisms of fixing and quoting LIBOR. While originally conceived for valuing and hedging exotics, Basel 3 suggests to develop the modelling approach also towards an incorporation of, for example, counterparty risk.

The talk was quite theoretical and the audience were challenged on how to further apply the proposed modellization approach to exotic derivatives, for valuation and hedging. The challenge was taken and vivid discussions followed the presentation, with a lot of in-depth quantitative questions and answers. In an afterthought the speaker pointed out the expressed aim of the talk to discuss current work, and conceded the demands on the audience thus made, not least because of reliance on methods which are only beginning to make their appearance in the advanced parts of mathematics education. These methods, however, should be those of the future, and he refers to the Universität Freiburg website of Eberlein for a first dip into these matters. The results of the talk in fact originate with the Freiburg PhD thesis of W. Kluge, via the Amsterdam and Prague MSc thesis of Lenka *Slámová*. Scholarly work of the speaker on the subject of the talk is nearing completion; he offers to make it available to topquants.nl in due course.

— summarized by

M.H.G. Schroeder, and Aneesh Venkatraman

Impact of the accumulation of regulation on the Dutch banking sector

- based on talk by Paul Wessels, Jeroen Heijneman (KPMG)

The aftermath of the financial crisis in 2008 has led to increasingly stricter regulations being proposed to hit the banking industry in the coming future. The financial services firm, KPMG had undertaken the task of analyzing the cumulative impact of these regulations on the Dutch banking industry. In this regard, the speakers, Paul Wessels and Jeroen Heijneman, presented the study done by KPMG into the possible effects of 38 new and adjusted regulatory rules by authorities in US, EU, Netherlands and worldwide, applicable to the banking sector in Netherlands.

The speakers emphasized that the consequences of the regulations on a standalone basis is usually more clear for the banks while there is a lack of insight into their cumulative effect particularly as far as Netherlands is concerned. The study by KPMG thereby aims to bridge this gap and provides a qualitative picture on the bank's continuing ability to finance the Dutch economy in the light of new regulations. The analysis also included a quantitative impact study on four supposedly most radical regulatory measures namely the BASEL-III/CRD-IV, Bank tax by the Dutch government, Ex-Ante deposit guarantee scheme by the Dutch Central Bank and the Bail-in debt for crisis management by EU. The study and talk focused on the capital, liquidity and profitability impact from these regulatory changes than on the modeling challenges involved in meeting the regulatory requirements and the speakers were of the opinion that the impact of new regulatory changes is large and can have a big effect on the profitability of banks. The study had investigated several possible future scenarios for the banks and a key issue that could emerge due to new regulations is that banks will need to reduce their balance sheets and reprice credits.

The talk was well presented and was followed by a lively discussion with the audience. Several topics were debated upon like the possibility of banks incorporating new ways to circumvent the regulations, existence of similar studies elsewhere in the market, sensitivity of the results by KPMG to changes in the assumptions and the sample space of bank data that was considered for the analysis etc. The speakers high-

"The consequences of the regulations on a standalone basis is usually more clear for the banks while there is a lack of insight into their cumulative effect particularly in Netherlands. The new regulatory changes can have a big effect on the profitability of banks and a key issue that could emerge is that banks will need to reduce their balance sheets and reprice credits."

— Paul Wessels Jeroen Heijneman

lighted that the results from the study are new and is being done for the first time in the Netherlands. The KPMG report has been sent to the Dutch parliament by the Minister of Finance and is on the agenda for discussion between the minister and the financial experts of the parliament on March 20, 2013.

— ***summarized by***

Aneesh Venkatraman

The Ultimate Forward Rate – Background, Issues and Impact

- based on talk by Roger Lord (Cardano)

"The UFR curve imposed by DNB for pension funds overcomes the main objections of market participants, and ensures hedge sensitivities are more in line with economical ones."

— Roger Lord

New regulations for insurance companies and pension funds, in the form of Solvency-II, will require that their liabilities be discounted using the so-called Ultimate Forward Rate (UFR) curve. The speaker, Roger Lord, from Cardano, a Dutch company specialising in providing risk management services focused on institutional investors, discussed the background of the UFR curve, the practical and theoretical issues involved in its term structure and the market impact of employing the curve.

The speaker began with a historical overview of how liabilities have been valued in Dutch pension funds over the years. Prior to the introduction of the Financial Assessment Framework (FTK in Dutch), liabilities had to be discounted at a fixed rate of 4%. The advent of the FTK, which prescribed the use of the market swap curve, made it transparent to pension funds that interest rate risk is a serious, and often dominant source of risk. Recently, pre-empting Solvency II regulations, the Dutch Central Bank (DNB) imposed the UFR curve for both insurers and pension funds. The main focus of the talk was to explain the Solvency II proposal for curve fitting via the Smith-Wilson based algorithm, the potential implications of the UFR curve on hedging, and the successful lobbying by Cardano (and several other academics) against the counter-intuitive hedge sensitivities resulting from the Smith-Wilson UFR curve. The successful lobby resulted in an amendment of the UFR curve, which brought the hedge sensitivities more in line with the market swap curve, and would not create such a market distortion.

In addition to the hedging implications, the speaker highlighted several other objections to the use of the UFR curve, such as the inconsistency caused between both sides of the balance sheet (hedges still will be valued on a MtM basis), the controversial and political choice of 4.2% for the UFR, dilemma of economic vs. regulatory hedging, transfer of money from young to old participants, as well as many other topics.

The talk was presented in an orderly fashion by starting from the basics, putting things in a rigorous mathematical setting and finally discussing the impact. The questions from the audience were mainly forward looking, like the chances of regulators making any changes to the proposal in future and its potential market impacts. The talk had been based on a recent paper *"An alternative model for extrapolation"*, Insurance Risk, September 2012 and another working paper , *"Dangerous design flaws in the Ultimate Forward Rate: The impact on risk, stakeholders and hedging costs"*, both authored by Joeri Potters, Bart Oldenkamp and Theo Kocken. Slides of the presentation can be found here.

— ***summarized by***

Roger Lord and Aneesh Venkatraman

Fundamental Review of Trading Book

*- based on talk by **Harmenjan Sijtsma (Rabo Bank)***

The last couple of decades have witnessed a decreasing trend in capital ratios (Equity/ Asset) over time and the recent financial crisis in 2008 evidently showed that the level of capital requirements for bank's trading activities is insufficient to absorb losses. The Basel committee introduced a set of revisions to the market risk framework since 2009 (Basel 2.5) which has now evolved in the form of a consultative paper ("Fundamental Review of the Trading Book") that sets out the direction which the Committee intends to take in the future. The main focus of the speaker, Harmenjan Sijtsma, was to present his views on the salient features of the document, the feedback and its potential implications on the capital requirements for the banks.

The speaker began by presenting the chronology of Basel regulatory capital framework for market risk since the Basel Accord established in 1988. The VAR model, introduced in the early 1990's, became a widely used risk measure for losses on financial assets and later a means of computing capital by banks using their proprietary models after the advent of 1996 Market Risk Amendment of Basel Accord. The first decade of the 21st century witnessed an increasing trend of securitized products that carry additional risks that are not necessarily captured in VAR like migration/ default risk on corporate bonds or CDS protection etc and which were supposedly the major cause for the financial crisis in 2008. This led to stronger regulations in the form of Basel 2.5 which is aimed towards increase in capital requirements in the form of stressed VAR, Incremental Risk Charge and Securitization risk. Finally, the consultative document by Basel provides a vision into the market risk regulations that would occupy center stage in future, the pivotal points being the replacement of VAR by Expected Shortfall as a capital measure, calibration on a stressed period instead of a calibration based on both stress and the most recent period, inclusion of the risk of market illiquidity and defining the boundary between trading/banking book.

The speaker highlighted that the new regulations will have major impact on the market risk modelling within banks and also poses big practical challenges such as IT implementation. His view is that the regulations are usually driven by severe market events and do not serve to be pre-emptive. As an example he mentioned that Expected Shortfall (ES) has possibly been introduced due to defaming of VAR following the credit crisis. The ES measure is not likely to contribute much if the underlying Profit-Loss distribution continues to be based on historical simulations, which is the case for most banks. In order for ES to be significantly more meaningful, a Monte-Carlo based simulation of the risk drivers may be required which would be a huge methodological and practical (IT) burden. Finally, the speaker felt that an out of the box thinking is needed from the regulators which currently seems very one-dimensional trying to get the model right but not taking a pro-active approach to consider all the potential future risks involved.

There were several technical questions raised by the audience related to stressed VAR, IRC and a lively discussion followed on whether the new regulations would still be required when the big banks split their investment banking and retail/consumer banking units and on whether those small banks should be allowed to go bust. The speaker challenged the audience to identify potential shortcomings in the existing market risk capital framework and think of possible enhancements to the framework from a regulator's perspective. A good discussion that ensued was on shortcomings in the VAR framework and the ways to possibly improve. Overall, the presentation was conducted in a very interactive manner with the audience being involved all the time which made it a very lively event.

— summarized by

Aneesh Venkatraman

"History proofs that regulation is mostly reactive, seeking modelling solutions that impact IT systems whereas not bringing more accuracy or even bringing fake accuracy (like ES pretends we can measure the tail risk). Therefore, the main challenge is to turn this around and seek a framework that takes a forward look on all the main risk drivers of the portfolio and translate these in a comprehensive framework."

— Harmenjan Sijtsma

CDOs and the Financial Crisis

- based on talk by Ton Vorst (Vrije Universiteit Amsterdam)

The beginning of 2000 witnessed a substantial increase in trading of structured financial products like Credit Default Obligations which later led to huge losses for investors during the financial crisis in 2008. The speaker, Ton Vorst, began by providing some interesting numbers that characterized the growth and fall of the CDO's and remarks on where the rating agencies went wrong. The main focus of the talk was to explain the mathematical model underlying the rating of CDO tranches and a discussion on their pricing methodology.

The speaker briefed the audience on the mechanism used by agencies like S & P, Moody to provide credit ratings to products that are subject to an underlying credit risk from the debtor. These ratings play a central role in structured financial markets and form the basis for many investment decisions. The rest of the discussion was surrounded on whether the rating agencies need to be blamed for the financial crisis that saw a collapse of risk free AAA - rated CDO tranches. The speaker explained that the rating agencies compute their rating based on the real world loss distributions which are used to calculate default probabilities. Hence, a single corporate bond or a portfolio of bonds (e.g. CDO tranche) having the same default probability would obtain a similar rating from the agencies. In this regard, the following principle outlined in the S & P document holds, " *Our ratings represent a uniform measure of credit quality globally and across all types of debt instruments. In other words, an AAA rated corporate bond should exhibit the same degree of credit quality as an AAA rated securitized issue*."

The speaker explained by using a simple Gaussian Copula model for default correlation that while a CDO tranche can have the same rating as a corporate bond, it is subject to high rating instability, i.e. fast downgrade in unfavorable market conditions. As per the model, the downgrade of a corporate bond by one notch corresponds to a downgrade of a similarly rated CDO tranche by three notches. The speaker also highlighted that the Fair spreads on CDO tranches are much higher than fair spreads on similarly -rated corporate bonds thus creating rating arbitrage possibilities. During 2008, banks had optimized their CDO pools such that they just got a high credit rating, although still having the largest possible credit spread. Finally, the speaker 's opinion on rating agencies was that, they were not wrong in their rating assessment while what was overlooked was the fact that the credit quality of a CDO tranche can deteriorate extremely fast during times of crisis which had apparently caused their collapse.

The talk was clearly explained and well received by the audience who were engaged in an lively discussion with the speaker. Several interesting questions were asked related to model risk and assumptions with regard to the Gaussian Copula Model used in the analysis. The speaker mentioned that the work presented in the talk has been based on the work of a PhD student Marcin Wojtowicz

— summarized by

Aneesh Venkatraman

"Since the start of the credit crisis, pricing and valuing simple interest rate derivatives has become both complex and subjective, where the repricing frequency of the floating leg, currency of the collateral and funding cost of the bank have to be taken into account"

— Ton Broekhuizen

"Fair spreads on CDO tranches are much higher than fair spreads on similarly-rated corporate bonds thus creating rating arbitrage possibilities."

— Ton Vorst

Multiple Discount and Forward Curves

- based on talk by Ton Broekhuizen (NIBC)

The recent credit crunch that started in 2008 witnessed a large increase in the spreads among various interbank interest rates, swap rates corresponding to different floating legs, FRA rates and forward rates implied by two consecutive deposits etc. Such regime changes were mainly driven by the market's perception of the credit and liquidity risk carried by financial institutions in the aftermath of the financial turmoil. The main focus of the speaker, Ton Broekhuizen, was to present the consequences of such structural changes in interest rates on the pricing of IR derivatives.

The speaker began the talk by recapping the valuation and discounting procedure used in the pre-crisis period which had low spreads and thereby allowed for a single curve per currency and standard no-arbitrage arguments for pricing. This was followed by highlights into the important modelling challenges that arise in the post-crisis era where standard assumptions like no-arbitrage pricing, relationship between forward and discount curves, the notion of LIBOR as risk free rate, tenor basis spreads being close to zero etc. no longer hold true. Moreover, the market quotes available now usually refer to collateralized transactions while there are no unambiguous quotes for uncollateralized transactions. In addition, some researchers as well as practitioners argue that the pricing of such uncollateralized transactions also depends on the bank's funding level. Reflecting the above, the speaker presented the multi-curve, multi-currency approach for pricing and valuing interest rate derivatives as a necessary improvement to the pre-crisis single-curve approach. While this is indispensable for all banks valuing IR instruments, this is less so for other asset classes and for other financial institutions. The speaker refers to the paper "*A note on the construction of multiple swap curves with and without collateral*" for further reading.

The talk was conducted in a very lively manner and it contained a summary of emerging broad industry practices with respect to pricing derivatives and some comments on how this can be achieved (to different extents) in some standard booking systems. It was followed by several technical and conceptual questions raised from the audience. The speaker was honest to admit certain open ends like treatment of inherent optionality resulting from choice of collateral currency.

— ***summarized by***

Aneesh Venkatraman

Using GPUs for counterparty exposure calculation: Experience Report - *by Cyril Schmidt (Quantitative Trading Risk Analytics Group, ABN AMRO)*

Abstract: The Quantitative Trading Risk Analytics group at ABN AMRO is currently working on a Monte Carlo simulation tool to calculate counterparty exposures. The tool is an in-house development of ABN AMRO. To gain calculation speed, we employ Graphical Processing Units (GPU) for pricing financial derivatives. In this report we share our personal experiences with GPU programming, the benefits of GPUs and the issues that we encountered.

Introduction: Counterparty credit risk for an institution is the risk that the counterparty to a financial contract will default prior to the expiration of the contract. Unlike other forms of credit exposure (e.g. on bonds and loans), counterparty exposure is very volatile during the lifetime of the contract in question.

Risk management often uses potential future exposure (PFE) as a measure of counterparty risk (see [1] for an overview of counterparty exposure measurement). The most accurate way of computing the PFE for a portfolio of financial derivatives (especially if it is covered by a netting or collateral agreement) is Monte Carlo simulation. Its main drawback is the sheer amount of computation that needs to be done. For each PFE calculation, we need to price the entire set of trades with the counterparty N times (for accurate estimates, N is often chosen between 5000 and 15000). A risk manager will usually require potential future exposure at several (50 to 100) time points in the future, which increases the computation time 50- to 100-fold.

Graphical Processing Units: GPUs found in modern video cards are specialized multi-core processing systems designed to handle large amounts of parallel computations, which are typical in video games. In the past decade the GPUs attracted a lot of interest as general-purpose computing devices. NVIDIA, one of the biggest manufacturers of GPUs, published CUDA [3], a set of tools to run arbitrary computations on their GPUs.

Fortunately, Monte Carlo calculations are by their nature easy to parallelize. In a Monte Carlo simulation, every scenario is independent from the others, which means they can be computed in parallel. This makes GPU a natural fit for our problem.

Project setup: At ABN AMRO's Models and Tools department (predecessor to modern QTRA, Quantitative Trading Risk Analytics), we were using an in-house counterparty exposure calculation tool codenamed Exion. It worked well for relatively small portfolios, but as the size grew, the processing time went up to the point when the tool became impractical. We built a cluster of six Linux boxes with a quadcore CPU in each and ran big portfolios on it. Being reasonably fast, the cluster generated so much heat and noise that people started complaining.

Bearing that in mind, we were looking for a way to increase performance while keeping the system cool and quiet. In 2012 we started a pilot project to calculate counterparty exposure using GPU. Although NVIDIA's

CUDA toolkit is not the only platform for GPU code development, it is by far the most popular. It provides a C++ compiler and a set of libraries and tools for general-purpose computations on NVIDIA's GPUs. We chose CUDA mostly because of the maturity of the toolset and its popularity within the development community.

GPU peculiarities: From the beginning of the pilot project we did not expect to reuse any code from the previous version of our Monte Carlo engine. Exion was written mostly in Haskell [5], and CUDA programming in Haskell was still in its infancy when we started our project. Having written quite a bit of CUDA code, we now see that we would not have had much code reuse even if Exion had been written entirely in C++. We saw that CUDA code needs to be structured quite differently from the code designed to run on a CPU.

Single Instruction Multiple Data (SIMD): CUDA gains speed by running the same function (referred to as kernel) in multiple threads simultaneously, in a SIMD fashion. Each group of 32 threads, a warp in CUDA parlance, executes the same instruction in all 32 threads. If one thread branches off the group, the rest of the warp will have to wait for it to finish its unusual business and rejoin them.

Memory access: Calculations on a GPU are much faster than memory access, so it pays off to minimize data fetching and storing, sometimes even at the cost of extra computations. In addition, GPUs are sensitive to memory access patterns of the function being executed. Memory bandwidth is utilized optimally when memory access is coalesced, that is, all threads in a warp use the same cache line.
In addition to global memory, NVIDIA graphic cards contain shared memory, which is located on the GPU chip. It is smaller but faster than global memory, so using shared memory wisely will improve the kernel's performance.

Kernel limitations: Although NVIDIA put a lot of effort in the implementation of the C++ support on GPUs, some C++ features, notably STL, cannot be used in kernels. Until recently, kernel code could not be even linked, which meant that all the functions called by a kernel had to be defined in the same translation unit.

Lessons learned:

It is worth the trouble: Our most important lesson is that GPU technology is well worth the effort of learning CUDA and fine-tuning the code to make the most of the GPU. Even on a low-end consumer video card (Quadro 600 with 96 cores) we achieved a 20-fold speedup, compared to a Core2 Duo CPU (Intel Core2 Duo E7500, 2.93 GHz running Monte Carlo in a single thread). The card remained cool and quiet.

Optimize by experimenting: Making fast software for GPUs involves much more of trial-and-error than the optimization for traditional CPUs. Often it is impossible to predict the effect (or lack of effect) of a certain optimization on the performance of the kernel. For example, switching from double-precision to single-precision computation yielded 7 times faster code, which we did not expect at all (I believe that the speedup is mostly because fetching a double from memory takes twice longer than fetching a float, but we were not able to prove this hypothesis). Some other optimizations that we conceived and implemented actually made things worse, so we had to roll them back.

Not having STL does not hurt much: The limitations of CUDA kernels never became a stumbling block for us. It is by all means nice to have STL containers and algorithms at your disposal, but doing without them in kernel code was never a problem for us.

Future work: The purpose of the pilot was to assess the benefits of GPU computing for our counterparty simulation project. It convinced us that GPU computing has a lot to offer to Exion; our next steps will be to optimize the development process.
One of the best ways of developing high-quality software efficiently is to utilize existing libraries. CUDA offers a set of highly optimized libraries, such as CUBLAS (linear algebra), CURAND (random number generation) and Thrust (general purpose). By employing these libraries we can reduce the amount of development and improve code quality at the same time.

Conclusion: Running computations on a GPU is a powerful way to speed up a Monte Carlo simulation. The CUDA platform provides good support for C++ programming on GPUs. The technology continually evolves and has a well established development community.

References:

[1] Zhu, Steven H. and Pykhtin, Michael, A Guide to Modeling Counter-party Credit Risk.

[2] Glasserman, Paul, Monte Carlo Methods in Financial Engineering (Stochastic Modelling and Applied Probability), Springer, August 2003.

[3] NVIDIA CUDA

[4] CUDA C Best Practices Guide

[5] The Haskell Programming Language

Convergence of "Regress-Later" Series Estimators in Static Portfolio Replication

— *by Eric Beutner, Antoon Pelsser, Janina Schweizer*
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The global financial crisis has highlighted the significance of sound risk management and lead regulators to challenge financial institutions' risk models and to tighten solvency measures. Basel III and Solvency II define these regulatory reforms. Risk models are expected to accurately produce risk figures in a timely fashion such that economic decision making can pro-actively keep up with the fast pace of market environments. Due to the complexity, non-tradable character and size of their liabilities insurances face difficulties in market consistently valuing and appropriately shocking their balance sheets such that risk measures can timely be extracted. Generally, analytical formulas for valuing the full insurance liability portfolio are not available and alternative numerical methods become necessary. In that context, methods that project the liabilities into simplified functional representations have been suggested to enhance risk analysis. "Portfolio replication" and "Least-Squares-Monte-Carlo"-type function fitting (LSMC) have become buzz words for the Solvency II internal model methodologies and are generally known as liability proxy modeling techniques. These techniques originate in the financial derivatives literature. We focus on achieving a general static replication technique for a large class of contingent claims, thereby extending the current theory to insurance liabilities, and discuss the asymptotic properties of the proposed estimator. As suggested in relevant related literature the static replication is achieved by constructing a countable orthonormal basis.

A nonparametric approach is taken, which by definition signifies that the parameters of our model lie in an infinite-dimensional parameter space. In particular, attention is limited to all contingent claims with finite second moments. The limitation allows to model the derivatives in the

L_2 -Hilbert space, which, given a basis, enables to statically replicate any element of the space through an orthonormal basis representation. To illustrate the fundamentals consider a simple one-dimensional framework, in which all contingent claims, $X(T)$

are ultimately functions of the Brownian motion ,

$$W(T)$$

where T is the maturity date. We are interested in approximating and estimating functionals on the Brownian motion that can be written as a conditional expectation

$$\mathrm{E}\left[X(T)\middle|W(s)\right] := g_0(W(S)), s \le T$$

It is a well-known result that the random variable $g_0(W(S))$ is expressible

in terms of the orthonormal basis,

$$e_k(W(S)) \forall k \in \mathrm{N}$$

spanning the space

$$g_0(W(S)) = \sum_{k=1}^{\infty} \alpha(k) e(k) W(s),$$

where the coefficients are given by the expectation of the target function and the basis pertaining to the coefficient. We classify two types of estimators, "regress-now" and "regress-later". While in "regress-now" an approximation function to the conditional expectation of the target function is attained, "regress-later" pertains to the construction of an approximation to the target function itself. Intuitively, "regress-now" estimates the pricing function of a contingent claim while "regress-later" estimates its payoff function and is priced through pricing the basis terms. In practitioners' jargon LSMC is equivalent to "regress-now" coupled with polynomials as basis and portfolio replication corresponds to "regress-later" with standard financial instruments.

In practical applications we are interested in estimating the above static replication. Nonparametric regression estimation techniques, known as series or sieve estimation, consider the estimator as a function of both, the sample size and the number of regressors. The infinite-dimensional parameter space is thereby approximated by a sequence of finite dimensional sieve spaces. Under the L_2 -norm

the estimator is given through least squares regression of $X(T)$

against a subset of the full basis. Any asymptotic convergence theory then depends on letting both the number of regressors *K* and the sample size *N* grow to infinity. The general convergence rate of the "regress-later" estimator can be derived tantamount to the existing theory on "regress-now" estimators. Both estimators achieve the optimal theoretical convergence rate. The convergence rate highly depends on the properties of the chosen basis. We introduce a simple orthonormal basis consisting of indicator functions that fulfils all requirements for obtaining convergence. Although piecewise linear functions may not be perceived as the best basis in terms of the speed of convergence, we advocate their universality as their orthonormality is independent of the underlying probability meas-

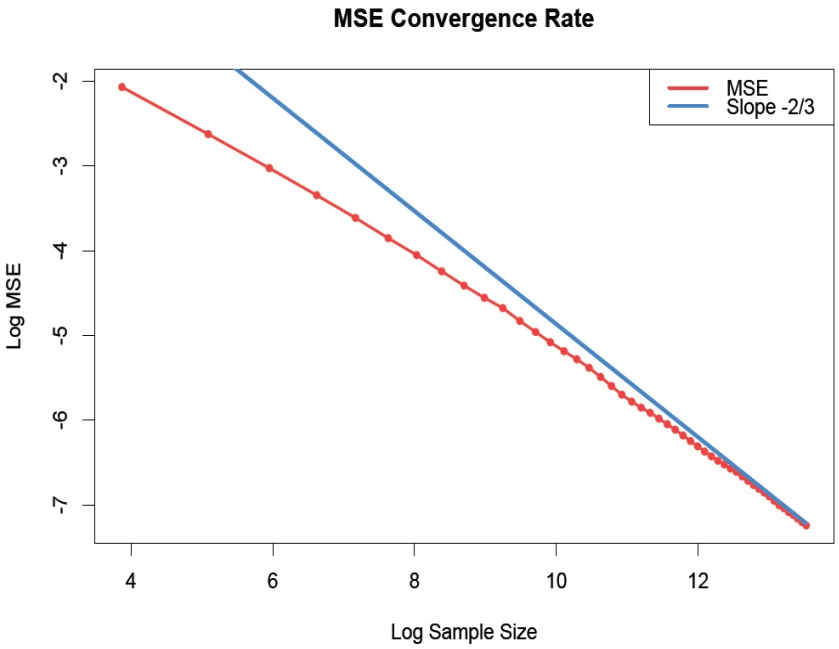
ure. This property is a significant advantage over commonly applied polynomials. The optimal growth rate of the regressors K in relation to the sample size N is derived to be

$$K \propto N^{\frac{1}{3}}$$

The estimator then achieves the optimal convergence rate in mean square of

$$O_P(N^{-\frac{2}{3}})$$

The above figure illustrates the theory and indicates that in the limit the theoretical convergence rate is attained given the optimal growth rate of K proportional to N. We want to remark that the established theory extends to multi-dimensional path dependent contingent claims by invoking the theory on Hilbert space tensor products. While mathematically the static replication for such claims is attainable, in practical application it suffers from the curse of dimensionality as a large basis is required.
We have verified a general framework for statically replicating contingent claims through orthonormal basis functions and thereby address a current challenge in the insurance industry. We give a theoretical ground and validation for the proxy modeling techniques used in practice. Moreover, we discussed the asymptotic



convergence rate of the estimators. Note that the convergence of the estimators highly depends on the chosen basis. The current underlying theory does not allow for many basis of interest. Future research therefore focuses on relaxing the assumptions in place and broadening the framework.

Upcoming Events

1. The next event is the 2013 TopQuants spring workshop on May 22nd. The event will be held at the SNS office in either Utrecht or Amstelveen. The keynote speaker will be Coen Teulings, director of the CPB, Netherlands Bureau for Economic Policy Analysis. The official invitation will be mailed soon and further details of the event will be posted in due course on the TopQuants homepage .

2. The next issue of the TopQuants newsletter will follow in September 2013. Contributions for it are already welcome. Kindly contact Aneesh Venkatraman, (aneesh.venkatraman@rbs.com).