Sales Training and Swaption Pricing under New Regulatory Environment

A Major Qualifying Project
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ABSTRACT

In order to address the changes resulting from the 2008-09 recession, this project created training for foreign exchange salespeople in Royal Bank of Scotland (RBS) on credit charges, funding rate changes, a new pricing tool and new-hire appropriate conduct, with technical improvements for some current applications. In addition to fulfil RBS's expectation, the project explores the pricing details of Interest Rate Swap Option (Swaption) in MATLAB through both analytical approach and Monte Carlo simulation.

EXECUTIVE SUMMARY

We aimed to address some of the information gaps created by fast paced-changes in Royal Bank of Scotland (RBS): the first objective was to create training programs that explain current internal procedures and the second objective was to improve these procedures where possible. Foreign exchange (FX) Structuring requested that we focus on four major topics: changes to how RBS accounts for the risk of dealing with a client (client risk pricing components), implications on pricing due to a change in the rate at which RBS can borrow money (bank specific pricing components), determining if a deal is a good fit for a counterparty (appropriateness) and a user guide for changes to XPortfolio, an old RBS program. Past experience within the company indicated that training programs were an efficient method to distribute information and would be a good way to circulate information on these topics.

Before beginning to gather information within RBS, we surveyed the prevailing environment and identified a problem; FX Structuring needed to deal with new regulations and controls that arrived too quickly for them to do anything other than adapt. It did not have time to educate others on all the changes.

It seems unlikely that these changes will be the final substantive changes to FX. Many within politics are pushing for new policy tools to deal with institutions deemed "structurally important" in ways other than bankruptcy or bailout (Mijuk, 2009; Paletta, 2009). How these new regulations will affect the business model of a financial institution remains to be seen, but given their likelihood our product needs to be easily updateable.

We relied heavily on interviews to gather the information needed to make training programs. We entered interviews with overall topics we wanted to understand and a list of questions that were potentially related, intending on using the questions to help the interviewee start talking about the topics. These interviews frequently referred us to office memos that gave basic details on our topics, allowing us to ask clear and specific questions in follow-up interviews. In order to create the programs we interviewed key employees from the following areas on related topics:

Counterparty risk pricing components: - Counterparty Exposure Management

- Corporate Risk Solutions UKCB   - FX Structuring

- GBM Exotic Deal Clearance

- Market and Credit Risk Methodology

- Total Credit Risk Management

Bank-specific pricing components:

- Corporate Risk Solutions UKCB

- FX Structuring

XPortfolio user guide:

- FX Structuring

- GBM IT

- UK Bank Sales

Appropriateness of a deal for a client:

- Corporate Risk Solutions UKCB

- Currency Options Trading

- FM Regulatory Risk

- FX Structuring

- Taxation

- UK Bank Sales

The first training topic, counterparty risk pricing components, resulted in a training guide for Risk Weighted Assets (RWA), Credit Value Adjustment (CVA), Wrong Way Risk (WRR) and Credit Line Utilization (CLU). It includes the definition, what desk had final responsibility for the term, the current formula and which application should be used to find the value. It was written to serve as an easily updateable way to show FX Salespeople how to find these values and to provide a general topic brief for anyone who wishes to understand the concepts.

In our second topic, bank specific pricing components, we created a brief guide discussing the necessary adjustments to prices for deals with uncollateralized clients. We also created a one page laminate for faster reference.

Our third training program contained the information a new FX salesperson must understand to be able to do their job. This guide is intended to serve as a road map, giving general definitions and descriptions before offering links to documents with more specific information. It covers what a salesperson should be thinking about in all parts of the deal, before a deal, during a deal and after a deal.

The last training topic was the recently-released upgrade to XPortfolio pricing functionality, which we presented as a complete guide and a laminate for internal users and as a complete guide only to external users. Some of the most interesting features are the ability to dock windows and streamlining the process between developing and dealing a new type of

structure. The guide also serves to promote the planned future features, such as offering a single point for pricing all structures.

During our time interviewing to determine the state of current systems, we noticed potential areas for improvement. These were addressed by improving the functionality of two helper spreadsheets: the RWA calculator and the IAS accounting sheet. We added the ability to calculate RWA for vanilla strips to the RWA calculator spreadsheet. In the IAS accounting spreadsheet we implemented a function to split intrinsic and time value of a structure. These programs are written in VBA inside the excel macro.

Overall, this project fulfilled the intended goal of sharing information within RBS. . Increased access to this information carries benefits beyond increased process efficiency. More employees understanding the processes means more people will be thinking about how to improve them, something that can only benefit RBS.

Although our project primarily focused on increasing understanding of pre-existing concepts and procedures, we also spent time analyzing the procedures we were documenting. This led to recommendations that fall into the following general categories:

- Recommendation one is to provide FX Structuring and CRS UK with new online information sharing tools. For example, we recommend offering salespeople a space on the intranet to allow their currently informal discussions of the nuances of deal proposals a more permanent form and to increase access to the information. Lee Bulman has offered to sponsor these ideas

- Recommendation two is to address a potential for "double counting" risk in the CVA and WWR calculations, thereby reducing the credit charge. Tom Richards has offered to sponsor this idea.

- Recommendation three is to use RWA netting and checking RWA by counterparty and by desk. This would fix the current system of checking RWA on individual deals that is potentially at odds with the traditional business model.

- Recommendation four involves collateralization agreements (CSAs) and the real value they hold to RBS by allowing capital conservation. This value could potentially be monetized and shared with the client

- Recommendation five is to determine the feasibility of creating a temporary interface that allows a salesperson to input deal details only once and get RWA, CVA, WWR and CLU. There is already a plan for a long-term solution but an interim interface holds significant value.

AUTHORSHIP

This is the Major Qualitative Project report for both Computer Science and Mathematics department of Boya Wang. The project took place in London Wall Street Project Center during B term-2009 and in WPI campus during C term-2010. James Dickson is the project partner during B term and is the co author for parts of this report.

Chapter 7 (Monte Carlo Pricining of Swaptions) is drafted by Boya alone while Chapter 1 through Chapter 6 (Introduction, Background, Methodology, Data Analysis, Conclusion and Recommendation) are drafted by both Boya and James.

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We would like to thank Professor Daniel Dougherty for the patience and guidance throughout the entire project period, Professor Arthur Gerstenfeld for reviewing and guidance during the London Wall Street project period, and Professor Weiwei Xie for helping me through the swaption pricing process.

We would also like to thank all the employees in GBM for their support in this project. Without your help we would not have been able to draft this report. Specifically, we would like to thank:

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- Paul Samuels
- Peter Donnelly
- Lee Rushforth
- Neil Tandy
- Lee Rushforth
- Chetan Shah
- Tamas Korchmaros
- Lee Bulman
- Stuart Alden

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1.0   INTRODUCTION

The financial world is going through a period of tumultuous change after a series of bailouts and other forms of government intervention. It is simple to lose sight of the original cause of all the problems; easy credit caused an unfortunate chain of consequences, eventually leading to the current global recession. Retrospective analysis focuses attention on the United States Federal Reserve bank (the Fed) and its powerful tool: setting a target interest rate for banks to charge when they lend to each other. This tool essentially works as a money spigot; the target interest rate simply influences inter-bank lending rates. Typically, setting a higher rate tightens the spigot, setting a low rate loosens it.

This rate was kept around 1% from 2002 to early 2005, significantly increasing the money supply (Evans, 2009). Investors awash with cash had little reason to deposit their money in banks, finding it easy to get higher returns using cheap credit to purchase risky (and therefore high return) assets at slowly rising prices. During this period these risky assets had a historically low default rate and began to be perceived as low risk investments. Increasingly riskier loans were used to chase high returns on investments in increasingly exotic assets and securities (Wessel, 2009, pp. 55).

Banks had taken steps to spread around the risk of owning these assets, but in the end these attempts depended on a series of faulty assumptions. Essentially banks believed that the system allowed them to quickly securitize and sell loans they originated, removing the risk from their books. In the housing market, complicated new securities were created to shuffle risk that followed this business model (Wessel, 2009, pp. 104). Financial institutions purchased increasingly risky varieties of these securities, focusing on the stable returns produced in the current period of historically low default rates (Wessel, 2009, pp. 55).

Problems within this system surfaced when the housing bubble popped. Previous bubbles had been dealt with by shifting borrowing between credit markets (i.e. money market funds, pension funds) and the banking system. As one market tightened, the other became more desirable. In a surprising development, this bubble contaminated both lending markets. There was nowhere left in the financial system left to borrow money (Wessel, 2009, pp. 103).

Governments were forced to choose between a depression and bailing out the financial institutions that originated the problems. These painful and offensive choices served as a call to action (Solomon, 2009). New financial regulations were soon created.

It seems unlikely that these changes will be the final substantive changes to the financial world. Many within politics are pushing for new policy tools to deal with institutions deemed "structurally important" in ways other than bankruptcy or bailout (Mijuk, 2009; Paletta, 2009). How these new regulations will affect the business model of a financial institution remains to be seen, but given their likelihood it seems financial institutions will remain in a state of turmoil for some time.

Royal Bank of Scotland (RBS), no different from any other financial institution, was forced to adapt to these new regulations. However, these new regulations and controls arrived too quickly for RBS to do anything other than adapt; the various departments (called desks) did not have time to both continue doing their constantly changing jobs and educate others on all the changes.

The Foreign Exchange Structuring (FX Structuring) desk is attempting to address this gap in information and educate all members of the FX family. As the primary purpose of the desk is to provide pricing and support for the products salespeople deal, these programs will be tailored to salespeople. Without a current understanding of the systems used to price products, the salespeople have a difficult time properly doing their job.

To provide information to salespeople we conducted a series of interviews on four main topics: the current methods to include risk in the price of a structure, a minor adjustment to the price of a structure relating to the RBS funding rate, the best practices for determining if the structure is the best one for the client and a guide on how to use the recently released upgrade to a XPortfolio pricing functionality. These interviews also revealed technical issues that we could solve by adding functions to pre-existing spreadsheets, allowing salespeople to access updated information now rather than being forced to wait for the release of long term solutions. Our information and technology will allow salespeople to improve the speed and accuracy of their price quotes.

2.0 BACKGROUND

The goal of this project is to design, produce and deliver internal training programs for FX Structuring dealing with changes resulting from new regulation. In this section we discuss the problem the project addresses, define the base terms our project will build on, finding that the best way to gather necessary data is via interview and the best way to disperse it is via training programs. Creating these programs will be useful for all of RBS as the recent past has seen significant changes to how financial institutions do business. Being one of the first to address these changes offers the potential for higher gains.

2.1 Missing Information

FX Structuring is primarily a support desk, creating and pricing the structures that salespeople eventually deliver to customers. Recent years have made this job quite difficult as the internal RBS practices have changed too quickly to keep track of everything that occurred. FX Structuring was able to give salespeople enough information to continue to do their job, but there was a large amount of missing information that would allow salespeople to do their job better (Ben Nicklin, personal communication, October 21, 2009)

2.2 Defining Relevant Terms

We gathered information to provide a basic understanding of the terms provided to us in the project description before arriving at RBS. RBS has highly specific definitions and methods to address these terms and we felt it necessary to have a strong grasp on these more basic concepts before we learned about the advanced definitions.

For this section, we researched the following terms:

- **Capital hurdle:** The required amount of return on an investment. An investment proposal will be approved if the expected return is above the capital hurdle. Similarly, the capital hurdles rate is the required rate of return on a long term investment opportunity, which should equal the incremental cost of capital (AllBusiness, 2009).

- **Credit charges**: The cost to hedge against owning a certain product. Dealing a product carries certain risks, and this charge exists to address those risks (Ben Nicklin, personal communication, October 21, 2009).

- **Credit Utilization**: The amount of purchasing power you have, also known as credit "debit to credit ratio". Intuitively, an increase in credit utilization will decrease the amount of credit available for use. (Irby, 2009).

- **Wrong-way risk**: The risk that some credit qualities of a counterparty may be related to macroeconomic factors which also affect the value of derivatives transactions. For example: RBS agrees to pay the currency of the home country of the counterparty and would receive USD at a set exchange rate. If the home currency lost significant value the value of the deal to RBS significantly rises. However, as the counterparty has the majority of its funds in this now greatly devalued currency, the probability of counterparty default rises. (Harvey, 2004; Willie Zhao, personal communication, October 10, 2009; Ben Nicklin, personal communication, October 21, 2009).

- **Funding:** The rate at which RBS has access to funds. Historically, this value was London Interbank Overnight Rate (LIBOR) (Ben Nicklin, personal communication, October 21, 2009)

- **FX-structuring:** FX-structuring stands for FOREX (foreign exchange) structuring Desk duty. FX Structuring desk involves a host of functions, such as financial modeling, idea generation, pricing and simulation of structured products. The responsibilities are mainly pricing products for sales people's clients and talking to traders for volatility levels (Willie Zhao, personal communication, October 10, 2009).

2.3 Training Programs

The overall objective is to design, produce and deliver training programs on the following subjects:

* Counterparty Specific Risk Pricing Components
* Funding Based Premium Adjustments
* Appropriateness of Deal

2.3.1   Why build training programs?

The problem we are addressing is a cutting edge issue for RBS and all other banks. The terms are continuously evolving, especially after the financial crisis with Lehman's collapse and the subsequent fall-out. This leads to a lot of confusion within RBS affecting traders, salespeople and even FX structurers.

These points come together to suggest a company training program. A training program is a fast, cheap, and effective way to communicate information to varying areas of the company. It allows users to access information at their leisure. It also serves as a centralized area for the most recent definition of any term. This centralization ensures that any future updates can be effectively distributed throughout the company.

2.4   Interviewing

Interviewing is the ideal method of data gathering. It allows us to create personal relationships with those who know necessary information. These relationships are important as employees who like us will be more willing to help, likely leading to higher quality data. These relationships also allow us to attempt to ascertain any spots where company policy may diverge from best practice, a sensitive subject. This data would be very helpful and would require a trusting relationship to discover.

Further, we expected this to be a highly collaborative process. We are serving as data conduits to spread what the interviewee knows. As such, it is important that we can check our understanding of the identified concepts and later seek feedback on the validity of our outputs. All of this would be greatly aided by a strong personal relationship that can be created during interviews.

3.0 METHODOLOGY

The main goals of this project are to address some of the information gaps created by fast paced changes in RBS and to improve the programs currently used where possible. Open ended interviews were used to gather information. From this information training programs were created and improvements to the existing programs were done.

3.1 Interview Process

Interviews were the primary method used to gather the necessary information. First, Ben Nicklin was asked for referrals to employees who could speak about the training topics. Using Ben's knowledge of his colleagues to direct the interviews was the fastest way to start gathering information.

The next step was to make contact with the topic expert, typically via email or face to face conversation, to explain what was being created and what information was needed. The topic expert then produced documents and memos related to the topic. These documents were used to get a general understanding of the topic. This proved to be more efficient than gathering general information before an interview as an initial interview still resulted in the topic expert offering documents and setting up a follow-up interview. No problems were encountered skipping gathering information before initial contact.

After reading the documents, more specific questions for follow-up interviews were generated. At this point enough was known about the topic to ask useful questions, but not enough to predict answers. This naturally led to the use of open ended interviews. After all interviews, notes were compared and an interview transcript was written based upon the agreed upon interpretations of what the topic expert said. These transcripts simplified storage of all interview notes and serve as data.

If the topic experts were not able to answer all questions, they were asked to provide referrals to other employees that potentially had the information. This was a common occurrence, with one interview frequently leading to a series of other interviews.

Due to scheduling issues multiple projects were worked on simultaneously. Employees had schedules they needed to keep and it was necessary to work around this.

3.1.1 Counterparty Risk Pricing Components Participants

The following employees were interviewed to gather information on this topic:

- Stuart Alden
- Pavel Anderichenko
- Ben Burch
- Dan Eisen
- William Hassan
- Dean Lockwood

- Ben Nicklin
- Grainne O'Toole
- Ceire O'Rourke
- Justin Pendlebury
- Thomas Richards
- Mandeep Uppal

3.1.2 Bank Specific Pricing Components Participants

The following employees were interviewed to gather information on this topic:

- Adrian Campbell-Smith
- Ben Hamdani
- Ben Nicklin

- Ceire O'Rourke
- Thomas Richards

3.1.3 Appropriateness of the Deal for the Client Participants

The following employees were interviewed to gather information on this topic:

- Stuart Alden
- Daren Blaker
- Lee Bulman
- Peter Donnelly
- Duncan Farnsworth
- Annabel Lawrence
- Chris Leuschke
- Chris McHale

- Jeremy Maw
- Martin Merryman
- Ben Nicklin
- Mark Rowe
- Paul Samuels
- Chetan Shah
- Neil Tandy
- Simon Whittle

3.1.4 Prodigy User Guide Participants

The following employees were interviewed to gather information on this topic:

- Peter Donnelly   - Ben Nicklin

- Tamas Korchmaros   - Lee Rushforth

3.2 Generating Training Programs

First, the currently available training program software was examined. It was found to be adequate. The software had uniquely useful features, such as being accessible through multiple programs and tracking module completion by employee.

However, the training program lacked search capabilities. If the information was put exclusively into the training program, it wouldn't show up when searching the RBS intranet. To solve this, training programs were first created in Microsoft PowerPoint and then translated into the existing training program software. The PowerPoint was hosted on the FX Structuring site, allowing its information to show up when using the search engine.

3.3 Improving Currently Available Programs

Discussions with Ben Nicklin and Chetan Shah resulted in adding functionality to the RWA calculator spreadsheet and the IAS accounting spreadsheet. A series of brief discussions described the desired functionality and frequent feedback ensured that the new code met their needs.

3.4 Quality Testing

All training guides were written to be updateable. The information contained in the guides was cutting edge for RBS; the main point of the guides was to centralize all the relevant information so members of RBS could get a picture of the current systems. RBS intended on

taking the guides and making phrasing and presentation tweaks before they were widely published. Even after these tweaks, the information would continuously change, quickly demanding an updated version of the training guide. Due to the fluidity of the situation, success of the training guides was measured by how easy it would be to update.

To address this all guides were written with an explicit split between general concept definition and explanations of current internal processes. The general concepts will stand as correct forever while the explanations of current internal processes will demand frequent updates.

4.0 DATA AND ANALYSIS

This chapter will present a summary of the data we gathered and go on to analyze it. The main objectives of this project were to explain current processes within RBS and to improve them where possible. Each of these objectives will get their own section.

4.1 Explaining Current Processes

Our first objective, analyzing current processes, resulted in creating four training programs. Three of these programs were distributed, with a fourth being submitted to an upper level manager to be used as a starting point for his take on the same topic. For all of these topics, further details can be found in the training exercises attached at the end of each section.

4.1.1 Counterparty Risk Pricing Components

This topic resulted in a training guide for Risk Weighted Assets (RWA), Credit Value Adjustment (CVA), Wrong Way Risk (WRR) and Credit Line Utilization (CLU). It includes the definition, what desk had final responsibility for the term, the current formula and which application should be used to find the value. It was written to serve as an easily updateable way to show FX Salespeople how to find these values and to provide a general topic brief for anyone who wishes to understand the concepts. Our findings summarized in a table and the full training program can be found on the following pages:

	Definition	Ownership	Formula	Salespeople find using
RWA: Risk weighted assets	The capital RBS must post daily to account for the unexpected losses.	TCRM Trading Credit Risk Management	RWA hurdle= Lifetime Exposure at Default * K * Desired return on capital K is a risk weight decided by PD, LGD, and M	Tom Richard's spread sheet
CVA: Credit Value Adjustment	The premium paid to CEM to get the insurance of expected losses	CEM Credit Exposure management	CVA= EPE * PD *LGD LGD=1-RR LGD: Loss given default PD: Probability of default RR: recovery rate	Cremant
WWR Wrong way risk	The risk resulting form a correlation between the strength of the underlying currency and the counterparty	CEM	WWR=EPE * 1yr CDS / 10000 * tenor * (1-haircut) 1yr CDS: credit default swap Tendor: deal length in yrs Haircut: internal classification for the strength of a counterparty	WWR daily email pdf
CLU: Credit Line Utilisation	The most that the Bank would expect to lose in the event of counterparty default calculated to 95% confidence	TCRM Trading Credit Risk management	Simulate future FX rates to maturity using: 95% rate= exp(1.645* Vol * sqrt(t)) 5% rate= exp(1.645* Vol * sqrt(t)) The point of maximum exposure of the deal at these rates is CLU	NMOSS

Figure 1: Counterparty Risk Pricing Components

RWA, CVA, WWR and CLU:

Structure Risk Analysis

Nov 2009

Contents

- **Introduction to Structure Risks**

- **Expected and Unexpected Risks**
  - Credit charge for expected loss, RWA is capital held for potential unexpected losses

- **CLU**
  - Credit line utilization. The amount of credit used on a deal or a portfolio of deals

- **CVA**
  - Credit value adjustment. Typically the largest part of the credit charge

- **WWR**
  - Wrong way risk. Typically a secondary part of the credit charge

- **RWA**
  - Risk weighted assets. The amount of capital RBS is required to hold on a structure

Structure Risk : Pricing a Deal

When creating a premium, there are two major aspects to consider:

•The value of the structure
The value of the structure is found using complex, dependable formulas based on Black-Scholes
It is adjusted using robust tools, including smile valuations, providing very strong answers

•The risk of the structure
The risk of the structure is split into unexpected and expected risk. FSA guidelines require RBS to address 99.9%
of the potential losses from a deal

**The purpose of this training guide is to explain how risk calculations work, how RBS currently addresses
risk calculations and how they affect the final premium for a structure**

**This guide is made with FX Salespeople in mind, so it will focus on the risk components a salesperson
must understand and use when making a sale:**

-CVA (credit value adjustment)
-RWA (risk-weighted assets)
-WWR (wrong way risk)
-CLU (credit line utilization)

Risk components: Expected and Unexpected Risk

The graph below represents the three flavours of risk and discusses how they relate to losses.

The chart ties these concepts into RBS
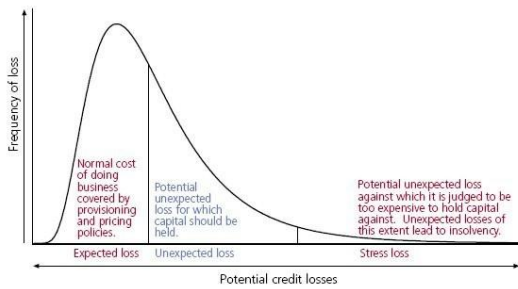
Type of risk	Method to address	Details
Expected loss	Credit Charge is prepared for the expected loss In RBS, this charge is composed of CVA and WWR	As shown in the graph, this loss is considered a normal cost of doing business. This loss shows up in the P/L statement as a normal cost of doing business
Unexpected loss	RWA is the capital requirement for the unexpected loss	This is the amount of capital RBS must hold against the possibility of widespread unexpectedly large default rates

**Expected and Unexpected risk make up 99.9% of the total risk on a deal.
RBS is not required to address the remaining 0.1%--the Stress loss**

Relations between the expected and unexpected losses:
Intuitively, as probability of default increases the amount required to account for the risk increases
Strangely enough, after a certain probability of default unexpected loss begins to decrease even as total risk increases

This is because "expected risk" becomes a larger and larger portion of the total risk as the probability of default rises, lessening the
unexpected potential losses

CLU: The Concept

CLU stands for credit line utilization:
This CLU figure represents with 95% confidence, based on historic rate movements, the most that the Bank would expect to lose in the event of counterparty default
Found by adjusting the forward rate underlying the deal to the 95th percentile for points until maturity. The resulting rate is then applied to RBS' exposure to a counterparty resulting from a single deal or a portfolio of deals. The point of maximum exposure represents the CLU value, or the RBS projection for maximum loss RBS could have from these deal(s).

Sales should check the CLU against the credit line of that counterparty
A client's credit line represents the maximum exposure RBS is willing to have to that counterparty

Essentially, check the total expected exposure of the counterparty portfolio against the maximum exposure RBS is willing to have to that counterparty
If a deal would push CLU over the exposure limit the deal becomes more complicated.
Actions such as collateralization and purchasing CDS could bring CLU back under the limit

CLU is owned by Trading Credit Risk Management (TCRM).

Salespeople currently find CLU using the NMOSS credit calculations and find the credit line and the current usage in the vanilla pricer
The process for finding CLU, the credit line and current usage of the credit line is shown on the following page
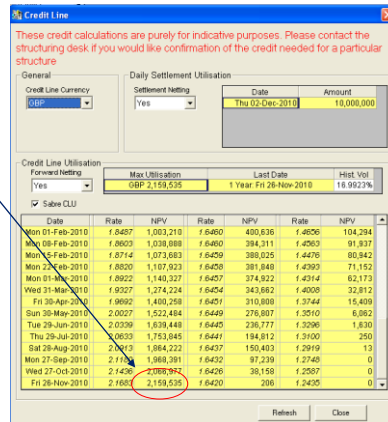
This calculation generates single deal CLU because running the required portfolio projections would take a long time
This means that while the presented CLU value is normally close, it is not exact.

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Finding CLU in NMOSS (1 of 2)

- CLU is found by first clicking on credit calculations as shown
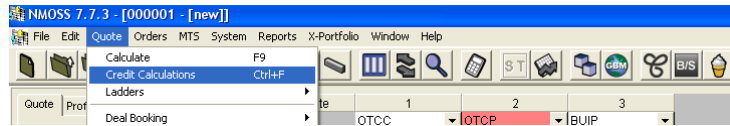
- CLU is then the highest value in the NPV columns.
  - Unfortunately, these columns cannot be sorted to display highest value
  - However the highest NPV is frequently near the end as these have the most time value

- In this case the CLU on this 1y deal is 2,159,535 pounds

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- The credit line and current utilization are found using the vanilla pricer

- The pricer requires an option to show the limit, term and current util of the counterparty so enter in some absurd hypothetical deal.
  - In this example we used a 1y GBPUSD 1.6 strike 1 notional to find the limit for Tesco

- The desired values are in the credit tab

- Please note that the limit will be displayed in the base currency, in this case GBP

- Desired information:
  - Duration RBS is willing to extend a credit line
  - Limit on this credit line
  - Current usage of this credit line
  - Remaining available credit. CLU value should not exceed this number.

- In this example the deal is a 1y and would take up 1,646,283 GBP of the available 13,577,595 GBP so it is acceptable
  - ENSURE YOU ARE COMPARING CLU AND LIMIT IN THE SAME CURRENCY

- It is important to pay more attention the closer you get to the credit limit. A totally full credit limit means you cannot deal with that counterparty until the deals expire!

CLU: The Formula

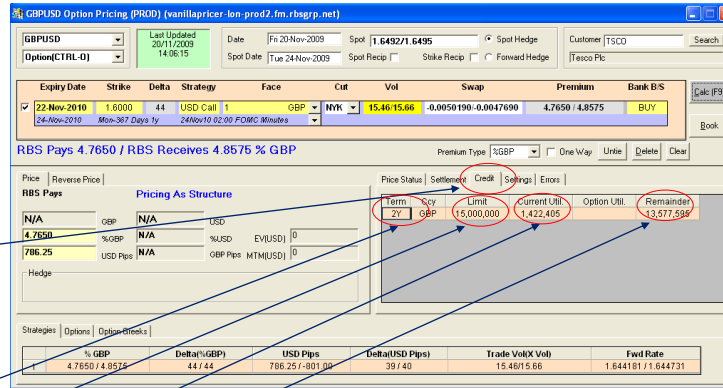**TCRM calculates CLU by simulating the expected 5th (low) and 95th percentile (high) future FX rates**
For Example:
GBPUSD 95th percentile FX rate
  = FX Forward rate * exp (1.645 * vol * sqrt(t)) for 95th
GBPUSD 5th percentile FX Rate
  = FX Forward rate * exp (-1.645 * vol * sqrt(t)) for 5th
The corresponding exposure is the CLU value.
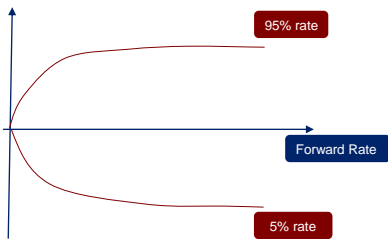
CLU is calculated by TCRM on a portfolio basis, arriving at a more correct total than summing the CLU of the individual deals could achieve

Details for the formula:

The 1.645 comes from 95% of the standard Normal distribution

T is time to maturity. It is represented as days/365
Put simply, a longer dated deal with use more CLU

The volatility represents change in the (underlying) rates
Volatility is set by Hawk risk engine that applies two principle methodologies: Monte-Carlo Simulation (MC) and Scenario-Consistent Aggregation (SCA). The methodologies heavily rely on historical rates

Further details:
The objective of the MC approach is to produce a multivariate distribution of simulated rates for a set of 26 currencies against the sterling. The approach used by the Risk Engine is to simulate the risk factors against the GBP while targeting the supplied correlations. Although the cross-volatilities are supplied, they are not used directly in Hawk.

For currencies outside of the MC set all cross-volatilities and no correlations are supplied.

Notes:
- Free floating Eurozone currencies are deemed to be highly correlated to EUR and are adjusted to reflect this
- Pegged and Managed floating currency vols are overwritten

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CVA: The Concept

CVA is credit value adjustment.
It is usually the largest portion of the credit charge

RBS uses CVA to account for some of the risks of lending money to a counterparty
•When this money is lent, there is some risk the counterparty will never pay it back
•CVA attempts to quantify this risk, but does it assuming that there is no correlation between the strength of the underlying currency and the counterparty. This is not always the case

CVA is owned by Counterparty Exposure Management (CEM).
In the event of a default, CEM promises to step in and take the loss.

Sales Tools:
Salespeople currently find CVA using Cremant.
CEM uses the same program to run the same calculation
The "Cremant Quick Pricing Guide" can be found at the CEM website or here: http://cbfmnet.fm.rbsgrp.net/S3246/P0

This calculation generates CVA, a portion of the credit charge which must be paid to CEM to insure the deal

CVA: The Formula

CEM uses:

CVA = Expected Positive Exposure * Probability of Default * (1 – Recovery Rate)
    = EPE * PD * LGD

Expected positive exposure is a projection of the total amount the counterparty would owe the bank at default
To find EPE, RBS simulates future market rates for a number of points over the life of the trade. As RBS will still be forced to pay its debts in the event of counterparty default, this negative exposure is ignored. EPE is only the total positive exposure that RBS stands to lose in the event of a counterparty default

Probability of default is the bank's projection, subject to certain regulations, of the likelihood of counterparty default
This value comes from the counterparty's MGS credit rating, which is typically inferred from the Credit Default Swap (CDS) market

LGD is the banks' projection, subject to certain regulations, of the portion of the total value of the deal the bank would recoup in the event of a default
As with PD, this value comes from the counterparty's MGS credit rating which is typically inferred from the CDS market

CEM treats all deals with a counterparty as a single portfolio. At times adding a new deal into this portfolio may naturally hedge RBS against a current position with that counterparty, resulting in 0 CVA

WWR: The Concept

WWR stands for wrong way risk.
It is a secondary portion of the credit charge and is sometimes a part of FX deals

RBS uses WWR to account for risks resulting from a correlation between the strength of the underlying currency and the counterparty
This attempts to account for macroeconomic factors that could affect the creditworthiness of a counterparty. Generally, this results from two overall types of situations:
- •Counterparty Risk: local counterparty credit status being affected subsequent to an adverse market rate move
- •Country risk: under extreme circumstances, the risk that insufficient foreign currency is available in the local market for a local counterparty to settle the foreign-currency forward obligations with RBS.

WWR is owned by Counterparty Exposure Management (CEM).
It is the second portion of the credit charge, with CEM promising to step in and take the loss in the event of a default

Salespeople currently calculate WWR using the WWR pdf files sent out daily. This process is explained within the pdf
This calculation generates WWR, a portion of the credit charge

WWR: The Formula

CEM uses:

WWR = Expected Positive Exposure * 1yr CDS/10,000 * tenor * (1 - haircut)

EPE:
EPE is Expected Positive Exposure and despite the same acronym it is different (typically larger) than the value used in CVA
$EPE = premium + (1 - \exp(-2 * FX\ Vol * SquareRoot\ (tenor))) * notional$
This is calculating total positive exposure RBS stands to lose in the event of counterparty default

1yr CDS:
1yr CDS/10,000 is using the strength of a currency as an approximate measurement of the market risks associated with the deal

Tendor:
Tenor is the length of the deal. It is (actual days/365)

Haircut:
The haircut is an RBS internal classification for the strength of the company

Exceptions:
There is no WWR for deals under a month and/or involving G-10 currencies

RWA: The Concept

RWA is risk weighted assets. It is the capital RBS must post daily to account for unexpected risks associated with a commitment
RBS is required to hold this capital by the FSA.

The RWA value that is important to salespeople is the RWA Hurdle, or income on RWA value.
This value is a desired return on the capital required to do the deal.
RBS creates this hurdle by projecting out the total capital it expects to post and applying the desired return on capital to this value

RWA is owned by Trading Credit Risk Management (TCRM).

RWA is currently calculated by salespeople using spreadsheet released by Tom Richards.
This spreadsheet has been recently upgraded so that it can handle all types of structures.
This sheet generates a RWA hurdle, or minimum AV required to do the deal

"RWA/CVA/WWR Calculator Instructions", a guide to use the spreadsheet is found on the FX Structuring page or here:
http://cbfmnet.fm.rbsgrp.net/S2467

RWA: The Formula

TCRM uses:

Spot RWA = Exposure at Default * K
This formula is mandated by FSA regulation BIPRU 13.6
In this formula K is a risk weight

RWA hurdle = Lifetime EAD * K * Desired return on capital
TCRM builds off of the spot RWA formula to create lifetime RWA. This value is then divided by the maturity to make it annualised
The variables as they apply to the lifetime RWA formula:

K is a risk weight and is a function containing probability of default, loss given default and time to maturity (PD, LGD, M)

The EAD calculation changes depending on whether or not the structure is path dependent:
If it is path dependent, RBS calculates EAD as:
EAD = MTM + add-on
The add-on varies according to length of deal and type of structure and MTM is calculated over the life of the deal and then annualised

If the structure is not path dependent the formula becomes more complicated:
EAD = EEPE * α
EEPE is found by first using the standard projections to find EPE, or total positive exposure to the counterparty over the first year of
     the deal. EPE is then adjusted to make it non-decreasing. See the picture below. The actual profile is the two curves, but the
     portions where the EPE would decrease are removed in favour of the highest preceding value.
This value is then annualised

The constant is set by FSA and has a 1.4 minimum value. RBS currently uses 1.6

Desired return on capital is set by management
Most recent hurdle can be found on the TCRM page, within the CRS IoRWA calculator
TCRM page: http://cbfmnet.fm.rbsgrp.net/S19
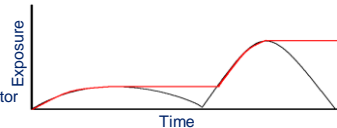
Clarifying Exposure

Given the various types of exposures covered in this topic, it proves useful to highlight the differences in how each calculation deals with "exposure".

See the explanations to the right and an example below of a hypothetical graph of CLU, EEPE and EPE for a counterparty's portfolio
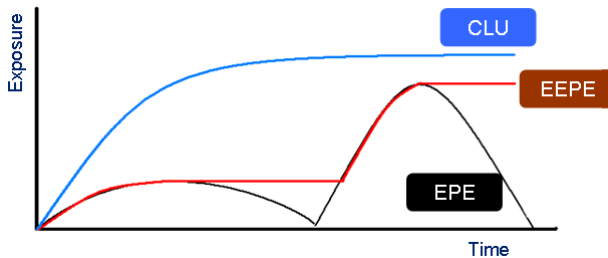
CLU:

CLU draws the potential exposure to the 95th percentile MTM of the deal

EPE

EPE is used in CVA and is occasionally written as EP.

This value is RBS' internal projections for how the deal will move to simulate projected loss

EEPE

RBS' FSA approved projection method. It calculates non-decreasing exposure to a counterparty

EAD

EAD is used to calculate RWA and is very similar to EEPE as:

EAD = EEPE * α; where α varies by bank and is 1.6 for RBS

Similar to EEPE, but this portion of the formula is mandated for all by the FSA

Practical Application

FINDING THE NUMBERS:
CVA is found using Cremant
CEM's userguide: http://cbfmnet.fm.rbsgrp.net/S3246/F66/download/Cremant_Quick_Pricing_guide_Ver5.pdf

Cremant is the same program CEM uses and the CVA value it produces is the final value

CLU is found using the NMOSS credit calculations for CLU and the vanilla pricer for maximum exposure and current usage
A demonstration of this is shown earlier in this guide

The CLU value is CLU for the single deal only as the actual simulation run by TCRM would take too long
It is close enough to be used but it is not the final, exact value

WWR is found using the WWR pdf files sent out daily
The formula is explained within the sheet

RWA is found using Tom Richards' spreadsheet
The RWA value is RWA only for the single deal as the actual simulation run by TCRM would take too long
Userguide from FX Structuring: http://cbfmnet.fm.rbsgrp.net/S2467/F128/download/RWA_CVA_WWR_How_to.ppt

USING THE NUMBERS:
Cost of structure = NMOSS quote - CVA – WWR
At this value RBS is making no money on the structure

Addressing the RWA hurdle, or the required return on equity set by management, comes next. This is the recommended profit on this single deal
It is important to note that RWA hurdles can be slightly tailored to counterparty. With permission of a sales manager, it is allowable to go under the RWA hurdle on a deal if it can be reasonably expected to lead to high AV deals in the future

CLU is used to check if the deal will break the maximum allowable exposure to the counterparty. If so, the deal must be changed in some way to stay under this limit

4.1.2 Bank Specific Pricing Components

To address this topic we created a brief guide discussing the necessary adjustments to prices for deals with uncollateralized clients. We also created a one page laminate for faster reference. The overall process as it is presented on our laminate and our full training program can be found on the following pages:
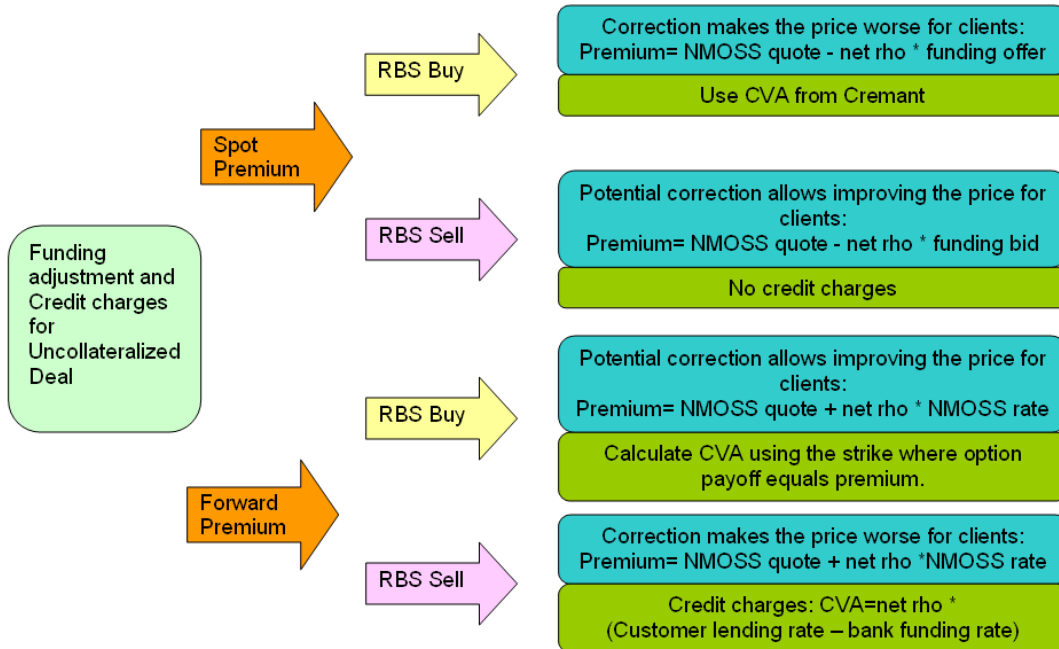
Figure 2: Funding Fix Laminate

Funding and Credit Charges for Vanilla Options:

Spot and Forward Value Premium

Correct as of Nov 2009

Contents

Objective

- This guide is intended to explain how changes to Bank Funding rates resulting from the recent financial crisis have affected vanilla option prices quoted in NMOSS.

- It will also discuss why the convention of Forward Value premium is increasingly being adopted for vanilla options and what adjustment to Spot Value premium prices must be made to allow for this.

- Finally, it will cover the calculation of Credit Charges for Forward and Spot value premium vanilla options.

Why are Interest Rates so Important to Option Pricing?

- The interest rate is a key component of the Black and Scholes option pricing formula.

- The correct interest rate must be used or a mis-price will result.

To know what rate is the correct one to use, let's consider the "mechanics" of trading options for both uncollateralised and collateralised counterparties.

Option Mechanics: Uncollateralized Counterparty

- Consider the example where an uncollateralised customer sells an option to RBS and receives premium value spot.

- RBS has an immediate outlay with no return for 1 year. Thus RBS must fund the amount of the premium for 1 year.

- The relevant rate to use in the option pricing formula is the rate at which RBS is able to obtain funding in the interbank market i.e. the RBS funding rate.

	RBS position		Customer position
Now	-premium	RBS pays spot value premium to customer	+ premium
	RBS must fund this position		
1 year later	+option payoff	Customer pays RBS if the option is in the	-option payoff
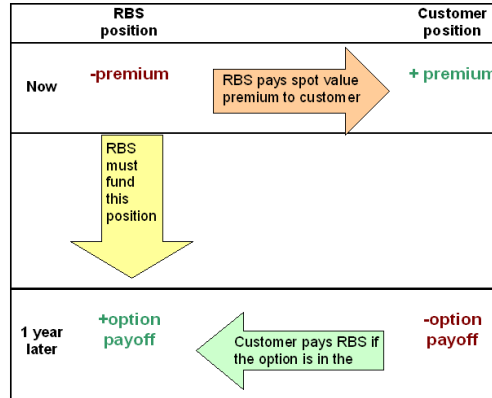
Option Mechanics: Collateralized Counterparty

- Consider the example where a collateralised customer sells an option to RBS and receives premium value spot. Since they are collateralised, they must post an amount with RBS equal to the outstanding mark-to-market of the option. At the outset this is equal to the premium. In this way the premium that RBS pays is immediately "returned".

- RBS no longer needs to find funding for the premium because it is being provided by the counterparty themselves. However under the collateralisation agreement, RBS must pay interest on this collateral at a special rate known as OIS.

- The relevant rate to use in the option pricing formula in this case is OIS.

	RBS position		Customer position
Now	-premium	RBS pays spot value premium to customer	+premium
	+premium	Customer post an amount=outstanding MTM of the option with RBS	-premium
	RBS no longer needs to fill the premium "hole" since this has been done by the customer. The price for this is the interest under OIS rate		
1 year later	+option payoff	Customer pays RBS if the option is in the money	-option payoff

What is NMOSS actually doing?

- NMOSS in its current form strictly prices Spot Value premium options for Collateralised counterparties. The interest rate it uses is neither the RBS funding rate nor the OIS rate, but rather a third mysterious hybrid rate that is consistent with historical industry conventions.

- While this interest rate was always known to be "wrong" the volatilities quoted in the market recognised this and were adjusted to correct for it. Thus the prices output by NMOSS were correct for Spot Value premium options for Collateralised counterparties.

- Note that the interest rate of the non-premium currency is implied from the mysterious premium currency hybrid rate and the (correct) forward points. That means that while the interest rates are both wrong, their *differential* is correct. This will be useful later.

Let's summarise the three key funding rates.

Three Flavours of Funding Rates

Rate	definition	Used for	Value
RBS Funding Rate	The rate at which RBS can fund itself for maturities less than one year	Uncollateralized counterparty	As of November 9, 2009 it is about LIBOR + 40bp
OIS	Collateralized funding rate	Collateralised counterparty	As of November 9, 2009 it is about LIBOR – 20bp
NMOSS Rate	Hybrid of two interest rate curves based on historical industry conventions that are now obsolete	Collateralised counterparty	Similar to OIS, could be used for collateralised counterparty

NMOSS interest rates are close enough to collateralized rates that RBS is treating NMOSS quotes as correct spot premium for a collateralised counterparty

Although ok for collateralized, using the NMOSS quote for an uncollateralized client leads to an incorrect premium

"The problem: incorrect premium for uncollateralised counterparty"

Historically, NMOSS prices were correct for **Uncollateralised** counterparties because bank funding rates were the same as collateralised funding rates. As a result of the financial crisis, these interest rates have diverged. This has had two consequences:

1. NMOSS prices for uncollateralised counterparties are now wrong

2. To eliminate the Funding component from vanilla option prices, interbank convention has shifted to Forward Value premium pricing. This convention is likely to extend beyond the Interbank market so everyone needs to understand what adjustments apply for Forward Value vs Spot Value premium prices. For this reason, when asking option prices from traders, you now need to specify the premium value date.

A Solution for Spot Value Premium Deals for Uncollateralised Counterparties

What is Rho?

Rho represents the sensitivity of the premium of a structure to a change in interest rate

Take a GBP call, USD put spot deal with GBP pricing preference as an example:

Rho GBP is the GBP amount that NPV will change with 1% change in GBP interest rates

Rho USD is the GBP amount that NPV will change with 1% change in USD interest rates

Currently:

Recall that for uncollateralised counterparties, the GBP and USD rates are wrong *by the same amount*. That means the resulting error in the premium can be quantified by using the net Rho figures.

Solution:

Reduce the NMOSS premium by net rho * (RBS funding rate – NMOSS Rate)

Net rho represents the net change in NPV with each 1% change in both rates, allowing us to quantify the effect of correcting the NMOSS quote

Rho is found in the Greeks tab of NMOSS and displays as shown

In the example shown here:

Corrected premium = 646,534 – (98,396 + (-85,522)) * Funding Rate Differential

	Aggregate	1
Code:		OTCC
Type:		Vanilla
Style:		
Buy/Sell:		Sell
EUR:		Call - EUR
USD:		Put - USD
Strike:		1.5000
Barrier1:		
Barrier2:		
Expiry:		Thu 08-Dec-2011
Delivery:		Mon 12-Dec-2011
EUR Amnt.:		10,000,000.00
USD Amnt.:		15,000,000.00
Include?:		Yes
Details:		
NPV:	-646,534	-646,534
Deal?:	N/A	Refer
	Aggregate	1
Delta USD:	6,332,626	6,332,626
Gamma USD:	-316,263	-316,263
Vega EUR:	-54,858	-54,858
Theta EUR:	434	434
X FactorEUR:	8	8
Y FactorUSD:	-5,150	-5,150
Rho EUR:	98,396	98,396
Rho USD:	-85,522	-85,522

Quote | Profile

Strategy Parameters:
Ccy Pair: USD/EUR
EURUSD
Details⁻¹ ☐ Rates⁻¹ ☐
Spot:
1.4848 / 1.4850
Counterparty:

Strip ☐

Presentation:
Pricing Preference:
EUR

Position:
Bank

Dates:
Trade Date:
08-Dec-2009
Spot Value Date:
10-Dec-2009

▶ Greeks
Prices
Rates

25

Vanilla Option: Customer buys / RBS sells, Premium Value: Spot

Situation:	**FUNDING:**
Customer buys: Customer gets vanilla option RBS sells: RBS gets premium	By paying premium upfront, customer is assisting RBS's funding position We can monetize the difference between the rates in the system and the rate at which RBS can get funding using net rho. Therefore, the updated spot premium is: **Premium = NMOSS Premium - Net Rho * Funding bid differential** However, the salesperson can choose to not share this lowered cost with the client and keep it as AV.
	CREDIT: No credit charges. The customer owes no money so there are no issues with credit

Vanilla Option: Customer sells / RBS buys, Premium Value: Spot

Situation:	**FUNDING**
Customer sells: Customer gets premium RBS buys: RBS gets vanilla option	Paying premium upfront is detrimental to RBS's funding position Thus RBS **Premium = NMOSS quote - Net rho * Funding offer differential**
	CREDIT Since RBS buys the option and exposes to potential loss when counterparty defaults, there will be credit charges **CVA from Cremant**

Addressing Changes in Forward Premium Options

Changing the NMOSS premium to a forward premium requires "inflating" at the correct interest rate.

- NMOSS shows spot value premium for collateralised counterparty.
- The correct rate to "inflate" is the discount rate for collateralised counterparties is the OIS rate.
- In matters of funding, forward value premium is the same for all counterparties so these fixes will always work

Adjustment (see next pages for demonstration):

Add net rho * NMOSS (*) Rate to the premium that NMOSS reports

Check

As a double check of this number, enter a triggered digital (eg AUIM or ADIM then double-click on the barrier and choose "Yes") with the rebate equal to this inflated premium. Confirm that the NPV of this instrument is the same as the spot value premium.
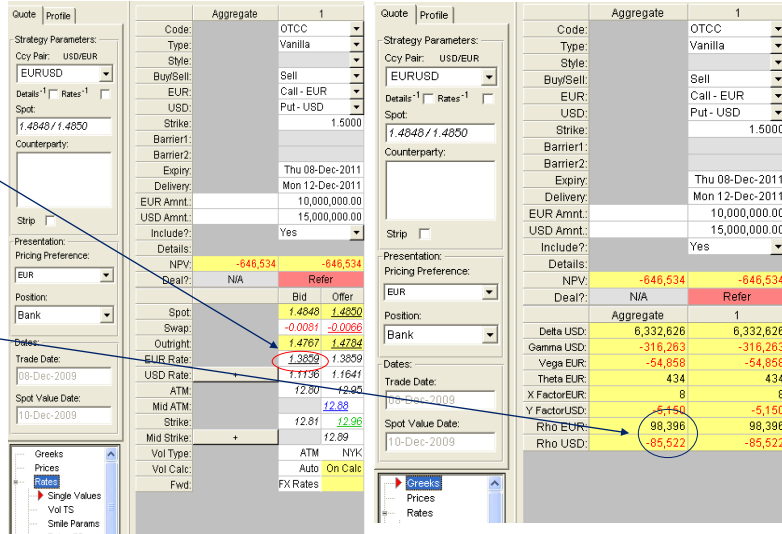
(*) strictly speaking we should be using the OIS rate here, but this is close to NMOSS and these adjustments are interim measures until the systems are upgraded

Finding Forward Premium Using Net Rho

Select :

"Rates-> Single Values"

to find NMOSS Discount rate.

"Greeks"

Then find the absolute value of the difference in Rho values to find Net Rho

Corrected premium :
= NMOSS premium + net rho * NMOSS rate
=646,534 + 12,874 * 1.3859 = 664,376.08

Checking Forward Premium Using Triggered Digital

Construct a digital ADIM in NMOSS, and trigger the barrier by double clicking on it.

(the level of the Barrier doesn't matter)

Enter the rebate amount calculation previously and recalculate the file

Note that the present value of referred premium is equal to the present value of the option.

Conclusion:
Corrected premium = notional of the triggered digital = 665,000

	Aggregate	1	2
Code:		OTCC	ADIM
Type:		Vanilla	Digital (US)
Style:			Down & In (Matu
Buy/Sell:		Sell	Buy
EUR:		Call - EUR	
USD:		Put - USD	
Strike:		1.5000	
Barrier1:			2.0000
Barrier2:			
Expiry:		Thu 08-Dec-2011	Thu 08-Dec-2011
Delivery:		Mon 12-Dec-2011	Mon 12-Dec-2011
EUR Amnt.:		10,000,000.00	665,000.00
USD Amnt.:		15,000,000.00	N/a
Include?:		Yes	Yes
Details:			
NPV:	113	-646,534	646,646
Deal?:	Refer	N/A	N/A
	Aggregate	1	2
Delta USD:	6,332,626	6,332,626	0
Gamma USD:	-316,263	-316,263	0
Vega EUR:	-54,858	-54,858	0
Theta EUR:	458	434	25
X FactorEUR:	8	8	0
Y FactorUSD:	-5,150	-5,150	0
Rho EUR:	85,428	98,396	-12,968
Rho USD:	-85,522	-85,522	0

Quote | Profile

Strategy Parameters:
Ccy Pair: USD/EUR
EURUSD

Details⁻¹ ☐ Rates⁻¹ ☐

Spot:
1.4848 / 1.4850

Counterparty:

Strip ☐

Presentation:
Pricing Preference:
EUR

Position:
Bank

Dates:
Trade Date:
08-Dec-2009

Spot Value Date:
10-Dec-2009

Greeks
Prices
Rates
  Single Values
  Vol TS

RBS 15

Vanilla Option: Customer buys / RBS sells, Premium Value: Forward

Situation:

Customer buys:

Customer gets vanilla option, holds forward premium until delivery

RBS sells:

RBS receives forward premium on delivery

FUNDING

Correct the premium by either using

Premium = (NMOSS quote + net rho * NMOSS Rate)

Check by iterating with a triggered digital, as showed in previous slide

CREDIT:

RBS is lending premium to customer for duration, so there will be credit charges. The pre-existing method for addressing this is to use the bank's lending rate to this customer to calculate credit charges. Using this rate will give a conservative number as the lending rate already accounts for funding aspects.

Ways to find the charge without using the lending rate:
Credit charge = Net rho * (customer lending rate - bank funding rate)
or
Credit charge = 1 year PD * maturity * LGD * prem

RBS 16

Vanilla Option: Customer sells / RBS buys, Premium Value: Forward

Situation:	**FUNDING**
	Correct by using
Customer sells:	**Premium = (NMOSS quote + net rho * NMOSS Rate)**
Customer receives forward premium on delivery	**Check by iterating with a triggered digital**
RBS buys:	
RBS gets vanilla, holds forward premium until delivery	**CREDIT:**
	Performing a Cremant calculation of the CVA on the original option will be conservative. RBS has not yet paid the forward premium and this lessens exposure to the counterparty as it can withhold the premium if the counterparty defaults.
	Solution:
	Perform the Cremant calculation of the CVA on an option with a strike equal to the break-even strike of the actual option.

A Final Notice

- During this module we have spoken about the Funding adjustments that must be made to NMOSS prices for uncollateralised counterparties or for a Forward Value premium. These manual adjustments will only have to made until systems are upgraded to be "Collateral Aware". It is for this reason that pricing systems will require the counterparty name before calculating a price.

- Not all banks are at the point of including Funding aspects in their pricing. When you are showing prices in competition against such banks, opportunities may exist!

- This module has only covered the Funding aspects of Vanilla Options. Adjustments to existing system prices will also be required for non-Vanilla options involving premium and possibly even to restructures where no premium is paid. Please contact the FX Structuring desk in these circumstances.

4.1.3 Appropriateness

This guide is intended to provide the information a new FX salesperson must understand to be able to do their job. This guide is a road map, giving general definitions and descriptions before offering links to documents with more specific information.

This topic was quite difficult to pin down. We ended up splitting it into four large sections: Overarching Concepts, Pre-Deal, During a Deal, and Post-Deal. This split worked naturally as it made it clear that appropriateness contains more than ensuring a client is matched to a structure that addresses their needs. Our full training guide can be found on the following pages:

GLOBAL BANKING & MARKETS

RBS
The Royal Bank of Scotland

Protecting your client, your bank and yourself

Nov 2009

Objectives

At RBS we seek to transact the right FX product. We are not interested in just doing a deal, but rather the *appropriate* deal. We strive for relationships with our clients which are successful over the long term.

Doing the right deal sometimes means saying "no" to a customer.

This training module covers what attributes make the right deal, what information should be conveyed to the customer with all deals and what pitfalls to avoid.

It is intended to give new starters within FX sales a general concept of relevant topics within the FX world.

"The right deals, transacted in the appropriate manner are essential to building mutually valuable long-term relationships between RBS and it's customers. Demonstrating and documenting the customers acknowledgement of its business, along with the benefits and risks associated with these FX solutions, only enhances our relationship through the cycle"

Iain Boot

Head of CRS UK & Channel Islands

RBS

Contents

Overarching Concepts

This section covers topics a salesperson needs to understand and think about at all times

Overarching Concepts: Reputation Risk

Reputation Risk
The risk that being involved in a deal would lower public opinion of RBS. Even if RBS is not legally liable for the outcome of a deal, reputation risk may still exist
RBS is most concerned about the opinions of regulators and customers

Understanding who owns and manages the customer via the KYC process assists to a certain degree in assessing the customer risk, as does due diligence throughout the transaction.

We should always be conscious of the record and reputation of our customer and be sensitive to the openness and transparency with which it conducts its relationship with us and appears to conduct its business generally.

Although RBS is not liable for the conduct of a customer, the customer may feel differently. Therefore, if a customer suffers as a result of doing business with RBS the customer will likely think less of RBS as an institution. This situation should be avoided

Overarching Concepts: Overriding GBM Principles

Overriding GBM Principles

If the details of the transaction were in the public domain, we would feel entirely confident that our role in the transaction could be substantiated as part of our normal business activity.

A key objective is to identify those transactions which require additional scrutiny at inception and to ensure that such transactions receive a level of review commensurate with the legal and reputation risks associated with the transaction.

GBM relies on the experience and professional judgement of its employees to identify these risks, but examples which may require additional scrutiny include:
- Transactions with questionable economic substance or business purpose
- Transactions whose economic effect is offset by a simultaneous transaction involving the same parties or their affiliates
- Transactions which appear to be designed primarily to achieve a tax or financial reporting effect, particularly when executed at year end or at the end of a financial reporting period, or to avoid regulatory or legal requirements
- Transactions with unusual profits or losses or which give rise to compensation which appears disproportionate to the services provided by CBFM or to the risks assumed by CBFM
- Transactions involving requests for side letters or other oral or undocumented agreements, which are not expected to be reflected in the transaction documents

Overarching Concepts: No Investment Advice

It is important that your conduct does not give the client any reason to believe that advice is being offered.

Each client should be made aware at the outset of a proposed transaction that RBS is not acting as its adviser. Verbal reminders to the client are recommended.

If a client asks for advice, an opinion or recommendation in respect of any investment product or strategy, the client should be informed that RBS do not advise, recommend or otherwise give an opinion.

What can be said will depend on the context, form, precise content, characteristics of the client and the nature and complexity of the product (or strategy) under consideration.

If it appears that the client may be relying on RBS, or otherwise viewing RBS as an adviser or fiduciary this should immediately be brought to the attention of your line manager and, if necessary, GBM Regulatory Risk. The client's perception of its relationship with RBS should be corrected immediately. Written confirmation is encouraged.

Investment advice is likely if a salesperson gives a recommendation to do a specific deal given the counterparty's unique circumstances.

Permissible dialogue:
- A Vanilla Forward would allow you to lock in the current Forward Rate
- Have you considered the benefits of entering into a collar?
- A participating forward may be appropriate to manage your exchange rate exposure.

Non-permissible dialogue:
- **If I were you**, I would enter into a Forward Plus to lock in a known worst-case rate with some participation;
- From what you have told me, a collar **is the right product for you** to manage your Foreign Exchange rate risks;
- With exchange rates set to rise, **you should enter into a vanilla option** as a form of protection;
-Comparing the attributes of Forward with those of a Collar, the Collar **is the best product for you.**

Pre-Deal

This section covers topics a salesperson frequently needs to understand before dealing with a client

Pre-Deal: Requisites

Requirements before a counterparty can do deals with RBS

All clients need to have completed a **Know Your Counterparty (KYC) form,** to be **classified** and to have a **credit line** before a salesperson can do a deal with them

FSA regulations require RBS to determine certain information before doing a deal. RBS complies by performing a KYC and classification on all counterparties. Internal policy requires the credit line

KYC

This is largely a protection against money-laundering

Counterparty classification

Determine which of the set FSA classifications the counterparty falls in. This defines how RBS can do business with client

Credit Line

Most FX transactions have a chance of being out-of-the-money for the client at some time in their life. That potential future unrealised loss represents a credit exposure for RBS. This exposure (also known as the Credit Limit Utilisation or CLU) is quantified at the outset of each FX transaction and is monitored throughout its life. The **Credit Line** is the limit of the acceptable duration and amount of the total exposure that RBS has with a client.

If an unfamiliar client calls in, it is vital the pre-deal work has been done:

-First check to see if the client has a credit line

-If the client does not have a credit line, open up Nucleus and check if the client is listed

-If the client is not listed, use a similar company to determine the client sector and forward the client to the relevant Relationship Manager (RM)

Pre-Deal: KYC and Counterparty Classification

Although KYC and classification are largely the responsibility of an RM, a salesperson may be asked to help. It is therefore useful to have a general understanding of them.

Know Your Counterparty (KYC)

FSA regulations require RBS to gather information on a client before doing a deal. The intention is to prevent money laundering. The process requires RBS to:

-be reasonably satisfied that customers are who they say they are, to know whether they are acting on behalf of another

-determine that there is no legal barrier (e.g. government sanctions) to providing them with a product or service

-assist law enforcement, by providing available information on customers or activities being investigated.

If interested, further details on the KYC process can be found here:

http://cbfmnet.fm.rbsgrp.net/S1344/P17

Classifying the Counterparty

Before RBS can deal with a counterparty, the counterparty must first be classified. This is a response to FSA regulations setting how RBS must treat each classification of counterparty. There are three classifications:

Retail	Professional	Eligible (Eligible Counterparty)
■ Clients not falling within the definition of Professional or Eligible clients	■ Are considered to be sufficiently experienced and knowledgeable to make their own investment decisions and assess the risks inherent in their decisions	■ Are the most sophisticated investors or market participants
■ Are afforded the most regulatory protection	■ Are afforded fewer regulatory protections	■ Only trading businesses can have this category of clients
		■ Are provided a 'light-touch' regulatory regime

If interested, further details on the classification process can be found here:

http://cbfmnet.fm.rbsgrp.net/S809/F15/download/GBM_Client_Categorisation_Policy.pdf

This page explains the process to create a new counterparty and provides more useful links:

http://cbfmnet.fm.rbsgrp.net/S809

Pre-Deal: Legal Definition of Relationship

RBS requires that there is a contract that defines terms and stipulates how RBS will work with the counterparty. Professional and Retail counterparties receive:

Terms of business:
- A smaller document that takes portions of ISDA, allowing RBS to do business with smaller counterparties interested in smaller hedges

What is an ISDA?
International Swap Deals Association (ISDA):
- The strongest protection for RBS and therefore its preferred contract. This is an industry standard agreement that provides the necessary term and relationship definitions
- This is a lengthy document and carries with it some document legal review fees

- Any of the following factors, listed in order of importance, make a counterparty more likely to have an ISDA:
-- Large company
-- Long dated deals
-- High value deals
-- High frequency of deals

All retail and professional counterparties get a Terms of Business
Some counterparties sign an ISDA, an act made more likely by the above factors

Pre-Deal: Contact Clearance

Is the contact within the counterparty cleared to deal?

Situations do exist where the contact is not cleared. It is therefore very important to try and ensure that the contact is able to commit the counterparty to a deal

However, there is no formal process to go through to ensure that the contact has authority, but salespeople must not assume the contact has authority

Potential considerations to check if the contact can deal:
-        What is the decision making process of the company?
-        Is the contact a company officer? If not (for example, if they are a financial controller or accountant) then it becomes more important to ask
-        Is the client a subsidiary? If so, does their parent company approve of FX deals?

During a Deal

This section covers topics a salesperson frequently needs to understand
while proposing a deal to a client

During a Deal: Frequently Useful Information

The product solution is the last piece in the puzzle. In order to determine the appropriate solution, you first need to gather as much information as possible about the client and the nature of the exposure. Here are some topics you should pursue as part of this investigation.

Risk management aims
What is the client trying to accomplish by hedging? What did they call FX structuring hoping to do?

Cashflow analysis
Avoid solutions with potential obligations in excess of the customer's underlying flows

Internal Policy of the client
Proposed solutions need to be consistent with the company's internal hedging policy (if one exists)

Budget rate
The position of the budget rate relative to prevailing market rates will have a big impact on the nature of the potential hedge.

Past hedging policies and internal opinions of them
What has been previous hedging practice and how successful has it been?

Frequency of price changes
A counterparty that frequently adjusts its prices will typically be less interested in entering into long dated hedges

Contractual exposures of the company
If hedging against a cash flow coming from a contract, what does the contract say? What parts are guaranteed?

Profit margins
Profit margins roughly equate to a company's tolerance to risk. Lower margins means a smaller rate move could cause bankruptcy. Unfortunately, it also makes the client less able to afford hedges

Sensitivity of client to balance sheet vs. P/L volatility
How much P/L volatility is a lot to the counterparty? £200,000? £300,000?

Competitiveness of the marketplace
Is the client still able to make money if it is locked into an unfavourable rate?

Always check if the desired hedge and rate are realistically possible. Do not be afraid to say no!
Further details on useful information can be found in "9 Key Topics" here: http://cbfmnet.fm.rbsgrp.net/S3242/P1

During a Deal: Structure Selection

FX Structures:
The vast majority of structures are complicated packages of the same building blocks. It is therefore useful to understand them before venturing out into the more complex products:
- spot deals
- FX forwards
- options:
>   1st generation: over-the-counter call (put) OTCC/OTCP
>   2nd generation: Knock in, Knock Out; Digital
>   3rd generation: script, baskets

The FX Structuring Guide (currently version 2009) explains these and other more complex structures:
Found on the FX Structuring Help and Advice section: http://cbfmnet.fm.rbsgrp.net/S2467

The trade offs required to offer a better rate:
When dealing any structures, the ability exists to offer the client a better rate. It is important for a salesperson to understand that this better rate comes with risks and to be sure that the client's flows can support all potential outcomes.
For example:
A client wishes to use gearing to get a better rate on a structure:
-This means the client agrees to take double the notional in some cases
-Ensure the client has flows that enable it to meet this obligation! If the client is using gearing to gamble that rates won't move greatly in order to get a better rate, a salesperson can say no!

A client wishes to use a knock-out to get a better rate:
-This means the structure will terminate after it becomes a certain amount in the money (meaning that it will stop protecting the client just when the client needs the protection the most)
-Ensure the client can survive this risk and is not gambling that this outcome will never happen to get the better rate

In all cases, ensure the client understands the risks and has flows that fit with the chosen structure. It is not RBS' place to facilitate a counterparty betting a situation will not happen, a salesperson can say no!

During a Deal: Hedge Accounting

IAS/FAS Accounting Considerations

There are two accounting standards to be aware of: FAS 133 for the United States and IAS 39 for most of the rest of the world.
Under these standards, all hedging activity must be accounted for at fair value. The standards also lay down circumstances where a concept known as *Hedge Accounting* may be applied. Hedge Accounting permits changes in unrealised mark-to-market of a hedge to be reported to the Income Statement *only when the underlying exposure matures.*

One of the main differences between IAS 39 and FAS 133 is that under IAS 39 only the intrinsic value of an option designated as a hedge qualifies for hedge accounting while FAS 133 allows both the intrinsic value AND the time value of an option to be designated for Hedge Accounting.

Hedge accounting is desirable for counterparties with concerns about the impact of hedging on their Income Statement. RBS has an application to help understand the implications of IAS/FAS The key features:
- Displays the effects of splitting or "bifurcating" a complete hedging solution into one part that qualifies for hedge accounting and a residual part that does not
- Reports this split adhering to either FAS or IAS standards

This tool can thus be used to demonstrate the likely volatility that will be introduced into the Income Statement as a result of transacting a hedge solution.

Both the FX Structuring Guide (currently version 2009) containing more details on IAS/FAS Accounting and the IAS/FAS helper spreadsheet can be found at: http://cbfmnet.fm.rbsgrp.net/S2467

During a Deal: Tax Motivated Deals (1 of 2)

Following RBS becoming largely government owned, it has lost virtually all of its appetite for deals with tax implications
The deal no longer needs to be entirely tax motivated to be turned down. It simply needs to have an obvious tax angle

The Bank is regularly approached by customers wishing to undertake transactions primarily for tax purposes and which require us to facilitate the transactions in some way. These proposals vary considerably in terms of their level of tax-aggressiveness and hence they must be looked at on a case-by-case basis.

However, the following guidelines should greatly assist the consideration of such proposals:

- The Bank has to consider the extent of any reputational risk (primarily with the Inland Revenue / Customs & Excise) it is incurring by assisting the customer (even if RBS' role appears relatively simple)

- Inserting the Bank into a transaction merely to authenticate it is unlikely to be approved. The Bank's fundamental rationale in such circumstances is that there should be a commercial reason. In addition great care must be taken when we are undertaking the transaction for no other reason than to defer/save/avoid tax.

- **If such a proposal is brought to you it should be referred to Simon Pudge, Head of Tax, Corporate Banking (tel 020 7714 4595)** at the earliest opportunity. The customer should also be asked for copies of all advice he has received in respect of the proposal (accounting/tax/legal/Counsel's opinion) as they will make it easier for Group Tax to analyse and assess. If the customer is unwilling to provide such documents, the proposal should be refused.

- However simple the customer may believe the Bank's role to be, due to our concern over reputational risk the foregoing review and discussion takes a significant amount of management and executive time. In addition the administration of our participation may well be complex in order to achieve the desired aim. The resulting substantial internal costs and potentially future costs if tax authorities question RBS must be considered when entering into such transactions.

During a Deal: Tax Motivated Deals (2 of 2)

There is no complete list of features which may indicate that a deal is tax motivated or has tax risk, but the following should be a useful checklist:
- Off-market pricing in certain parts of the structure
- An interest rate which is related to profits or some other factor
- Special purpose vehicles
- Inclusion of off-shore entities
- Unexpected use of derivatives
- Circularity
- Unusual share capital in terms of rights or values
- Borrowings for unusually short periods
- Cash being offered back as collateral

If a deal shows one or more of the above features, the tax motivation question should be asked and if there are any doubts, the transaction should be referred to Group Tax.

During a Deal: Credit Process

Credit Utilization

When you do a deal with your counterparty, you have to check the client's credit utilisation status and ensure that the deal CLU will not exceed available credit line.

CLU of any proposal can be found in the NMOSS credit calculation, while total line and current utilization of the line can be found in the vanilla pricer.
The detailed procedure could be found in the RWA_CVA_WWR_CLU training module.

However, this CLU is indicative only. The actual CLU value is owned by TCRM
The formula used to calculate CLU in NMOSS is the same one TCRM uses, but NMOSS potentially can still differ from official TCRM CLU. If you wish to be sure, contact TCRM for a finalized quote before dealing

TCRM contact information can be found in the TCRM contacts sheet: http://cbfmnet.fm.rbsgrp.net/S19

If the client wants a structure that will break their credit line, options do exist:

Credit Support Annex (CSA): An amendment to ISDA that serves as a collateralization agreement.
- This allows a counterparty to post the value of RBS' exposure according to certain conditions. Collateral serves to greatly lower and could totally eliminate all CLU from a deal.
- If the counterparty has not signed an ISDA, giving them a CSA will require the counterparty to sign one

Speak to your RM about a CSA if it seems useful for your client

During a Deal: Proposing a Structure

RBS has its own internal requirements for showing proposals. This is not legally mandated, rather this is a product of RBS' experience over time.

The proposal can be broken up into sections, with specific best practice requirements for each:

Background
- Contact information for the RM and the salesperson
- State the goal of hedging
- Mention methods previously used to hedge
- Show the spot used to calculate deals. If client is unsure on the final notional, state the one used in projections

Proposed Hedging Categories
- Provide at least three alternatives (frequently starting with do nothing, forward and vanilla option before going more exotic)
    -- Explain the protection against rate movements offered for each structure
    -- Explain the flexibility to participate in favourable rate movements offered
    -- Mention the premiums
    -- Mention the maximum obligation of the structure
    -- Mention the maximum term of the structure
- Provide a comparison between the structures generally explaining under what rate it would be ideal

Notes/Disclaimers:
- Show the CLU of each deal and make clear the (potentially high) breakage costs for each strategy
- Make clear the pricing is indicative only
- Mandatory CLU disclaimer and mandatory general deal disclaimer

Do not be bound by these requirements! The goal is to provide the client will all necessary info. If something else seems helpful, don't be afraid to include it

Giving the final price quote and closing the deal over the phone has certain requirements. All conversations take place on a recorded line and should confirm the following:

- The client is aware they are being recorded, which is normal, and that the recording forms a record of the agreement to deal
- Client has read and understood all documents containing details of the proposal
- The client is authorized to deal within its company (has the full capacity to enter the transaction on behalf of xxx)
- RBS is not a financial advisor and does not provide investment recommendations
- Alternatives were discussed and the client choose this structure
- The transaction type and potential outcomes. This should include whatever is relevant to the deal including spot, premium, maximum notional etc…
- Breakage costs and CLU of the deal
- If the deal is a restructure, mention the current MTM (potentially a loss) of the current deal

Once satisfied the client understands and agrees to the deal, execute it

Post-Deal

This section covers topics a salesperson frequently needs to understand after closing a deal

Post Deal: Showing Valuations

Deal valuations are shown only on client request
It is possible for a client to never request a valuation on their deal

Valuations are requested for a variety of reasons
- Accounting requirements
- Interest in deal value
- To report at financial year end
- To begin the process of closing a deal early

The exception to this is when restructuring a deal:
It is good practice to ensure the client understands the current MTM of their deal and does not believe it
can hide from losses by rolling them into the future

Post Deal: AV Amortisation

Amortisation of AV

If a valuation is requested on a <u>high AV deal</u>, <u>soon after the transaction date</u> and there <u>have been minimal</u>
<u>market movements</u> then showing a valuation will essentially show the client the AV taken on the
deal
Showing the client RBS' AV is bad practice and should be avoided

To address this issue, RBS allows for amortisation of AV
Any AV adjustment is manual (which can sometimes cause problems for products such as Ccy Option Structures)
and is recorded in a log by Client Valuations as adjustments have to be recorded in the 'Banks Books and
Records'. The maximum length of time for amortisation is 12 months and, as far as they're aware, there are
no specific amount limits set out.

The current process is as follows:
- Front Office / Sales identify trade that requires AV to be amortised
- Front Office / Sales inform the relevant Head of Trading (Peter Neilsen/Symon Drake Brockman) including
business justifications
- Front Office / Sales obtain relevant sign off this MUST be from Peter /Symon or a direct report who is FSA
Approved
- Front Office / Sales informs the Client Valuations Team
- The Client Valuations Team check appropriate sign off has been obtained & Obtain signoff from FD (Chris Kyle)
- Trade is added to the AV log and the Collateral Team notified of the client and trade
- Trade is flagged in the systems as sensitive and the MTM is manually adjusted prior to being sent to the client
(all changes go through an authorisation step)

Post Deal: Restructure

Restructuring:
When the market moves significantly against a customer's hedge, how can we ensure that the relationship with the client remains on the best possible terms over the long-term?

When the customer is faced with such a position, it is much better to initiate discussion of alternatives rather than to wait for them to react. The benefits of this are:
- Monitoring of the customer's attitude
- Reinforcing the feeling they are not own their own
- Building the relationship

Remind the customer that while the market has moved against their hedge, this means it has moved in favour of their ongoing exposures.
Unless they are overhedged, this is often the best possible outcome. It allows future hedges to be transacted at better levels, if necessary improving the existing hedges along the way.
Also worth noting is if the hedge was sold properly in the first place, the customer will have acknowledged at the time that they were comfortable with all possible scenarios (including the current one).

If the underlying exposure of the customer will be better hedged by a new structure, it may be time to consider restructuring the deal
It is good practice to show current MTM (ie current closeout costs) alongside the restructuring alternatives

IMPORTANT:
Do not give the impression that restructures can solve all problems.

Further details on Restucturing can be found in the Training Module "Restructuring"

Post Deal: HRR

A type of restructure to look out for is Historical Rate Rollover. RBS policy is to avoid HRR, but there is a rigid process that allows for them in cases of legitimate need

HRR allows a counterparty to roll a deal forward at a historic rate. When used correctly, it allows a counterparty to defer the receipt of a cash flow it is not currently able to take to a later date
HRRs are a touchy subject due to this ability to defer receipt. By deferring the maturity date, the counterparty is able push loss on the deal until a later quarter (or potentially into the next business year)
This potential for fraud carries with it high reputational risks

RBS salespeople are never to suggest HRR as a potential solution. They can, however, be done if the client approaches the salesperson

Be aware the process is region specific. Check with your RM or compliance to find the HRR approval policy for your client's area

General Approval process for HRR in the UK:
- Client asks for an HRR
- Salesperson checks with line manager, gets approval
- Salesperson checks with compliance, gets approval
- Salesperson asks counterparty for a high level financial officer to provide written justification for the reasons behind the HRR request
- Upper level RBS officer gives the deal the ok

More details can be found in the Historic Rate Rollover Policy at: http://cbfmnet.fm.rbsgrp.net/S2467

4.1.4 XPortfolio User Guide

This complete user guide (for both internal and external users) provides a good understanding of the changes in XPortfolio resulting from the Prodigy project. The guides cover the following topics:

- Access the system
- Price a structure
- Create, run, and save a report
- Using the improved analyzing functions: DCI matrix and graph

For faster reference, we also created a laminate for internal users. This provides the steps for the major functions: pricing a product, build a report and initial step for other function (i.e. matrix and graph).

The two full guides and the laminate all contain the same information presented in slightly different ways. To avoid repetition, we will present only the external guide on the following pages:

E-Tools: X-Portfolio

XPortfolio-Introduction

XPortfolio is a sophisticated deal reporting and querying tool that allows viewing, management and analysis of all FX-related trades in one place. Located within RBSMarketplace, it has been built with a thorough yet easy-to-use querying facility and which greatly simplifies activities such as expiries, barrier triggers, restructures etc.

This user guide will also provide you a good understanding of the changes in XPortfolio resulting from the Prodigy project. These include new pricing functionality, new report generation and improved analyzing functions such as matrix and graph.

Summary statement:

The new XPortfolio pricing functionality was created by the Prodigy Project team. Eventually it will allow XPortfolio to serve as a single program capable of pricing all structures.
For the 1st release, XPortfolio will gain the ability to price Dual Currency Investments. A number of new structured investment products have also been added – making them available to trade on-line for the first time.

System features and benefits:

The new functionality allows XPortfolio to directly price a complex structure instead of manually constructing it using options and forwards. The initial product set is as follows:
Digital
Wedding Cake
Dual Currency Investment (DCI)
DCI Barrier - American Reverse KI
DCI Barrier - European Reverse KI
DCI Barrier - American Normal KO
Range Investment - American style
Range Investment - European style

In addition to this improved pricing functionality, the system offers:
Ability for Traders to Comment on Price Refusals
Multiple product pricing screen views (both grid and form views) to cater for different user needs
Product pricing grids – ability to price many products at once and select best
Enhanced booking reliability (with reference to current RBSM systems)
Ability to solve for variables other than the premium (i.e. set premium to 0 and calculate strike)

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XPortfolio-Access and Main Interface

Access XPortfolio:

After you successfully launched
RBSMarketplace, you'll see a window as below.

Click on the second icon ![icon] and XPortfolio
will be opened.
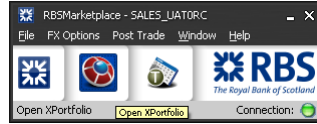
Function ribbon

Let's focus on the main interface first; XPortfolio has a function ribbon including "new pricing
panel", DCI matrix and Charts. As the picture shows, you could click on the function you want to
use and a new tab will be created for further operations. For example: when you click on "New
pricing panel", you'll see a window created (in this case it is titled "Trade 2")
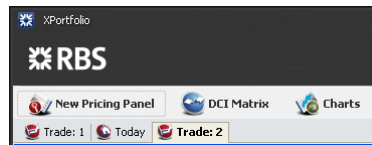
When you open XPortfolio, there are two tabs open: "Trade 1" and "Today".
Trade 1 is a pricing panel with a Dual Currency structure and the "Today" screen is intended as
a Montage of reports that can be saved and easily referenced in the future.
Those two tabs are XPortfolio's default and they will show up automatically when you start
XPortfolio.

View: Toggle floating

On every tab you will find the "Toggle floating" symbol ![icon] next to the close symbol. When you
click on it the embedded window would pop out and become a stand alone window. You now
can drag the window to wherever you want on the screen.
If you want to window to be back inside, click on symbol ![icon] and the window will be imbedded
again.
You can also drag windows out and back in again and dock them on edges of the screen as
required.

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XPortfolio-Main Interface

Left bar: Product selection

The main interface has a side bar on the left: "product selection", when you move your mouse to it, the side bar will extend itself to show you all the structures you could price inside XPortfolio. The shortcut for extend product selection is F2.
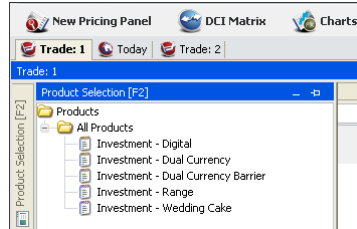
Right bar: FX rates & Saved report

There are also side bars on the right side: FX rates and Saved report;

The "FX rates" bar gives you a quick look on the spot bid/offer rates and changes of rates of each currency pair.
The mini-graph shows how the rates change: it started to draw the graph when you open XPortfolio and will update automatically.

The "saved report" bar shows all you're the reports you have saved in X-Portfolio. You could create a new report by clicking on "New" at the top of your report list.
The process of creating a new report is explained later in the report section

You could also view the reports under certain common criteria by clicking on "My Expires", "My Live Deals", or "Today deals". This will open a new tab showing the list of all reports under such criteria.
For example, "Today's deals" Shows all the deals with starting date equals today.

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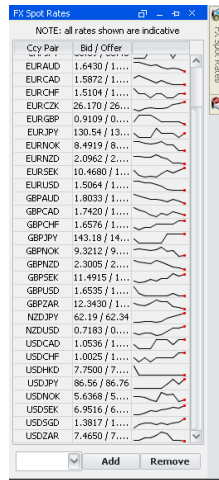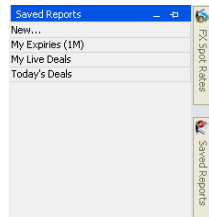
XPortfolio-Custom Report

The XPortfolio functionality in the RBSMarketplace toolbar is accessed via the two red icons

Custom report   Today report

Choose Custom Report icon to launch report window for running of a New or pre-saved Search.

Click "New.." to specify new search criteria using the Report Builder screen or
click "Open.." to load a pre-saved Search.

Custom Report
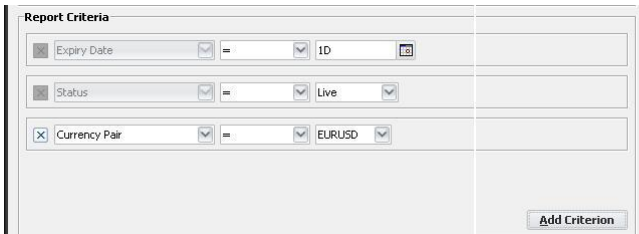
Clicking "New.." opens the Report Builder. Next, choose **Report Type** from the drop-down box.
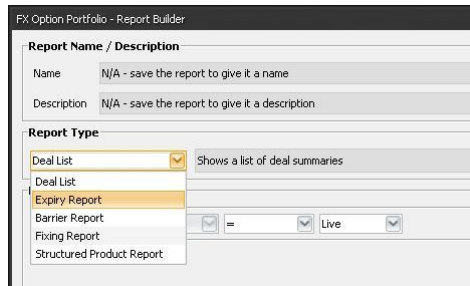
XPortfolio-Custom Report

Now build up the logic of the query in the **Report Criteria** section.

Note that a given Report type will have one or more default criteria (which can be edited but not deleted). The query can be refined by clicking the **Add Criterion** button one or more times.
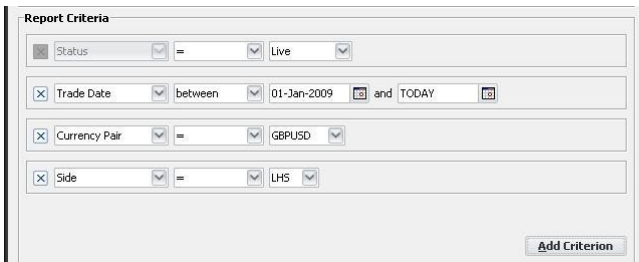
Example 1

Example 1 shows the Report Criteria section of the Report Builder for a sample **Expiry Report**. It will return all EURUSD trades with an option expiry tomorrow.

Example 2

Example 2 is a **Deal List** which will return all GBPUSD trades transacted since 2009 where the direction is sell GBP / buy USD

When you are satisfied with the query definition, choose the **Report Columns** and **Report Column Sorting** of the output (or accept the defaults).

Generate the results by clicking **Run Report >>> [F9]**

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XPortfolio-Custom Report

Results

The output from a typical XPortfolio query is shown below. Note that structured deals appear in **bold**, while individual deals appear as normal text

Ccy Pair (De...	Instrument Type	Structure Name	Headline Rate	Principal (Term)	Strike	Delivery Date ▲	Trade Date
GBPUSD		**Forward - Target Redemption Knockout**	**1.8100**				**04-Aug-2008**
GBPUSD		**Forward - Target Redemption Knockout**	**1.5800**				**06-Oct-2008**
GBPUSD	Forward	Swap		8,000,000.00	1.4518	26-Mar-2009	24-Feb-2009
GBPUSD	Forward	Swap		10,000,000.00	1.4564	26-Mar-2009	25-Feb-2009
GBPUSD	Forward	Swap		10,000,000.00	1.4564	26-Mar-2009	25-Feb-2009
GBPUSD	Forward			2,000,000.00	1.6900	31-Mar-2009	29-Dec-2008
GBPUSD	Forward			2,000,000.00	1.6900	31-Mar-2009	29-Dec-2008
GBPUSD	Forward			3,000,000.00	1.4553	09-Apr-2009	04-Dec-2008
GBPUSD	Forward			3,000,000.00	1.4750	09-Apr-2009	22-Dec-2008
GBPUSD	Forward			3,000,000.00	1.4475	21-Apr-2009	19-Jan-2009
GBPUSD	Forward			2,000,000.00	1.6900	30-Apr-2009	28-Jan-2009
GBPUSD	Forward			2,000,000.00	1.6900	30-Apr-2009	29-Jan-2009
GBPUSD	Forward			3,000,000.00	1.4395	26-May-2009	11-Feb-2009
GBPUSD	Forward			2,000,000.00	1.6900	29-May-2009	25-Feb-2009
GBPUSD	Forward			2,000,000.00	1.6900	29-May-2009	26-Feb-2009
GBPUSD	Forward			3,000,000.00	1.4163	05-Jun-2009	18-Feb-2009
GBPUSD	Forward			3,000,000.00	1.3999	18-Jun-2009	02-Mar-2009

Results can be sorted by clicking on the column headings.

Results can be exported to Excel by clicking

Further information about structured deals can be found by double-clicking the row. This will reveal another window containing all the available information, including the Expiry and Delivery Date Schedule. A sample Date Schedule is shown below right.

Text in this schedule (and the Results output) can appear in the following colours.

Normal: future expiry
Grey: expired
Red: expiring today
Blue: expiries on a possible extension

Dates

Expiry/Delivery Dates

	Expiry Date	Delivery Date
1	23-Feb-2009	25-Feb-2009
2	19-Mar-2009	23-Mar-2009
3	19-Jun-2009	23-Jun-2009
4	21-Jul-2009	23-Jul-2009
5	20-Aug-2009	24-Aug-2009
6	21-Sep-2009	23-Sep-2009

Date Count 6

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XPortfolio-Custom Report

Saving Reports

Reports that are run regularly can be saved. A report can be saved either in the Report Builder *before* the report has been run …

… or *after* it has been run in the Results window

Similarly, a saved report can be re-loaded by clicking the 'Open a report…' button in the Report Builder or the 'Open…' button in the Results window.

Any saved report is available for inclusion in the Today report.

Today Window

The Today window is designed to contain a number of user-defined reports which are useful to run regularly e.g. deals expiring today, deals with barriers less than 2% from market etc.
Any Custom Report that you save can be added to the Today Report.

Choose Today Report icon to launch it for the first time. Afterwards it will load automatically.

Configure the constituent reports and their layout by clicking here

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XPortfolio-Custom Report

Cashflow Analysis

When a portfolio of hedges contains more than one or two trades, it becomes difficult to establish whether the aggregate cashflows will be appropriate to the underlying exposures under *all* future combinations of exchange rate and date. For this reason, the XPortfolio Cashflow Analysis tool was developed.

The Cashflow Analysis tool can be run on a **single trade** by clicking [Cash Flow Analysis...] at the bottom right-hand corner of the Structure Details form.

The real power of the Cashflow Analysis comes to bear when it is used on **two or more deals**. To do this, select the deals in the Query Results form and then right-click as shown below.

Ccy Pair (D...	Deal Ref	Expiry Date	Headline R...	Strike	Structure Name	Structure Ref	Trade Date
EURUSD	4735307			1.4785			02-Jan-2009
GBPUSD	4735268			1.8675			02-Jan-2009
EURUSD	4733318			1.4855			31-Dec-2008
EURUSD		27-May-2009	1.4855		Accrual Forward - American	4292842	30-May-2008
EURUSD		31-Jul-2009	1.4785		Accrual Forward - American Cash flow analysis	4432826	01-Aug-2008
GBPUSD		31-Jul-2009	1.8675		Accrual Forward - American	4432935	01-Aug-2008

The output of the Cashflow Analysis Tool is shown below
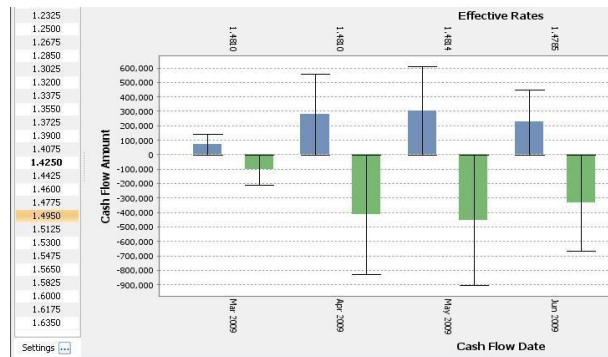
Select a spot rate from the ladder on the left-hand side of the output. The coloured bars will then show the cashflows in both currencies that will occur if spot stays at that level.
The "candlesticks" show the maximum and minimum possible cashflows under all scenarios.

With the Cashflow Analysis tool it is possible to assess whether the portfolio will be underhedged or overhedged in any circumstances. If that is the case, remedial steps can be taken …

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XPortfolio-Custom Report

Hypothetical Deals

All the power of XPortfolio would be limited if it were confined to existing deals with RBS only. With the use of the Hypothetical Deals feature it is possible to analyse your complete portfolio and even include future deals that are being considered to remedy an under/overhedge.

Hypothetical Deals, can be uploaded into XPortfolio by RBS. Note that all deals within XPortfolio have a Deal Origin which can be one of the following:-

RBS	Existing deal with RBS
non-RBS	Existing deal with another counterparty bank
Proposed	Future deal under consideration

To view hypothetical trades in XPortfolio you need to include a Deal Origin criterion

Hypothetical trades will appear in the query results window with a deal reference preceded by 'H'.

Structure Ref	Deal Origin	Counterparty	Ccy Pair (Dealt)	Structure
3429492	RBS		GBPUSD	Accrual Forward - P.
3430707	RBS		GBPUSD	Bonus - Proximity
	RBS		GBPUSD	
H1900526	Proposed		GBPEUR	Accrual Forward - A

To see the contribution of a Hypothetical deal to the aggregated cashflows of the portfolio, click ☑ Show structural breakdown and select the reference from the schedule on the right-hand side.

Cashflows for the selected deal will be highlighted (see below)

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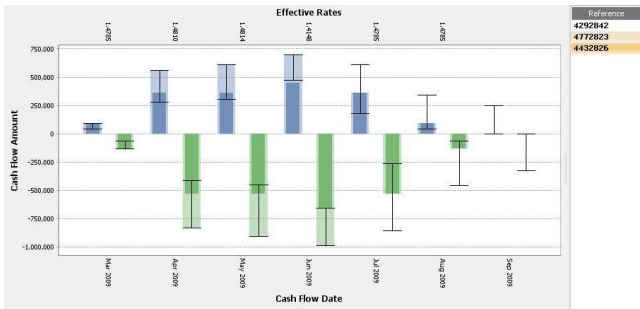
XPortfolio-Pricing Panel

Pricing a Structure

1. Click on new pricing panel on the ribbon and you'll enter the pricing tab.

2. Go to "Product selection" (or use F2), click on the product you want to price.

3. Type in or select the counterparty you want to trade with on the top.

4. Fill in each required input area of the product by either keying over or selecting from the list.

5. For "Solve For" section, key over two of the three values (strike, enhanced rate and premium) and it

   will solve for the third. AV cannot be keyed over

6. Click on "Calculate" button below (or use F9). The program will automatically calculate the blank

   value.

Outcome:
The calculation result will be shown with yellow background in the structure panel.

Calculate or trade:
You could select whether you want to calculate or trade this product by choosing the mode below the calculate button (or use Ctrl+F9). If you select Trade mode you are requesting a quote and the result will show in the same area as the calculation results.
The price is indicative price only.
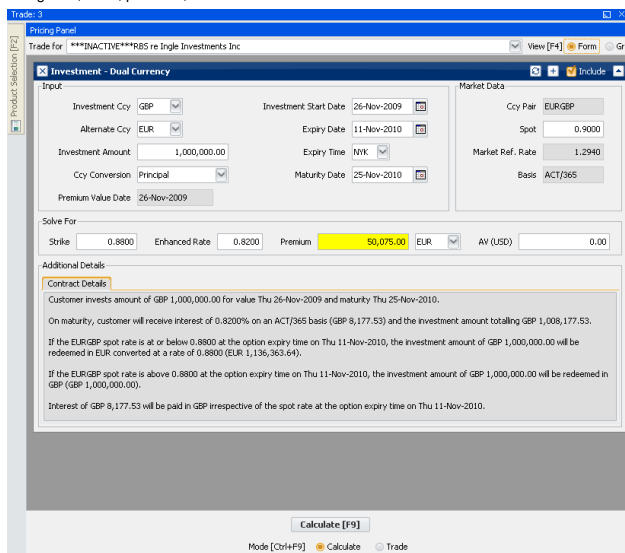
XPortfolio-Pricing Panel

Notes about the input areas:

All the input areas are required except Investment start date and maturity date. The default value for start date is two days after today and the default maturity date is two days after the expiry date. Different product has different areas required and prodigy assigns default values for certain areas. Please check the Appendix for details.

Additional Details:

Notice that at the bottom of the structure panel, there is the "Additional Details". Click on the words and you will see a tab extended below to explain the trade in plain English.
The summary of the trade functions like a mini contract, recording all the information above, such as trading date, rates, premium, etc.

XPortfolio-Pricing Panel

View of the pricing panel:

The pricing panel has two views: Form and Grid. You can switch between them according to personal preference by mouse selection (or F4).

As all previous screens have used form view, here's a grid view example:

Investment Ccy	GBP
Alternate Ccy	EUR
Investment Amount	1,000,000.00
Investment Start Date	26-Nov-2009
Premium Value Date	26-Nov-2009
Expiry Date	11-Nov-2010
Expiry Time	NYK
Maturity Date	25-Nov-2010
Strike	0.8800
Ccy Conversion	Principal
Enhanced Rate	0.8200
Premium	50,075.00
Pricing Preference	EUR
AV (USD)	0.00
Spot	0.9000
Market Ref. Rate	1.2940
Ccy Pair	EURGBP
System Spot	
Basis	ACT/365
Contract Details	Customer invests amount ...

Product panel function:

At the top right corner of each structure panel, you'll see four function icons:

- : convert to a different product
- : copy this product
- Include : Active and inactive this product. If you don't want to consider this product temporarily, uncheck this option.
- : Hide this product.

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XPortfolio-DCI matrix

1. Click on DCI matrix on the function ribbon and you'll enter the DCI matrix panel.

2. Type in or select the counterparty you want to calculate for.

3. Fill every blank in the "investment details" section and select at least one Alternate ccy. The number of alternative currency you select is the number of DCI matrix you'll get.

4. Fill in the "Solve for" section, you could choose either "Enhanced rate", or "Strike" to solve. Choose the one you want to solve and fill in the required information. This will set the column headers of your matrix.

5. Select expiries period from the "Expiries" section, you could select more than 1 period and also you could add at most three customized expiry date. This part will set the row headers of your matrix.

6. Click on "Calculate" button below or F9 to calculate the matrix.

The outcomes:
The outcome will be presented as a currency pair matrix with each expire period, enhanced rate and strike.

Calculate or trade:
You are able to choose either calculate or trade (request a quote) mode by click on the function you want or [Ctrl+F9]

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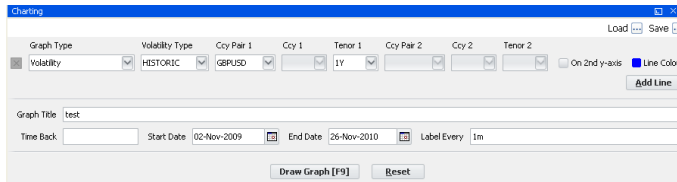
XPortfolio-Graph

Using the "Chart function":

1. Click on "Charts" button on the main function ribbon, you'll see a input panel pop up:

2. Select the graph type, some of the following input areas will be enabled/disabled according to different type you choose. Fill in all required areas. Check/uncheck "on 2nd y-axis".

3. If you want to draw more than one line, click on "Add Line" button and repeat step two.

4. Type in a graph title and give the time information: time back (how far the chart should go back e.g.. 1m, 3m, 1y), start date, end date, label period.

   Time back: how much data to chart: 1d-one day; 1m=one month; 1y=one year
   Label Every: periods between labels on x-axis: 1d=one day; 1m=one month; 1y= one year

5. Click on "Draw Graph" button or F9 and you'll see the graph as below. If you want to reset the graph, please click on "Reset" button.

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XPortfolio-Graph
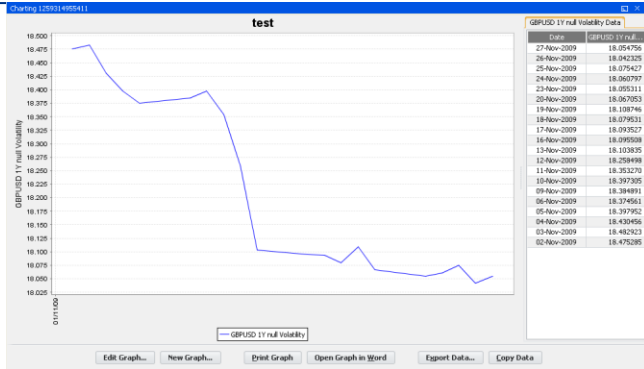
Graph operations:

The graph has the three main parts: the graph picture, the detailed data on the right and the function buttons at the bottom,

After drawing a graph, Prodigy allows you to edit the graph, export graph data etc.
Please look at the buttons at the bottom of the graph; those are the functions you could use for this graph:

Edit graph: Allow you to change what data appears on the graph

New graph: To draw a new chart

Print Graph:

Open graph in Word: This opens a snapshot of the graph body. If you also need the data, you have to export them; see below.

Export data: you could choose to export the data on the right to a file, to excel, or cancel operation.

Copy data: copy the right side data and then you could paste to wherever.
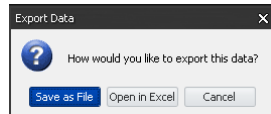
4.2 Added Functionality

Our second objective, improving processes where possible, resulted in added functionality to two helper spreadsheets. The spreadsheets solve different problems in the FX world, with the IAS Helper primarily used by FX Structuring and the RWA_CVA_WWR calculator used primarily by salespeople.

4.2.1 RWA_CVA_WWR calculator

The RWA_CVA_WWR calculator is an excel spreadsheet used to calculate various capital requirements for a trade. Originally it supported the following structures: vanilla option, FX forward, exotic structures, and exotic strips. Here is the main interface (with the functions we added functions circled):

Figure 3: RWA Calculator Front Page

As shown above, we added the following functionality to the spreadsheet:

a) Expanded the functionality of exotic strips page to handle the calculation for both vanilla and exotic strips, shown in the following picture:

FX EXOTIC OPTIONS & STRUCTURES (UNCOL
FX VANILLA STRIPS (UNCOLLATERALISED)

Counterparty Calculation	
PD	0.32%
LGD	100.00%
Total Maturity of Trade	0.98
Counterparty Risk weighting (K)	**0.0775**

First Currency	EUR
Second Currency	GBP
Historic Vol	12.30%

Strip Results	
Total Notional	11,000,000
Lifetime EAD (fwdlike structure)	397,688
Lifetime RWA (fwdlike structure)	408,454
CVA (fwdlike structure)	291

Figure 4: Counterparty Risk Factors Panel

b) Display total RWA calculation at each maturity date for both strips, shown in the following picture:

	Dates	NumYears	Notional	Vanilla prem	Premium of RBS long	Integrated Addon	Lifetime EAD (fwdlike)	Lifetime EPE (fwdlike)	CVA components	Lifetime RWA per date
1	27-Jan-2010 Wed	0.15	1,000,000	19,048	19,048	1,507	4,592	2,870	1	4,716.7283
2	24-Feb-2010 Wed	0.23	1,000,000	23,400	23,400	2,274	8,514	5,321	4	8,744.0769
3	29-Mar-2010 Mon	0.32	1,000,000	27,663	27,663	3,178	14,066	8,792	9	14,447.2043
4	28-Apr-2010 Wed	0.40	1,000,000	31,035	31,035	4,000	19,862	12,414	16	20,399.8096
5	26-May-2010 Wed	0.48	1,000,000	33,880	33,880	4,767	25,842	16,151	25	26,541.2091
6	28-Jun-2010 Mon	0.57	1,000,000	36,953	36,953	5,671	33,531	20,957	38	34,439.1440
7	28-Jul-2010 Wed	0.65	1,000,000	39,541	39,541	6,493	41,079	25,674	53	42,190.9544
8	26-Aug-2010 Thu	0.73	1,000,000	41,890	41,890	7,288	48,845	30,528	71	50,167.1334
9	28-Sep-2010 Tue	0.82	1,000,000	44,412	44,412	8,192	58,211	36,382	95	59,786.5665
10	27-Oct-2010 Wed	0.90	1,000,000	46,516	46,516	8,986	66,882	41,801	120	68,692.2269
11	26-Nov-2010 Fri	0.98	1,000,000	48,597	48,597	9,808	76,264	47,665	150	78,328.7815
12	29-Dec-2010 Wed	1.07		-	-	-	-	-	-	-
13	10-Nov-2010 Wed	0.94		-	-	-	-	-	-	-
14	09-Dec-2010 Thu	1.02		-	-	-	-	-	-	-
15	10-Jan-2011 Mon	1.10		-	-	-	-	-	-	-
16	10-Feb-2011 Thu	1.19		-	-	-	-	-	-	-
17	10-Mar-2011 Thu	1.27		-	-	-	-	-	-	-

Figure 5: Strips Output Panel

c) The ability to generate an email with the calculation result and send to the users email address

There are major benefits of this added functionality. First, the application is now function complete. This means FX sales could use it to deal with all types of products they will encounter with. Second, sending the result in email offers a straight forward presentation of the structure, helping salespeople to keep records.

The approach is fairly simple for these functions; we added the vanilla strips function to the spreadsheet by using Excel internal function-IF to give different calculations under vanilla and exotic strips. We implemented the "send email" button in the front page and assigned macro

to it. The VBA code behind connects to Outlook 2003, generates an email with proper "To" and "CC" list, selects the right output area in the calculator as the email content and finally sends out the email.

4.2.2 IAS Helper

IAS Helper is an excel spreadsheet that is used for hedge accounting. It splits a structure into a hedge accounting portion and residual portion to allow the structure to qualify for the special treatment under accounting standard IAS 39. The spreadsheet originally reported the total value of each portion, showing a combined total of the intrinsic value and time value of the structure. However, under IAS 39 only intrinsic value of an option structure qualifies for hedge accounting and FX structurers had to convert the output of IAS Helper manually to find it. We aimed to automate the process of finding intrinsic value by adding this functionality into the spreadsheet, a goal accomplished by:

a) For the non-experienced users, we have a series of prompts that guide them through finding the necessary inputs, placing them properly and calculating the result afterwards

b) For the experienced users, they can input the information on their own and run the calculation function

To add this functionality we introduced two new tabs, "RBS buy" and "RBS sell", to hold the intrinsic forward portion bought by RBS and sold by RBS. The formula behind these was provided by FX Structuring.

Given the complicated nature of this spreadsheet an example is helpful. To determine the hedge accounting split of a cylinder (a common FX structure) with a 1.7 high and 1.6 low, you must setup the following structures in NMOSS (an RBS structure pricing system). The actual structure is 1*+2*; the intrinsic forward bought by RBS is 3*+4*, the intrinsic forward sold by RBS is 5*+6*.

	Aggregate	1*	2*	3*	4*	5	6
Code:		OTCC ▼	OTCP ▼	OTCC ▼	OTCP ▼	OTCC ▼	OTCP ▼
Type:		Vanilla ▼	Vanilla ▼	Vanilla ▼	Vanilla ▼	Vanilla ▼	Vanilla ▼
Style:		▼	▼	▼	▼	▼	▼
Buy/Sell:		Sell ▼	Buy ▼	Sell ▼	Buy ▼	Sell ▼	Buy ▼
EUR:		Call - EUR ▼	Put - EUR ▼	Call - EUR ▼	Put - EUR ▼	Call - EUR ▼	Put - EUR ▼
USD:		Put - USD ▼	Call - USD ▼	Put - USD ▼	Call - USD ▼	Put - USD ▼	Call - USD ▼
Strike:		1.7000	1.6000	1.6000	1.6000	1.7000	1.7000

Figure 6: Example of Setup Required to use IAS Helper

After inputting these structures into NMOSS, the user runs a function for each structure pair that generates a table containing MTM value (this is the value of the structure) at varying exchange rates and varying times. These tables will then be copied into IAS Helper (manually for experts, via prompts for non-experienced). The example shown here is the combined value output after inputting it into IAS Helper:

	A	B	C	D	E	F	G	H	I	J	K
1	EURUSD	03-Dec-09	12-Jan-10	21-Feb-10	02-Apr-10	12-May-10	21-Jun-10	31-Jul-10	09-Sep-10	19-Oct-10	02-Dec-10
2	2.478	-3,736,722	-3,431,025	-3,123,274	-2,815,202	-2,190,829	-1,879,703	-1,567,629	-940,928	-627,568	-313,958
3	2.4229	-3,550,519	-3,260,148	-2,967,780	-2,675,131	-2,081,843	-1,786,243	-1,489,716	-894,173	-596,392	-298,366
4	2.3679	-3,355,751	-3,081,380	-2,805,082	-2,528,556	-1,967,791	-1,688,436	-1,408,179	-845,243	-563,767	-282,050
5	2.3128	-3,151,874	-2,894,202	-2,634,694	-2,375,026	-1,848,316	-1,585,973	-1,322,759	-793,984	-529,588	-264,956
6	2.2577	-2,938,339	-2,698,082	-2,456,103	-2,214,059	-1,723,033	-1,478,516	-1,233,173	-740,223	-493,741	-247,029
7	2.2027	-2,714,612	-2,492,492	-2,268,795	-2,045,155	-1,591,533	-1,365,699	-1,139,109	-683,775	-456,103	-228,205
8	2.1476	-2,480,221	-2,276,949	-2,072,275	-1,867,819	-1,453,398	-1,247,133	-1,040,227	-624,432	-416,534	-208,415
9	2.0925	-2,234,822	-2,051,075	-1,866,134	-1,681,604	-1,308,240	-1,122,424	-936,162	-561,967	-374,882	-187,585
10	2.0375	-1,978,299	-1,814,702	-1,650,140	-1,486,204	-1,155,765	-991,223	-826,545	-496,134	-330,979	-165,628
11	1.9824	-1,710,918	-1,568,023	-1,424,396	-1,281,601	-995,922	-853,337	-711,069	-426,681	-284,638	-142,451
12	1.9273	-1,433,549	-1,311,819	-1,189,574	-1,068,317	-829,134	-708,956	-589,659	-353,434	-235,652	-117,950
13	1.8723	-1,147,974	-1,047,787	-947,263	-847,791	-656,710	-559,068	-462,852	-276,542	-183,838	-92,008
14	1.8172	-857,344	-779,032	-700,490	-622,938	-481,476	-406,156	-332,562	-197,178	-129,341	-64,494
15	1.7621	-566,983	-511,047	-454,528	-399,096	-309,016	-255,330	-203,582	-119,230	-74,114	-35,260
16	1.7071	-284,560	-253,542	-220,213	-188,301	-149,418	-117,908	-88,358	-52,117	-27,308	-5,903
17	1.652	-10,280	-10,504	-9,518	-8,780	-7,349	-5,815	-4,200	-2,531	-1,067	-1
18	1.5987	270,137	237,223	204,092	172,105	136,571	106,550	78,980	46,606	23,807	3,872
19	1.5488	573,456	512,505	453,098	394,609	305,395	250,437	198,228	115,811	71,032	33,091
20	1.5018	902,695	815,330	730,159	645,730	498,459	418,477	341,164	201,752	131,671	65,374
21	1.4576	1,250,715	1,136,233	1,023,996	912,584	706,045	598,973	494,436	294,884	195,553	97,658
22	1.416	1,611,568	1,469,040	1,328,702	1,189,153	921,948	786,170	652,468	390,587	260,023	129,941
23	1.3767	1,981,153	1,809,713	1,640,334	1,471,609	1,142,541	976,786	812,553	487,109	324,569	162,225
24	1.3395	2,356,585	2,155,489	1,956,273	1,757,506	1,365,675	1,169,045	973,450	583,854	389,120	194,509
25	1.3042	2,735,865	2,504,506	2,274,817	2,045,349	1,590,125	1,362,045	1,134,639	680,652	453,672	226,792
26	1.2708	3,117,635	2,855,535	2,594,896	2,334,259	1,815,230	1,555,360	1,295,925	777,460	518,223	259,076
27	1.239	3,500,985	3,207,789	2,915,856	2,623,736	2,040,647	1,748,803	1,457,240	874,271	582,775	291,359
28	1.2088	3,885,320	3,560,770	3,237,310	2,913,505	2,266,207	1,942,294	1,618,563	971,081	647,326	323,643
29	1.18	4,270,260	3,914,177	3,559,034	3,203,420	2,491,830	2,135,803	1,779,889	1,067,892	711,878	355,927
30	1.1526	4,655,563	4,267,827	3,880,903	3,493,406	2,717,480	2,329,318	1,941,215	1,164,702	776,430	388,210
31	1.1264	5,041,084	4,621,614	4,202,848	3,783,426	2,943,142	2,522,835	2,102,541	1,261,513	840,981	420,494
32	1.1013	5,426,730	4,975,477	4,524,832	4,073,462	3,168,808	2,716,353	2,263,867	1,358,324	905,533	452,777

Figure 7: Value of Combined Structure as Inputted into IAS Helper

After charts for all three structure pairs are inputted, IAS Helper will modify the charts as follows:

1) Combined value (all the payoffs are from RBS perspective)

This is the total value of a structure and requires no modifications

2) RBS buy (Intrinsic forward portion bought by RBS)

Values floored at 0: Any MTM values <0 are replaced with 0 and all MTM values >=0 remain unchanged

3) RBS sell (Intrinsic forward portion sold by RBS)

Values capped at 0. Any MTM values >0 are replaced with 0 and all MTM values <=0 remain unchanged.

From these three structure pairs, IAS Helper generates the desired structure, containing intrinsic value only, that qualifies for IAS accounting and the residual portion that does not:

4) IAS Output (Intrinsic value of the overall structure)

To find the intrinsic value of the overall structure, IASHelper adds the modified value of "RBS buy" and "RBS sell" and the result matrix is stored in sheet "IAS Output".

"IAS Output" = Floored "RBS buy" + Capped "RBS sell"

4 = Capped 2 + Floored 3

5) Residual Output (portion of the structure that does not qualify for hedge accounting)

"Residual Output" = "Combined Input" – "IAS Output"

The spreadsheet then generates heat charts for over the life of the structures. This is a graphic representation of the data originally entered into IAS Helper: MTM of the structures over time at various exchange rates. It displays these for the combined output, IAS Input and the Residual Output:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	EURUSD (EUR)	31-Dec-09	31-Jan-10	28-Feb-10	31-Mar-10	30-Apr-10	31-May-10	30-Jun-10	31-Jul-10	31-Aug-10	30-Sep-10	31-Oct-10	30-Nov-10	02-Dec-10
2	2.2250	2,637,600	2,462,500	2,304,000	2,125,200	1,785,500	1,534,000	1,358,700	1,177,200	812,500	583,100	407,100	246,500	235,800
3	2.2000	2,541,200	2,372,600	2,219,900	2,047,600	1,720,300	1,477,900	1,309,100	1,134,300	782,900	561,800	392,300	237,600	227,200
4	2.1750	2,440,800	2,278,900	2,132,200	1,966,700	1,652,300	1,419,500	1,257,300	1,089,400	751,900	539,600	376,800	228,200	218,300
5	2.1500	2,340,500	2,185,200	2,044,600	1,885,800	1,584,300	1,361,000	1,205,600	1,044,500	721,000	517,400	361,300	218,800	209,300
6	2.1250	2,235,800	2,087,400	1,953,000	1,801,300	1,513,100	1,299,900	1,151,300	997,500	688,500	494,100	345,000	208,900	199,900
7	2.1000	2,130,700	1,989,200	1,861,100	1,716,300	1,441,700	1,238,400	1,096,900	950,300	655,900	470,800	328,700	199,100	190,400
8	2.0750	2,022,000	1,887,600	1,765,900	1,628,300	1,367,600	1,174,700	1,040,300	901,300	622,100	446,500	311,700	188,800	180,600
9	2.0500	1,911,800	1,784,500	1,669,400	1,539,000	1,292,500	1,110,000	982,900	851,500	587,700	421,800	294,500	178,400	170,600
10	2.0250	1,799,300	1,679,300	1,570,700	1,447,700	1,215,600	1,043,700	924,000	800,300	552,400	396,400	276,800	167,600	160,400
11	2.0000	1,684,600	1,571,900	1,470,000	1,354,400	1,137,000	975,900	863,800	748,000	516,200	370,400	258,600	156,700	149,900
12	1.9750	1,568,500	1,463,200	1,368,000	1,260,000	1,057,400	907,200	802,600	694,800	479,400	344,100	240,200	145,500	139,200
13	1.9500	1,449,400	1,351,600	1,263,200	1,162,700	975,300	836,400	739,500	639,700	441,200	316,500	221,000	133,900	128,000
14	1.9250	1,329,900	1,239,600	1,158,000	1,065,100	893,100	765,300	676,100	584,400	402,900	288,900	201,700	122,200	116,900
15	1.9000	1,207,000	1,124,300	1,049,600	964,400	808,100	691,800	610,300	526,700	362,800	260,000	181,300	109,800	105,100
16	1.8750	1,084,000	1,009,000	941,200	863,600	723,200	618,300	544,500	469,100	322,800	231,000	161,000	97,500	93,300
17	1.8500	959,300	892,000	831,200	761,300	637,100	543,700	477,600	410,100	281,700	201,100	139,700	84,600	80,900
18	1.8250	834,400	774,800	721,000	658,800	550,800	469,000	410,500	351,000	240,500	171,000	118,300	71,500	68,400
19	1.8000	709,700	657,800	611,000	556,600	465,300	395,100	344,000	292,300	199,700	141,000	96,600	57,900	55,400
20	1.7750	585,100	541,000	501,200	454,500	380,000	321,500	277,800	233,800	159,100	111,000	74,800	44,100	42,100
21	1.7500	462,500	426,400	393,800	355,200	297,500	250,700	214,600	178,200	121,100	83,100	54,300	30,400	28,800
22	1.7250	342,000	314,400	289,200	258,900	218,000	183,000	154,400	125,900	85,600	57,500	35,200	16,700	15,500
23	1.7000	223,200	204,800	187,800	166,600	141,300	118,000	97,600	77,500	52,900	34,300	18,800	6,000	5,100
24	1.6750	108,700	101,500	94,700	84,400	71,800	60,000	49,600	39,300	26,900	17,300	9,400	2,900	2,500
25	1.6500	-6,300	-2,200	1,200	2,000	2,000	1,800	1,500	1,100	800	400	100	-100	-100
26	1.6250	-127,100	-110,800	-96,300	-83,600	-70,700	-58,700	-48,100	-37,900	-25,900	-16,700	-8,900	-2,400	-2,000
27	1.6000	-247,900	-219,400	-193,800	-169,300	-143,500	-119,200	-97,800	-77,000	-52,500	-33,700	-17,900	-4,700	-3,800
28	1.5750	-388,900	-349,800	-314,900	-280,000	-235,100	-196,900	-166,100	-135,600	-92,100	-62,000	-38,500	-19,000	-17,700
29	1.5500	-531,000	-481,500	-437,300	-392,200	-327,700	-275,500	-235,400	-195,400	-132,400	-90,900	-59,700	-34,100	-32,400
30	1.5250	-695,200	-635,000	-581,200	-525,400	-438,700	-371,000	-320,900	-270,600	-184,400	-129,100	-87,500	-51,800	-49,400
31	1.5000	-862,000	-791,000	-727,500	-660,900	-551,800	-468,400	-408,200	-347,400	-237,500	-168,100	-115,800	-69,800	-66,700
32	1.4750	-1,048,100	-965,200	-891,000	-812,600	-679,300	-578,500	-506,800	-434,100	-297,800	-212,100	-147,100	-88,800	-84,900
33	1.4500	-1,240,000	-1,144,800	-1,059,600	-968,900	-810,800	-692,100	-608,500	-523,300	-359,800	-257,200	-179,000	-108,300	-103,600
34	1.4250	-1,445,100	-1,336,800	-1,239,800	-1,136,000	-951,500	-813,700	-717,000	-618,300	-425,800	-304,900	-212,500	-128,600	-123,000
35	1.4000	-1,661,100	-1,539,000	-1,429,400	-1,311,700	-1,099,500	-941,500	-830,900	-717,600	-494,600	-354,500	-247,200	-149,600	-143,100
36	1.3750	-1,884,400	-1,748,000	-1,625,300	-1,493,200	-1,252,300	-1,073,300	-948,300	-819,900	-565,400	-405,400	-282,800	-171,100	-163,700
37	1.3500	-2,122,800	-1,970,600	-1,834,100	-1,686,000	-1,414,900	-1,213,400	-1,072,800	-928,000	-640,100	-459,100	-320,300	-193,800	-185,400
38	1.3250	-2,370,000	-2,201,800	-2,050,500	-1,886,300	-1,583,200	-1,358,300	-1,201,400	-1,039,700	-717,200	-514,400	-358,900	-217,200	-207,800
39	1.3000	-2,626,300	-2,441,200	-2,274,600	-2,093,300	-1,757,400	-1,508,200	-1,334,300	-1,154,900	-796,800	-571,500	-398,800	-241,300	-230,900
40	1.2750	-2,895,900	-2,693,000	-2,510,100	-2,310,800	-1,940,200	-1,665,400	-1,473,600	-1,275,600	-880,100	-631,300	-440,500	-266,600	-255,000
41	1.2500	-3,177,800	-2,956,000	-2,756,000	-2,537,700	-2,131,000	-1,829,300	-1,618,800	-1,401,400	-966,900	-693,600	-484,000	-292,900	-280,200
42	1.2250	-3,470,800	-3,229,400	-3,011,500	-2,773,400	-2,329,100	-1,999,500	-1,769,500	-1,532,000	-1,057,000	-758,300	-529,100	-320,300	-306,300

Figure 8: Combined Output

EURUSD (EUR)	31-Dec-09	31-Jan-10	28-Feb-10	31-Mar-10	30-Apr-10	31-May-10	30-Jun-10	31-Jul-10	31-Aug-10	30-Sep-10	31-Oct-10	30-Nov-10	02-Dec-10
2.2250	2,643,000	2,465,000	2,303,600	2,124,900	1,785,300	1,533,900	1,358,700	1,177,200	812,500	583,100	407,100	246,500	235,800
2.2000	2,546,100	2,374,700	2,219,300	2,047,200	1,720,000	1,477,900	1,309,100	1,134,300	782,900	561,800	392,300	237,600	227,200
2.1750	2,445,000	2,280,500	2,131,300	1,966,000	1,651,900	1,419,300	1,257,300	1,089,400	751,900	539,600	376,800	228,200	218,300
2.1500	2,343,900	2,186,300	2,043,300	1,884,900	1,583,800	1,360,800	1,205,500	1,044,500	721,000	517,400	361,300	218,800	209,300
2.1250	2,238,000	2,087,600	1,951,100	1,800,000	1,512,400	1,299,500	1,151,200	997,500	688,500	494,100	345,000	208,900	199,900
2.1000	2,131,600	1,988,400	1,858,500	1,714,600	1,440,700	1,237,900	1,096,700	950,300	655,900	470,800	328,700	199,100	190,400
2.0750	2,021,000	1,885,300	1,762,200	1,625,800	1,366,100	1,173,900	1,040,000	901,200	622,100	446,500	311,700	188,800	180,600
2.0500	1,908,600	1,780,600	1,664,400	1,535,700	1,290,400	1,108,900	982,400	851,300	587,600	421,800	294,500	178,400	170,600
2.0250	1,793,300	1,673,000	1,563,900	1,443,100	1,212,600	1,042,100	923,300	800,100	552,300	396,400	276,800	167,600	160,400
2.0000	1,674,900	1,562,700	1,460,900	1,348,100	1,132,800	973,600	862,600	747,600	516,000	370,400	258,600	156,700	149,900
1.9750	1,554,400	1,450,500	1,356,100	1,251,500	1,051,700	903,900	800,900	694,100	479,200	343,900	240,200	145,500	139,200
1.9500	1,429,300	1,333,800	1,247,100	1,151,100	967,300	831,400	736,800	638,600	440,800	316,400	221,000	133,900	128,000
1.9250	1,303,400	1,216,500	1,137,500	1,050,100	882,500	758,600	672,300	582,700	402,300	288,800	201,700	122,200	116,900
1.9000	1,170,600	1,092,800	1,022,000	943,600	793,000	681,700	604,200	523,800	361,600	259,600	181,300	109,800	105,100
1.8750	1,037,800	969,000	906,400	837,000	703,500	604,900	536,200	464,900	321,000	230,400	160,900	97,500	93,300
1.8500	898,100	838,800	784,800	724,900	609,400	524,000	464,600	402,900	278,200	199,700	139,500	84,500	80,900
1.8250	757,600	707,800	662,400	612,100	514,600	442,600	392,600	340,500	235,100	168,800	118,000	71,500	68,400
1.8000	610,900	571,100	534,800	494,500	415,800	357,800	317,400	275,400	190,200	136,600	95,500	57,900	55,400
1.7750	461,600	432,000	404,800	374,700	315,200	271,300	240,900	209,100	144,500	103,800	72,600	44,000	42,100
1.7500	307,400	288,300	270,600	251,000	211,300	182,100	161,900	140,700	97,300	69,900	48,900	29,700	28,400
1.7250	148,200	139,800	131,900	123,200	104,000	89,900	80,300	70,000	48,500	34,900	24,500	14,900	14,300
1.7000	29,700	29,200	28,400	27,600	23,600	20,800	19,000	16,900	11,800	8,600	6,100	3,800	3,600
1.6750	14,200	14,000	13,600	13,200	11,300	10,000	9,100	8,100	5,700	4,100	2,900	1,800	1,700
1.6500	-800	-700	-600	-500	-400	-300	-300	-200	-100	-100	-100	0	0
1.6250	-10,900	-9,300	-8,000	-6,600	-5,300	-4,200	-3,400	-2,700	-1,800	-1,200	-800	-400	-400
1.6000	-21,100	-17,900	-15,400	-12,600	-10,200	-8,100	-6,500	-5,200	-3,400	-2,300	-1,500	-800	-800
1.5750	-194,200	-179,300	-166,100	-151,500	-126,800	-108,300	-95,200	-81,900	-56,400	-40,300	-28,000	-16,900	-16,100
1.5500	-376,400	-349,000	-324,600	-297,600	-249,500	-213,700	-188,500	-162,700	-112,100	-80,300	-55,900	-33,800	-32,300
1.5250	-569,200	-528,700	-492,500	-452,300	-379,500	-325,300	-287,300	-248,300	-171,200	-122,700	-85,500	-51,700	-49,400
1.5000	-763,400	-709,700	-661,600	-608,100	-510,400	-437,700	-386,800	-334,500	-230,700	-165,400	-115,300	-69,700	-66,700
1.4750	-969,000	-901,300	-840,500	-773,100	-648,900	-556,700	-492,200	-425,800	-293,700	-210,500	-146,800	-88,800	-84,900
1.4500	-1,178,500	-1,096,600	-1,022,900	-941,200	-790,100	-678,000	-599,600	-518,800	-357,800	-256,600	-179,000	-108,300	-103,600
1.4250	-1,397,000	-1,300,200	-1,213,100	-1,116,500	-937,400	-804,400	-711,500	-615,700	-424,700	-304,600	-212,500	-128,600	-123,000
1.4000	-1,623,600	-1,511,400	-1,410,400	-1,298,300	-1,090,100	-935,600	-827,600	-716,300	-494,100	-354,400	-247,200	-149,600	-143,100
1.3750	-1,855,700	-1,727,800	-1,612,400	-1,484,500	-1,246,600	-1,069,900	-946,600	-819,300	-565,200	-405,400	-282,800	-171,100	-163,700
1.3500	-2,100,000	-1,955,400	-1,825,100	-1,680,500	-1,411,200	-1,211,300	-1,071,800	-927,700	-640,000	-459,100	-320,300	-193,800	-185,400
1.3250	-2,352,000	-2,190,200	-2,044,400	-1,882,600	-1,581,000	-1,357,100	-1,200,900	-1,039,500	-717,200	-514,400	-358,900	-217,200	-207,800
1.3000	-2,611,900	-2,432,500	-2,270,600	-2,091,200	-1,756,100	-1,507,600	-1,334,000	-1,154,900	-796,800	-571,500	-398,800	-241,300	-230,900
1.2750	-2,884,000	-2,686,000	-2,507,500	-2,309,500	-1,939,500	-1,665,100	-1,473,500	-1,275,600	-880,100	-631,300	-440,500	-266,600	-255,000
1.2500	-3,167,400	-2,950,200	-2,754,200	-2,536,900	-2,130,500	-1,829,100	-1,618,700	-1,401,400	-966,900	-693,600	-484,000	-292,900	-280,200

Figure 9: IAS Output

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EURUSD (EUR)	31-Dec-09	31-Jan-10	28-Feb-10	31-Mar-10	30-Apr-10	31-May-10	30-Jun-10	31-Jul-10	31-Aug-10	30-Sep-10	31-Oct-10	30-Nov-10	02-Dec-10
2.2250	-5,400	-2,500	400	300	200	100	0	0	0	0	0	0	0
2.2000	-4,900	-2,100	600	400	300	0	0	0	0	0	0	0	0
2.1750	-4,200	-1,600	900	700	400	200	0	0	0	0	0	0	0
2.1500	-3,400	-1,100	1,300	900	500	200	100	0	0	0	0	0	0
2.1250	-2,200	-200	1,900	1,300	700	400	100	0	0	0	0	0	0
2.1000	-900	800	2,600	1,700	1,000	500	200	0	0	0	0	0	0
2.0750	1,000	2,300	3,700	2,500	1,500	800	300	100	0	0	0	0	0
2.0500	3,200	3,900	5,000	3,300	2,100	1,100	500	200	100	0	0	0	0
2.0250	6,000	6,300	6,800	4,600	3,000	1,600	700	200	100	0	0	0	0
2.0000	9,700	9,200	9,100	6,300	4,200	2,300	1,200	400	200	0	0	0	0
1.9750	14,100	12,700	11,900	8,500	5,700	3,300	1,700	700	200	100	0	0	0
1.9500	20,100	17,800	16,100	11,600	8,000	5,000	2,700	1,100	400	100	0	0	0
1.9250	26,500	23,100	20,500	15,000	10,600	6,700	3,800	1,700	600	100	0	0	0
1.9000	36,400	31,500	27,600	20,800	15,100	10,100	6,100	2,900	1,200	400	0	0	0
1.8750	46,200	40,000	34,800	26,600	19,700	13,400	8,300	4,200	1,800	600	100	0	0
1.8500	61,200	53,200	46,400	36,400	27,700	19,700	13,000	7,200	3,500	1,300	200	100	0
1.8250	76,800	67,000	58,600	46,700	36,200	26,400	17,900	10,500	5,400	2,200	300	0	0
1.8000	98,800	86,700	76,200	62,100	49,500	37,300	26,600	16,900	9,500	4,400	1,100	0	0
1.7750	123,500	109,000	96,400	79,800	64,800	50,200	36,900	24,700	14,600	7,200	2,200	100	0
1.7500	155,100	138,100	123,200	104,200	86,200	68,600	52,700	37,500	23,800	13,200	5,400	700	400
1.7250	193,800	174,600	157,300	135,700	114,000	93,100	74,100	55,900	37,100	22,600	10,700	1,800	1,200
1.7000	193,500	175,600	159,400	139,000	117,700	97,200	78,600	60,600	41,100	25,700	12,700	2,200	1,500
1.6750	94,500	87,500	81,100	71,200	60,500	50,000	40,500	31,200	21,200	13,200	6,500	1,100	800
1.6500	-5,500	-1,500	1,800	2,500	2,400	2,100	1,800	1,300	900	500	200	-100	-100
1.6250	-116,200	-101,500	-88,300	-77,000	-65,400	-54,500	-44,700	-35,200	-24,100	-15,500	-8,100	-2,000	-1,600
1.6000	-226,800	-201,500	-178,400	-156,700	-133,300	-111,100	-91,300	-71,800	-49,100	-31,400	-16,400	-3,900	-3,000
1.5750	-194,700	-170,500	-148,800	-128,500	-108,300	-88,600	-70,900	-53,700	-35,700	-21,700	-10,500	-2,100	-1,600
1.5500	-154,600	-132,500	-112,700	-94,600	-78,200	-61,800	-46,900	-32,700	-20,300	-10,600	-3,800	-300	-100
1.5250	-126,000	-106,300	-88,700	-73,100	-59,200	-45,700	-33,600	-22,300	-13,200	-6,400	-2,000	-100	0
1.5000	-98,600	-81,300	-65,900	-52,800	-41,400	-30,700	-21,400	-12,900	-6,800	-2,700	-500	-100	0
1.4750	-79,100	-63,900	-50,500	-39,500	-30,400	-21,800	-14,600	-8,300	-4,100	-1,600	-300	0	0
1.4500	-61,500	-48,200	-36,700	-27,700	-20,700	-14,100	-8,900	-4,500	-2,000	-600	0	0	0
1.4250	-48,100	-36,600	-26,700	-19,500	-14,100	-9,300	-5,500	-2,600	-1,100	-300	0	0	0
1.4000	-37,500	-27,600	-19,000	-13,400	-9,400	-5,900	-3,300	-1,300	-500	-100	0	0	0
1.3750	-28,700	-20,200	-12,900	-8,700	-5,700	-3,400	-1,700	-600	-200	0	0	0	0
1.3500	-22,800	-15,400	-9,000	-5,800	-3,700	-2,100	-1,000	-300	-100	0	0	0	0
1.3250	-18,000	-11,600	-6,100	-3,700	-2,200	-1,200	-500	-200	0	0	0	0	0
1.3000	-14,400	-8,700	-4,000	-2,100	-1,300	-600	-300	0	0	0	0	0	0
1.2750	-11,900	-7,000	-2,600	-1,300	-700	-300	-100	0	0	0	0	0	0
1.2500	-10,400	-5,800	-1,800	-800	-500	-200	-100	0	0	0	0	0	0

Figure 10: Residual Output

5.0 CONCLUSION

This project created training guides and added new functionality for the FX Structuring desk within RBS. We performed a series of interviews and reviewed RBS internal documents to identify and improve current processes.

5.1 Training Programs

We created four training guides in our time at RBS. Three of those guides (counterparty risk pricing components, funding and XPortfolio guides) were released to employees while the appropriateness guide was submitted to Chris Leuschke to for further review.

The fragmentation of the information required for our guides was noticeable. As we gathered information from around RBS we found that the information we wanted was frequently contained only in unpublished memos or known by a select few employees.

Our experience made clear the utility of our training guides; if nothing else they serve as a guidebook explaining where to get and how to use the information FX Salespeople need.

5.2 New Functionality

Upgraded tools should decrease the time required to provide a deal quote. Salespeople are now able to generate indicative (a number that should be reasonably close to the real value but one that cannot be used in a finalized deal) RWA for all types of deals where previously they had to refer to TCRM for certain structure types.

Similar benefits arise from automating the time vs. intrinsic value split in the IAS Helper spreadsheet. By simplifying the process required to split time and intrinsic value, employees can access the information faster.

5.3 Conclusion

The training programs we created and spreadsheet upgrades provide RBS a current picture of key topics within the organization. To address the pace of changes, we designed the training programs and added new functionality with updates in mind. This is intended to allow RBS to maintain easy access to up to date information.

6.0 RECOMMENDATIONS

After finishing our research and identifying potential areas of improvement, we generated recommendations that could address the issues. We focused on further increasing access to information. This resulted in 8 methods to achieve the goal of creating self-updating processes so the information can easily be adjusted in the future to reflect changes:

- Create a CRS UK intranet page
- Create a blog run by FX Structuring to document the frequent small conversations and offer information on changes in the FX world
- Determine viability of a shorter term solution offering a single input interface for the RWA, CVA, WWR and CLU programs
- Change EPE in WWR to WWE to highlight that EPE in WWR and EPE in CVA are different numbers
- Change the credit charge formula to remove double counting of risk
- Check RWA by counterparty and by desk to allow the traditional business model to continue
- Monetize the value to RBS of a client signing a CSA and pass some of this to the client
- Require written confirmation of deals that are sufficiently complex

6.1 Corporate Risk Solutions Website

Proposing a deal to a client is governed by a set of internal best practices. However, these don't seem to be listed anywhere. Salespeople currently address this by using email to share deal proposals, discussing how they explained various structure types and sharing general methods of how to write a strong proposal.

This is problematic for writing the appropriateness guide. The other sections give a brief topic introduction and then link to further reading on the subject. CRS UK best practices for client proposals are not listed anywhere, nor are there examples hosted on the intranet. If a salesperson wishes to learn about proposals or see examples they currently would have to ask another salesperson for a proposal that salesperson had created.

We recommend giving CRS UK its own intranet page and moving the best practices discussion there. This page would begin as a public storage area for client proposals, client plans and clear ways to explain a type of structure to a client. It could be upgraded to serve as a general knowledge database, adding permanence to the currently person to person discussions.

Lee Bulman has expressed interest in this recommendation and has offered to sponsor it.

6.2   FX Discussions

Problems in the FX world currently are largely solved by face to face conversations. Although this solves the issue being discussed at that moment, there is no record of the solution. The potential for repeating conversations exists as the information remains inaccessible to all others in FX.

While specific issues are addressed via conversations, more general FX issues are currently covered at Virtual Team meetings. These meetings serve many purposes: team building, sales idea brainstorming, sharing best practices, RBS programs training, discussing new products and discussing new topics that affect the FX world. Information shared from these meetings suffers from similar problems as above: there is no permanent record of the discussions, limiting access to the information.

We recommend adding a dedicated discussion page to the FX Structuring intranet site to add permanence and increase access to information that pertains to the FX world. This site would function as a blog where anyone in the FX world can write a post. The blog would work as follows:

Rules of posting:
- All posts would be made as short as possible.
- The most common post type would be a problem/solution post. This would be a short log of a conversation that solved an issue, written by the employee who originally had the problem.
- A problem/solution post would have a pertinent title, one paragraph describing the problem and one paragraph describing the solution.

- The posts should be categorized under appropriate topic tags (including who helped solve the issue) and submitted.

- Each post would have comment space for other solutions or additional advice. This section would not be for additional questions; all comment sections would contain a disclaimer directing readers to contact the person who helped solved the issue if they have questions.

Posts approving process and common fix features:

- All posts would be reviewed by a member of the FX Structuring team before being published. Comments on posts would not be reviewed.

- If FX Structuring determines a problem is a common one, it can create a Common Fix post. This would be a generic method for solving the overall issue, built off of a well rated (more on this in a moment) problem/solution post if possible.

- Common Fix posts would be reviewed infrequently to ensure the information is still correct (we recommend every 3 months)

- FX Structuring could create more formal posts sharing information such as summaries of Virtual Team meetings and updates on important changes in FX.

System rating and updating:

- There would be a 1-7 rating system for users to rate how helpful a post was. This information would be presented as both a lifetime average and an average over the last 3 months.

- If it is deemed feasible, the system would run a check every time a new rating was given. If the post receives more than a certain number of ratings over a certain period (we propose 15 ratings over 3 months), an email is sent to the person who helped solve the issue. This level of ratings indicates that the post is popular and that it likely contains some issue that should be addressed. If well rated it could potentially be converted to a common fix.

- A script would run at the end of the year that deleted all problem/solution posts over one year old.

This system would push the employee with a problem to truly understand their issue and solution. By encouraging them to write a brief summary, they are essentially being asked to teach others how to solve their same issue. If the employee finds they are unable to write this summary then they did not truly understand their solution and should return to ask more questions. Best of all, this summary creates a permanent record of the problem/solution, addressing the original problem of fragmented and difficult to access information.

An additional benefit would be identification of topic experts. This could be done either formally or informally: formally if FX Structuring wishes to attach review responsibility for certain tags to certain employees or informally where users can simply filter by tag and note who frequently answers a type of question.

6.3 Temporary Interface for RWA, CVA, WWR and CLU

Currently salespeople need to use four different programs to find these values. There is a high potential for errors in this system as it demands a salesperson manually enter the same information repeatedly into the different programs. This is a known problem and there is a long-term solution in the works: run all values through Cremant.

We recommend determining the feasibility of offering a single interface that requires inputting all information only once and passes the information to all the programs. RBS would gain significant mid-term benefits from this.

6.4 Exposure in WWR and CVA

Both CVA and WWR are calculated using Expected Positive Exposure (EPE). However, the EPE used in CVA is different from the EPE used in WWR.

We recommend changing EPE in WWR to Wrong Way Exposure (WWE) to eliminate the potential for confusion.

6.5 Double-Count in WWR

Credit charge is currently calculated as follows (to avoid confusion we will use WWE to represent the exposure measure in WWR):

$$\text{CVA} = \text{EPE} * (1\text{-RR}) * \text{PD}$$

$$\text{WWR} = \text{WWE} * 1\text{yr CDS}/10{,}000 * \text{tenor} * (1 - \text{haircut})$$

$$\textbf{Total Credit Charge} = \textbf{CVA} + \textbf{WWR}$$

However, there is a problem with this formula. If one is prepared to assume that a sovereign default will cause a customer default, the following formulas and diagram hold:

Figure 11: Current Credit Charge Calculation
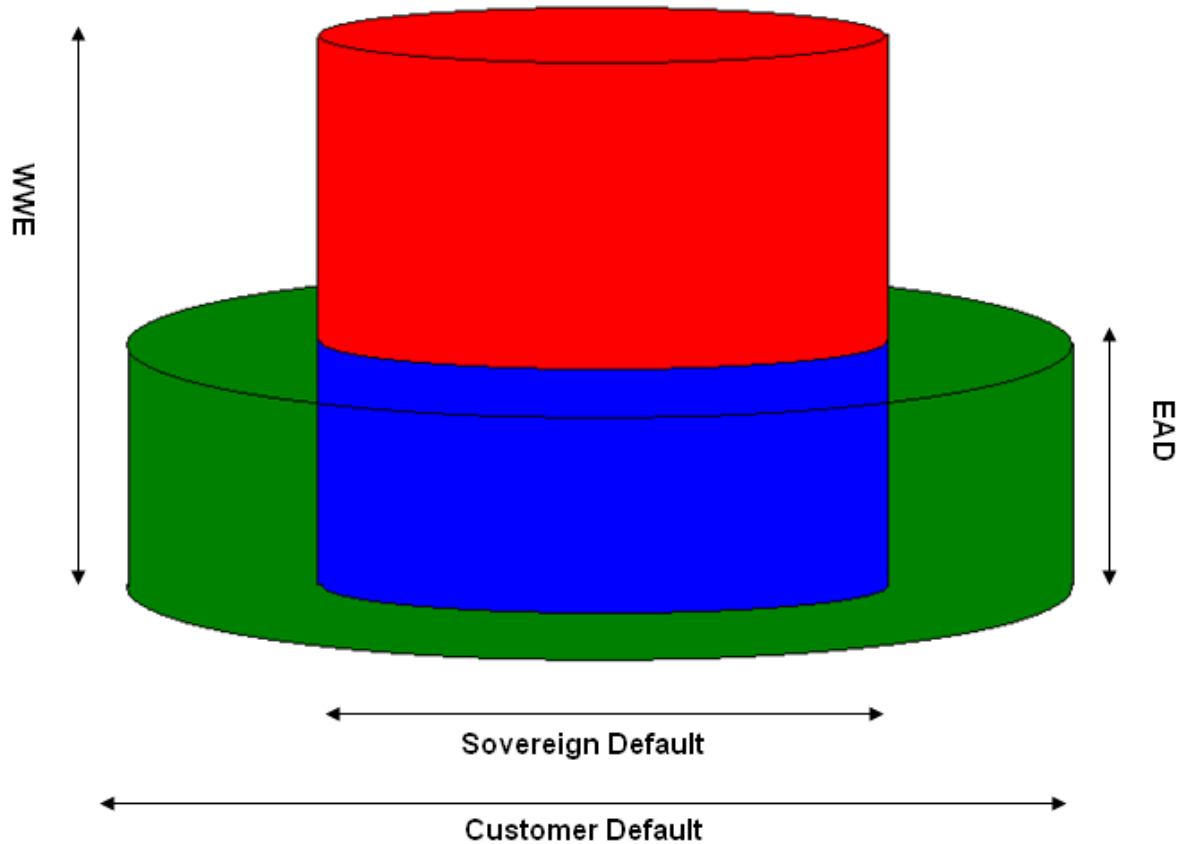
$$\text{CVA} = \text{EPE} * (1\text{-RR}) * \text{PD}$$

$$\text{WWR} = \text{WWE} * 1\text{yr CDS}/10{,}000 * \text{tenor} * (1 - \text{haircut})$$

$$\textbf{Double-Count} = \textbf{EPE} * \textbf{Sovereign CDS} * \textbf{tenor}$$

The preceding graph leads to our recommendation; CEM should change the credit charge formula to:

Total Credit Charge = CVA + WWR – Double-Count

Tom Richards has offered to sponsor this idea.

6.6 RWA Hurdles

For a long time RBS had no RWA hurdle. In these times, a system developed; clients tracked their trading volume of simple structures (forward and options, for example) with each bank they traded with. They then took all their more complicated (and therefore higher profit for a bank) business to the banks at the top of this list. The system pushed banks to give the best price they could, at times taking small losses on forwards with the understanding that it would get them high profit deals later.

Although many clients still use this system, RBS has changed. FSA mandates that RBS must post an amount of capital when doing deals based on the details of a deal. This requirement led RBS to create a desired return on the capital it posts on each deal to ensure efficient capital allocation, now known as the RWA hurdle.

Applying the RWA hurdle to individual deals interferes with the current industry model of doing many smaller deals with a client in order to get higher profit deals in the future. If the hurdle is applied to individual deals, only the higher profit deals will pass the hurdle. However, RBS will never get these deals without winning the smaller deals that potentially fail to pass the RWA hurdle.

We recommend applying the RWA hurdle to a client's entire portfolio, checked quarterly. If the sum of all business with a client efficiently allocates capital, RBS should be willing to deal with that client. To ignore this net affect and turn away a client because some deals will not pass the hurdle is to refuse potential profits.

We also recommend applying the RWA hurdle to an overall desk, checked quarterly. If a desk is significantly missing this hurdle requirement action must be taken to protect RBS' capital.

6.7 Collateralization Agreements

Capital is now a prized commodity within RBS, leading to a rising amount of clients signing a collateralization agreement (frequently a CSA). RBS is interested in having clients sign a CSA as it lower capital usage and comes with an ISDA, a contract that offers RBS one of the strongest legal protections it can get in a deal.

We recommend monetizing the value of the capital conserved via a client signing a collateralization agreement and sharing this with the client. In essence, we are recommending rewarding the client for not using capital. RBS could potentially offer better premium, better rates or reimburse the client for their legal fees incurred reviewing the agreement.

6.8 Written Confirmation before Complex Deals

Official confirmation of deal details only occurs a few days after the deal is closed. This is problematic for complex structures that take a long time to deal as during this long period multiple variations of the same type of structure are discussed. RBS has had situations where the correct type of structure with slightly incorrect specifics was closed, a problem the current system catches only when the official deal confirmation is sent.

A potential solution to this is sending out an email confirming the details of a structure before closing the deal. This requires determining what types of structures and situations merit the time consuming administrative burden of gathering all information required to write such an email.

We recommend determining if pre-deal confirmation is necessary on a deal by deal basis. The following deal traits are especially pertinent to this decision:

- Deferred deliveries
- Restructures consisting of more than two parts
- Discussion of the structure involved multiple variations of a single structure
- The structure type is new to the counterparty.

This list should be supplemented by collecting examples of deals where the details were later found to be incorrect to attempt to determine patterns. It is a difficult task for structurers to

theorize which structures potentially could cause confusion. Collecting and analyzing real examples is a way around this issue.

7.0 MONTE CARLO PRICING OF SWAPTIONS

In this chapter, I aim to analyze and implement the detailed pricing steps of Swaptions – the type of options for interest rate swap which are commonly used in the investment field today. The first objective is to closely observe the payoffs of swaptions and summarize them in a general function. The second objective is to discuss the pricing of a swaption using both analytical approach and Monte Carlo simulation. The third objective is to use a zero coupon swaption as an example to illustrate the implementation of both methods listed above. This example will also include a comparison of the outputs from these two methods. The final objective is to compare the advantages and disadvantages of both methods and give suggestions for improvements.

Before going deep into the discussion about swaption pricing, I documented the final expression and derivation of Black Scholes formula. It is most widely used for the option price calculation, given the current price of the underlying asset, the strike price, the interest rate, and the volatility of the underlying asset.

To apply the Black Scholes formula to swaption, I first observed what a swap contract was and the differences between a swaption and an ordinary European style option. By generating the payoff function for swaptions and comparing it with the Black Scholes formula; I understood what changes needed to be made before applying Black Scholes formula in swaptions. Then after the discussion with my advisor, we decided the methods used for pricing a swaption: the analytical approach and Monte Carlo simulation. As the initial rate and strike swap rate are given, the analytical approach only needs to calculate the forward swap rate volatility under proper assumption, and then apply the Black Scholes formula to give the price of a swaption. On the other hand, the Monte Carlo simulation will randomly generate a large set of forward swap interest rates under lognormal distribution. By calculating the payoffs and taking the average, this method then is able to calculate the swaption price.

Afterwards we decided to use the Zero coupon swaptions as an example and calculated its price under both methods, in order to compare and confirm the accuracy of the above approaches. MATLAB is chosen as the programming tool because it has strong and convenient

functions to support the basic calculation and random variables generation. The outputs from both methods are quite close in regards to the forward rate volatilities and the prices. It is confirmed that both ways are very reliable in calculating swaption prices.

Finally the cost effectiveness of the calculation processes is examined and potential improvements are suggested. Monte Carlo method could be applied to many types of swaptions while the analytical approach is applicable only if the swaption volatility could be expressed in a mathematical formula. However, Monte Carlo method is much slower than the analytical approach as it has to simulate a large number of forward rate scenarios to ensure the accuracy of the output. Therefore, the calculation process of Monte Carlo simulation must be changed to improve its speed. It is suggested to change the current sequential calculating of each forward rate in MATLAB into paralleled calculation. This requires choosing a programming language that supports parallel processing, like C/C++ and JAVA. In addition, more future research about the implementing details must be done before the design of the new algorithm.

7.1   Interest Rate Swaption

7.1.1   The Interest Rate's Effect on Investment

"I think there's going to be heightened nervousness about whether interest rates are going to go up towards the end of the quarter because the economy does look strong. The extreme volatility that we have seen recently is going to continue."

Vicent Farell

Interest rates have essential effects on how the market moves, as they reflect the changes in general economic conditions, inflationary expectations, monetary and fiscal policies, and also US dollar strength (CBOE, 2000).   As a result, no matter which product you invest in, the interest rate will always be the major factor that affects you.

According to the Chicago Board Option Exchange (CBOE), the two closely watched interest rates are the benchmark rates on short-term and the U.S Treasury securities on long-term. For an investor, the changing in interest rates brings both opportunity and risk. If the investor has a

correct estimation on the forward rates movement, he/she might benefit significantly from the market, but if opposite, the interest rates movements could diminish their investment severely.

7.1.2 Interest Rate Swaps and Swaptions

An interest rate swap is an agreement to exchange fixed for floating interest rate streams (or vice versa) on a notional principal (Interest rate swap, 2010). Interest rate swaps can be used by hedgers to manage their fixed or floating assets and liabilities, while they can also be used by speculators to replicate unfunded exposures to protect from changes in interest rates (Interest rate swap, 2010).

A swaption is an option on an interest rate swap. A payer swaption gives the owner the right but not the obligation to pay fixed rate and receive floating rate in the underlying swap and a receiver swaption gives the right but not the obligation to receive fixed and pay floating rate. In nowadays, more than 90% swaptions are in European style.

To decrease the investment risk due to the interest rate fluctuation, swaption gives the investors the right to decide whether they will enter a swap contract with their counterparties. A swaption can be used to protect a firm against the risk of higher borrowing costs, but without giving up the possible benefit of lower interest rates.

7.1.2.1 A Swaption example

Both company A and company B are involved in import/export business, so the foreign exchange rate will have serious effect on their profit. Company A anticipated that the foreign exchange rates will rise in the near future and their payments will sequentially increase with it, so it will prefer to pay a fixed rate all the time to avoid the gradual increase of a payment. On the other side, company B estimates that the foreign exchange rate will drop so they believe that they will benefit by paying the floating rate according to the market. Although they have different opinions on the interest movement, neither would let the opportunity go if the interest rate moves in favor of them. To achieve both companies' business goal and maintain the opportunity to outperform, instead of entering an IRS directly, they agree upon a swaption contract. Details, such as the price of the swaption, the fixed rate, (also known as the swap rate), the length of the

option period, and the term of the underlying swap are determined at the beginning of the contract. If company A is the buyer of the swaption, it will choose to exercise the option if the fixed rate is more favorable than the prevailing market swap rate. Then company A pays B a fixed interest amount calculated from the fixed rate they agreed on at the beginning, and company B pays A by a floating rate which changes with the move of LIBOR. The following graph shows this transaction process.
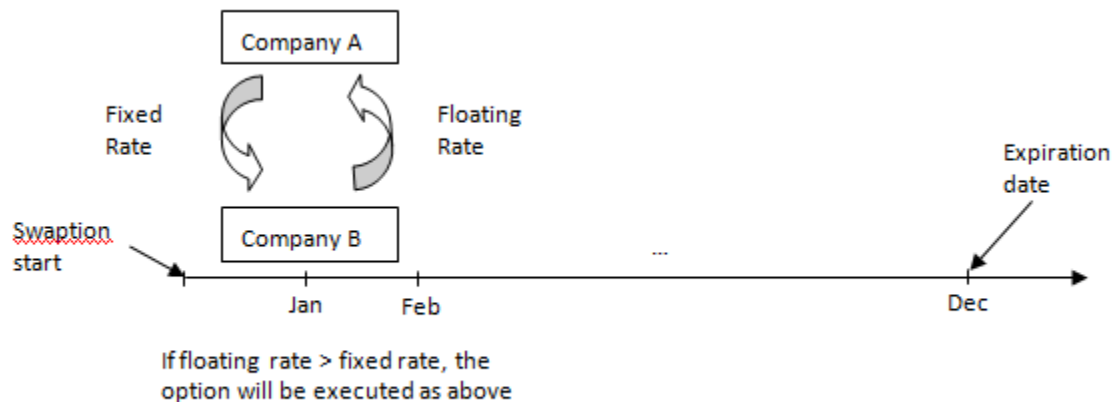
Figure 12: Swaption example

…

7.1.3 Pricing Interest Rate Swap Options

As we know, Black-Sholes formula is widely used in pricing all types of options, including swaptions. For a swaption price, it requires the current swap rate, the strike swap rate and the forward interest swap rate volatility. As the strike and the current swap rate are known, to get the price through Black Scholes formula, one common way is to calculate the volatility through proper assumption about the movement of the forward interest rates. This method is called analytical approach. Another widely recognized method is the Monte Carlo simulation. It simulates different swap rates moving scenarios under lognormal distribution and calculates the average price of those scenarios.

In this paper, we will use Zero Coupon Swaption as an example to discuss the above two methods in pricing a swaption, including the result accuracy, the calculation speed, as well as the potential improvements.

7.2   Option Pricing Formula

7.2.1 Interest Rate Options

Interest rate Options (IRO) are European-style, cash-settled options on the yield of U.S. Treasury securities (CBOE, 2000). The interest options could prevent a hedger from suffering the loss when the interest rates movement will devalue their investment, and still allow them to make benefit when the market outperforms. Of course, a speculator could also rely on the IRO to make profit with their estimations of the forward interest rate.

Just like other type of options, the IRO call buyer and put buyer have different expectations about interest rate movement in the future. For example, a call buyer anticipates interest rate will go up, increasing the value of the call position, while a put buyer thinks quite the opposite way. A major difference between interest rate options and other type of options is the underlying value: instead of using units of specific Treasury bills, notes or bonds, IRO based on the interest rates (CBOE, 2000).

There are three types most popular interest rate derivatives: bond options, interest rate caps, and swap options. Under a lognormal assumption, the Black Scholes model can be used to value this instruments (Hall, 2002).

7.2.2 Black Scholes Formula

Black Scholes model was first published in 1973, and became a very popular tool for pricing options ever since then (Hall, 2002). This model has been extended to apply for more types of options, and the traders in investment banks become very comfortable with the lognormal assumptions of this model and the volatility measure that describe the uncertainty.

Interest rate options are more difficult to measure than equity and foreign exchange derivatives, because the individual interest movement is more complicated than the stock price or

the foreign exchange rate, and the volatilities on different points of the yield curve are different, and the interest rates are used for both discounting and defining the payoff of the options.

7.2.2.1 Black Scholes formula for European options

The original Black Scholes formula for European call option is presented as follows: (Black-Scholes, 2010).

$$C(S,t) = SN(d_1) - Ke^{-r(T-t)}N(d_2)$$
$$d_1 = \frac{\ln(\frac{S}{K}) + (r + \frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}}$$
$$d_2 = d_1 - \sigma\sqrt{T-t}.$$

Similarly for the put option:

$$P(S,t) = Ke^{-r(T-t)}N(-d_2) - SN(-d_1).$$

For both the formulas above,

$N(\cdot)$ is the cumulative distribution function of the standard normal distribution

$T - t$ is the time to maturity

S is the spot price of the underlying asset

K is the strike price

r is the risk free rate (annual rate, expressed in terms of continuous compounding)

σ is the volatility in the log-returns of the underlying

7.2.2.2 The Derivation of Black Scholes formula

This formula is derived upon the following assumption about the interest rate and stock price:

$$dB(t) = rB(t)dt$$
$$dS(t) = \alpha S(t)dt + \sigma S(t)dW(t)$$

r is the interest rate, and $S(t)$ is the underlying asset's value at time t, the interest rate is calculated as compounded interest rate, and the underlying asset value is estimated using Brownian motion. α is a drift constant and the σ is the volatility of a financial product value in the market.

The derivative dW(t) follows the normal distribution ~ N(0, dt), since a Brownian motion W(T) is assumed under normal distribution ~N(0, T), which is used to model the irregular movement of an object and could be applied to physics modeling as well as the financial world.

So the underlying asset's price follows a lognormal distribution due to the normal distribution of dW(t).

According to Ito's lemma

$$df = \frac{\partial f}{\partial t} dt + \frac{\partial f}{\partial x} dX + \frac{1}{2}\frac{\partial^2 f}{\partial x^2}(dX)^2;$$

With $(dt)^2 = 0$, $dt*dW = 0$, and $(dW)^2 = dt$.

By applying Ito's lemma to lnS(t), we have:

$$dlnS(t) = \frac{1}{S(t)} dS(t) - \frac{1}{2}\frac{1}{S(t)}\left(dS(t)\right)^2$$

$$= \frac{1}{S(t)}\left[\alpha S(t)dt + \sigma S(t)dW(t) - \frac{1}{2}\frac{1}{S(t)}\left(\alpha S(t)dt + \sigma S(t)dW(t)\right)^2\right]$$

$$= \left(\alpha - \frac{1}{2}\sigma2\right) dt + \sigma dW(t)$$

Therefore, under the risk neutral measure, we have

$$lnS(T) = lnS(t) + \{(r-\frac{1}{2}\sigma^2)(T-t) + \sigma(W(T)-W(t))$$

$$S(T) = S(t)* e^{(r-\frac{1}{2}\sigma2)(T-t)+\sigma(W(T)-W(t))},$$

let $Y = (r-\frac{1}{2}\sigma^2)(T-t) + \sigma(W(T)-W(t))$, then

$$S(T) = S(t)*e^Y$$

Since $(r-\frac{1}{2}\sigma^2)(T-t)$ is a constant, and $\sigma(W(T)-W(t))$ follows a normal distribution ~N(0, $\sigma\sqrt{T-t}$), then Y follows the normal distribution of N($(r-\frac{1}{2}\sigma^2)(T-t)$, $\sigma\sqrt{T-t}$)

An option's price is decided as:

$$e^{-r(T-t)}* E\left[(S(T)-K)^+\right]$$

which is the discounted present value of the expected positive payoff value of the option.

$$e^{-r(T-t)}* E[(S(T)-K)^+] = e^{-r(T-t)}* \int_{-\infty}^{\infty}(S(T) - K)^+ f(y)dy$$

Let rewrite Y as $Y = r'\tau + \sigma\sqrt{T-t}*Z$, with $r'=r-\frac{1}{2}\sigma^2\sigma2$; $\tau=T-t$, $\sigma(W(T)-W(t)) = \sigma\sqrt{T-t}*Z$. In addition,

$$(Se^{r'\tau+\sigma\sqrt{\tau}Z} - K)^+ = \max[Se^{r'\tau+\sigma\sqrt{\tau}Z} - K, 0]$$

$$= \int_{-\infty}^{\infty} \max\left[Se^{r'\tau+\sigma\sqrt{\tau}Z} - K, 0\right] f(z)dz$$

To get rid of the max[], symbol, we need to solve the following inequality:

$$Se^{r'\tau+\sigma\sqrt{\tau}Z} - K > 0,$$

$$Se^{r'\tau+\sigma\sqrt{\tau}Z} > K$$

$$e^{r'\tau+\sigma\sqrt{\tau}Z} > K/S$$

$$r'\tau + \sigma\sqrt{\tau}Z > \ln(K/S)$$

$$Z > \frac{\ln\left(\frac{K}{S}\right) - r'\tau}{\sigma\sqrt{\tau}} = z_0$$

As a result, we have

$$\int_{-\infty}^{\infty} \max\left[Se^{r'\tau+\sigma\sqrt{\tau}Z} - K, 0\right] f(z)dz$$

$$= \int_{z0}^{\infty} (Se^{r'\tau+\sigma\sqrt{\tau}Z} - K) \frac{1}{2\pi} e^{-\frac{1}{2}Z^2} dZ$$

$$= \int_{z0}^{\infty} Se^{r'\tau+\sigma\sqrt{\tau}Z} * \frac{1}{2\pi} e^{-\frac{1}{2}Z^2} dZ - K \int_{z0}^{\infty} \frac{1}{2\pi} e^{-\frac{1}{2}Z^2} dZ$$

$$= A - B$$

$$B = K \int_{z0}^{\infty} \frac{1}{2\pi} e^{-\frac{1}{2}Z^2} dZ = K (1 - \phi(z0)) = K*N(-z_0)$$

The normal distribution graph could help in getting the value of N $(-z_0)$

$$A = \int_{z0}^{\infty} Se^{r'\tau+\sigma\sqrt{\tau}Z} * \frac{1}{2\pi} e^{-\frac{1}{2}Z^2} dZ = \frac{se^{r\tau}}{\sqrt{2\pi}} \int_{z0}^{\infty} e^{\sigma\sqrt{\tau}Z - \frac{1}{2}Z^2} dZ$$

$$= \frac{se^{r\tau}}{\sqrt{2\pi}} \int_{z0}^{\infty} e^{-\frac{1}{2}(Z-\sigma\sqrt{\tau})^2} dZ$$

$$= \frac{se^{r\tau}}{\sqrt{2\pi}} \int_{z0-\sigma\sqrt{\tau}}^{\infty} e^{-\frac{1}{2}X^2} dX; \quad X = Z - \sigma\sqrt{\tau}$$

$$= se^{r\tau}N(\sigma\sqrt{\tau} - Z)$$

7.2.2.3 Apply Black Scholes Model to Swaption

To apply BS formula to European swap options, several assumptions and changes have to be added to the original formula.

Suppose we have a swaption that gives us the right to enter at a future time $T_\alpha > 0$ on an Interest Rate Swap (IRS), whose first reset time coincides with T_α, with payments occurring at dates T_α, $T_{\alpha+1}$, $T_{\alpha+2}$, ...T_β.

Then the swaption strike K will be set as the fixed rate K of the underlying IRS, and the underlying asset value S(t) will be set as the forward swap rate $S_{\alpha,\beta}(T_\alpha)$. We will exercise the swaption at the maturity date T only if the S(T) is larger than the IRS fixed rate K. As the time line showed below,

Figure 13: Swap timeline

At each time T_j, for $j=\alpha+1$, $\alpha+2$, $\alpha+3$...β, two parties exchange their rates with one party pays the fixed amount, and the other pays the floating amount.
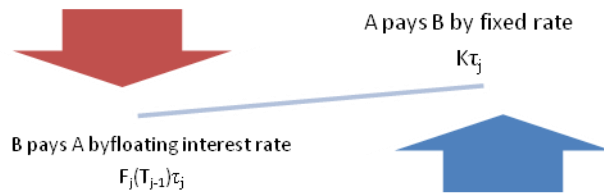
Figure 14: IRS example

So the payoff at time t for the payer party of such an IRS can be expressed as

$$\sum_{i=\alpha+1}^{\beta} D(t, T_i)\, \tau_i\, (F_i(T_{i-1}) - K)$$

The value of such a contract is:

$$\text{PFS}(t, [T_\alpha, \dots T_\beta], K) = E_t\{\sum_{i=\alpha+1}^{\beta} D(t, T_i)\, \tau_i\, (F_i(T_{i-1}) - K)\}$$

$$= \sum_{i=\alpha+1}^{\beta} P(t, T_i)\, \tau_i\, E_t^i (F_i(T_{i-1}) - K)$$

$$= \sum_{i=\alpha+1}^{\beta} P(t, T_i)\, \tau_i\, (F_i(t) - K)$$

Where $P(t, T_i)$ is the price of a zero-coupon bond (ZCP) at time t for the maturity T.

Since $\qquad F_i(t) = \frac{1}{\tau_i} \left(\frac{P(t, T_{i-1}) - P(t, T_i)}{P(t, T_i)} \right)$

$$= \sum_{i=\alpha+1}^{\beta} P(t, T_{i-1}) - (1 + \tau_i K)\, P(t, T_i) \qquad\qquad (1)$$

By setting equation (1) to zero, we have

$$\sum_{i=\alpha+1}^{\beta} P(t,T_{i-1}) - (1 + \tau_i K)\, P(t,T_i) = 0$$

$$\sum_{i=\alpha+1}^{\beta} [P(t,T_{i-1}) - P(t,T_i)] - K \sum_{i=\alpha+1}^{\beta} \tau_i\, P(t,T_i) = 0$$

$$S_{\alpha,\beta}(t) = K = \frac{P(t,T_\alpha) - P(t,T_\beta)}{\sum_{i=\alpha+1}^{\beta} \tau_i\, P(t,T_i)}$$

A swaption gives its holder the right but not obligation to enter at a future time $T_\alpha > 0$ and IRS, whose first reset time usually coincides with T_α, with payments occurring at dates $T_{\alpha+1}$, $T_{\alpha+2}$, $T_{\alpha+3}$, … T_β. The fixed rate K of the underlying swap is usually called the swap strike. Consequently, if we assume unit notional amount, the swaption payoff can be written as:

$D(0, T_\alpha)\, (S_{\alpha,\beta}(T_\alpha) - K)^+ \sum_{i=\alpha+1}^{\beta} \tau_i\, P(t,T_i)$

7.3   ZCP SWAPTION PRICING METHODS

This chapter focuses on how to price zero-coupon swaption. There are two common approaches to model the price of a swaption: an analytical approach with proper assumptions made for rates volatilities and the Monte-Carlo simulation for the prices. Both methods will be introduced here and a comparison and analysis about the accuracy will be made at the end of the chapter.

7.3.1 Zero-coupon Swap (ZCP)

A Zero-coupon interest rate swap (ZCP IRS) is one of the simplest swaps where the counterparty that pays fixed swap rate only pays at the last maturity date while the counterpart who pays floating rates needs to pay at each maturity date.

Figure 15: ZCP timeline

As the picture above showed, A pays B a single fixed payment at final pay date T_β, and B pays A stream of floating payments $\tau_i L(\tau_{i-1}, \tau_i)$ at times T_i in $T_\alpha, T_{\alpha+1, \ldots} T_\beta$.

The discounted payoff of a payer zero-coupon IRS at time $t <= T_\alpha$ is:

$$D(t, T_i)\left[\sum_{i=\alpha+1}^{\beta} P(T_\alpha, T_i)\,\tau_i * F_i(T_\alpha) - P(T_\alpha, T_\beta)\tau_{\alpha,\beta} * K\right]$$

Therefore, the value of the contract is given as (Brigo & Mercurio, 2006)

$$Value\ of\ the\ contract = E\{D(t, T_\alpha)[\sum_{i=\alpha+1}^{\beta} P(T_\alpha, T_i)\,\tau_i * F_i(T_\alpha) - P(T_\alpha, T_\beta)\tau_{\alpha,\beta} * K]\}$$

$$= \sum_{i=\alpha+1}^{\beta} E\left[D(t, T_\alpha)P(T_\alpha, T_i)\tau_i * F_i(T_\alpha)\right] - E[D(t, T_\alpha)P(T_\alpha, T_\beta)\tau_{\alpha,\beta} * K]$$

Apply risk neutral assumption $E[F_i(T_\alpha)] = F_i(t)$, we have:

$$Value\ of\ the\ contract = \sum_{i=\alpha+1}^{\beta} P(t, T_i)\tau_i * F_i(t) - P(t, T_\beta)\tau_{\alpha,\beta} * K$$

$$= \sum_{i=\alpha+1}^{\beta} P(t, T_i)\frac{P(t, T_{i-1}) - P(t, T_i)}{P(t, T_i)} - P(t, T_\beta)\tau_{\alpha,\beta} * K$$

$$= \sum_{i=\alpha+1}^{\beta} [P(t, T_{i-1}) - P(t, T_i)] - P(t, T_\beta)\tau_{\alpha,\beta} * K$$

$$= P(t, T_\alpha) - P(t, T_\beta) - P(t, T_\beta)\tau_{\alpha,\beta} * K$$

This is simply the value of the floating leg less the value of the fixed leg.

To make the contract fair for both counterparties, the value of the above equation has to be 0, and in such way, we could determine the fixed swap strike K. Therefore,

$$P(t, T_\alpha) - P(t, T_\beta) - P(t, T_\beta)\tau_{\alpha,\beta} * K = 0$$

$$K = \frac{P(t, T_\alpha) - P(t, T_\beta)}{P(t, T_\beta)\tau_{\alpha,\beta}} = F(t; T_\alpha, T_\beta)$$

where $F(t; T_\alpha, T_\beta)$ means the forward interest rate at time t for the period (T_α, T_β).

7.3.2 Zero-coupon Swaption

Zero-coupon Swaption is an option to enter a zero-coupon IRS.Like the calculation of other options, the payoff of such a swaption is:

$$D(t,T_i)[\sum_{i=\alpha+1}^{\beta} P(T_\alpha,T_i)\,\tau_i * F_i(T_\alpha) - P(T_\alpha,T_\beta)\tau_{\alpha,\beta} * K]^+$$

$$\text{Since } F_i(T_\alpha) = F(T_\alpha,T_{i-1},T_i) = \frac{1}{\tau_i}\left(\frac{P(T_\alpha,T_{i-1})}{P(T_\alpha,T_i)} - 1\right)$$

The payoff could be written as

$$D(t,T_i)\{\sum_{i=\alpha+1}^{\beta}[P(T_\alpha,T_{i-1}) - P(T_\alpha,T_i)] - P(T_\alpha,T_\beta)\tau_{\alpha,\beta} * K\}^+$$

$$= D(t,T_i)\{[P(T_\alpha,T_\alpha) - P(T_\alpha,T_\beta)] - P(T_\alpha,T_\beta)\tau_{\alpha,\beta} * K\}^+$$

$$= D(t,T_i)[1 - P(T_\alpha,T_\beta) - P(T_\alpha,T_\beta)\tau_{\alpha,\beta} * K]^+$$

$$= D(t,T_i)P(T_\alpha,T_\beta)\tau_{\alpha,\beta}\left[\frac{1-P(T_\alpha,T_\beta)}{P(T_\alpha,T_\beta)\tau_{\alpha,\beta}} - K\right]^+$$

$$= D(t,T_i)P(T_\alpha,T_\beta)\tau_{\alpha,\beta}\left[F(T_\alpha,T_\alpha,T_\beta) - K\right]^+$$

If we know the volatility of $F(*,T_\alpha,T_\beta)$, then we could apply Black Scholes formula. As we already know the standard forward rates $F_{\alpha+1}, F_{\alpha+2}, ... F_\beta$.

Let $F(t) = F(t,T_\alpha,T_\beta)$ and $\tau = \tau_{\alpha,\beta}$, then

$$1 + \tau F_t = \prod_{i=\alpha+1}^{\beta} 1 + \tau_j F_j(t)$$

$$\ln(1+\tau F_t) = \ln\left(\prod_{i=\alpha+1}^{\beta} 1 + \tau_j F_j(t)\right)$$

$$= \sum_{i=\alpha+1}^{\beta} \ln(1 + \tau_j F_j(t))$$

$$d\ln(1+\tau F_t) = \sum_{i=\alpha+1}^{\beta} d\ln(1 + \tau_j F_j(t))$$

Applying Ito's lemma, we get:

$$\frac{\tau dF(t)}{1+\tau F(t)} = \sum_{i=\alpha+1}^{\beta} d\ln(1+\tau_j F_j(t)) = \sum_{i=\alpha+1}^{\beta} \frac{\tau_j dF_j(t)}{1+\tau_j F_j(t)} + (*)dt$$

Where (*)dt term has no effect to the variance, because when we take variance, this term will be 0.

$$dF(t) = \frac{1 + \tau F(t)}{\tau}[\sum_{i=\alpha+1}^{\beta} \frac{\tau_j dF_j(t)}{1 + \tau_j F_j(t)} + (*)dt]$$

As each $F_j(t)$ and $F(t)$ follow the Geometric Brownian motion, dF(t)=(*)dt + σF(t)dW(t)

$$\frac{dF(t)}{F(t)} = (*)dt + \sigma dW(t)$$

$$Var(\frac{dF(t)}{F(t)}) = \sigma^2$$

So by solving the value of $\frac{dF(t)}{F(t)}$, we could know the swaption's volatility. Since

$$dF_j(t) = (*)dt + \sigma_j(t)F_j(t)dW_j(t)$$

$$Var(\frac{dF(t)}{F(t)}) = (\frac{1 + \tau F(t)}{\tau F(t)})^2 \sum_{i,j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} \sigma_i(t)\sigma_j(t)F_j(t)F_i(t)}{(1 + \tau_i F_i(t)) * (1 + \tau_j F_j(t))} dt$$

$$(v_{\alpha,\beta}^{zc}) = (\frac{1 + \tau F(t)}{\tau F(t)})^2 \sum_{i,j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} F_i(0)F_j(0)}{(1 + \tau_i F_i(0)) * (1 + \tau_j F_j(0))} \int_0^{T_\alpha} \sigma_i(t)\sigma_j(t) dt$$

Therefore, as all the required inputs are known, we could apply Black Scholes formula to calculate the price of the zero-coupon swaption:

$$ZCPS=\tau P(0, T_\beta) BL(K, F(0), v_{\alpha,\beta}^{zc})$$

7.3.2.1 Calculate Zero-coupon Swaption Price

Given the exact dynamics of the forward rates, we are going to check the price of zero-coupon swaption. Use the analytic formula:

$$ZCPS=\tau P(0, T_\beta) BL(K, F(0), v_{\alpha,\beta}^{zc})$$

Where $\tau = \tau_{\alpha,\beta}$. , and the volatility is given by the following formula:

$$(v_{\alpha,\beta}^{zc}) = (\frac{1 + \tau F(t)}{\tau F(t)})^2 \sum_{i,j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} F_i(0)F_j(0)}{(1 + \tau_i F_i(0)) * (1 + \tau_j F_j(0))} \int_0^{T_\alpha} \sigma_i(t)\sigma_j(t) dt$$

The instantaneous volatilities of the forward rate term that we are going to use are described as follows.

"We adapt the following formulation as our instantaneous volatilities. Humped and maturity-adjusted instantaneous volatilities depend only on time to maturity, typical rank-two correlations." (Brigo & Mercurio, 2006)

$$\sigma_i(t) = \Phi_i \psi(T_{i-1} - t; a, b, c, d)$$

$$\sigma_i(t) = \Phi_i\{[a(T_{i-1} - t) + d]e^{-b(T_{i-1}-t)} + c\}$$

With a= 0.1908, b=09746; c=0.0808; and d=0.0134

This is the "most normal" situation, in that it reflects a qualitatively acceptable evolution of the term structure of volatilities in time and allows for a satisfactory joint calibration to caplets and swaptions volatilities (Brigo & Mercurio, 2006).

We consider a family of forward rate whose maturity pairs are: 0y, 1y, 2y, 3y….19y, 20y.

Then we take the resetting of times into our previous formula. So T_0=1y, T_1=2y…T_{20}=19y; thus our initial input for forward rates are: $F_0(0)$, $F_1(0)$, $F_2(0)$…. $F_{19}(0)$, with $F_0(0)$ being the initial spot rate.

The swap strike K=F (0), and F(0) can be calculated using

$$1 + \tau F_t = \prod_{i=\alpha+1}^{\beta} 1 + \tau_j F_j(t)$$

Each $F_i(0)$ is showed as below in a expression with y. In this specific case, T_α=2y and T_β=19y;

$$F_0(0)=L(0; 1y)$$

$$F_1(0)=L(0; 1y, 2y)$$

……

$$F_{19}(0)=L(0; 19y, 20y)$$
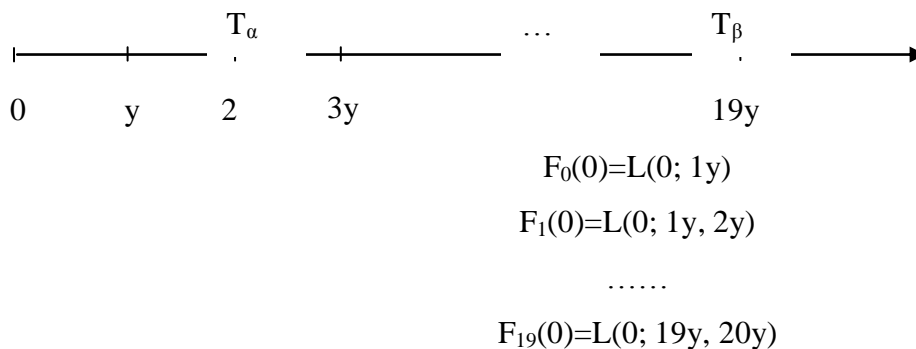
So far, we have all the data required to calculate the volatility and by writing a simple program in MATLAB (Appendix 1), we could get the estimated volatility for the ZCP swaption, then the price of the swaption can be obtained by applying Black schools formula.

7.3.2.2 Monte Carlo Simulation for ZCP Swaption Price

Price of zero-coupon swaption at time t=0 is written as:

$$P = E^{\Theta}\{D(0, T_\alpha)\tau_{\alpha, \beta}P(T_{\alpha,} T_\beta)[F(T_{\alpha\,;} T_\alpha, T_\beta)-K]^+\}$$

$$= P(0, T_\alpha)\, \tau_{\alpha, \beta}\, E^{\Theta}\{P(T_{\alpha,} T_\beta)[\, F(T_{\alpha\,;} T_\alpha, T_\beta)-K]^+\}$$

In order to use Monte Carlo method, we need to generate m realizations of $F(T_\alpha) = (T_{\alpha\,;}$ $T_\alpha, T_\beta)$, where m is usually a fairly large number. Then the price is the average payoff of the m realizations:

$$P \cong = P(0, T_\alpha)\, \tau_{\alpha, \beta}\frac{1}{m}\Sigma_i^m\, P\left(T_\alpha, T_\beta\right)\left(F_{(T_\alpha, T_\alpha, T_\beta)}^{(i)} - K\right)^+$$

Now we explain how to generate m realizations of the forward rate $F(T_\alpha)$. Recall that:

$$1 + \tau F(T_\alpha) = \prod_\alpha^\beta(1 + \tau_j\, F_j(T_\alpha))$$

i.e. $F_j(T_\alpha) = \dfrac{\prod_\alpha^\beta(1 + \tau_j F_j(T_\alpha)) - 1}{\tau}$

So, to simulate $F(T_\alpha)$, we need to simulate $F_{\alpha+1}(T_\alpha), F_{\alpha+2}(T_\alpha) \dots \dots F_\beta(T_\alpha)$

Recall the dynamics of forward rates under Q^α,

$$dF_k(t) = \sigma_k(t)F_k(t)\sum_{j=\alpha+1}^k\frac{\rho_{k,j}\tau_j F_j(t)\sigma_j(t)}{1+\tau_j F_j(t)}dt + \sigma_k(t)F_k(t)dZ_k(t)$$

By Ito's lemma, we have

$$d\ln F_k(t) = \sigma_k(t)\sum_{j=\alpha+1}^k\frac{\rho_{k,j}\tau_j F_j(t)\sigma_j(t)}{1+\tau_j F_j(t)}dt - \frac{\sigma_k^2(t)}{2}dt + \sigma_k(t)\,dZ_k(t)$$

We now make it discrete with a sufficiently small time step Δt

$$\ln F_j^{\Delta t}(t+\Delta t) = \ln F_j^{\Delta t}(t) + \sigma_k(t)\sum_{j=\alpha+1}^k\frac{\rho_{k,j}\tau_j F_j^{\Delta t}(t)\sigma_j(t)}{1+\tau_j F_j^{\Delta t}(t)}\Delta t - \frac{\sigma_k^2(t)}{2}\Delta t + \sigma_k(t)\sqrt{\Delta t}\,Z_k$$

$$F_j^{\Delta t}(t + \Delta t) = F_j^{\Delta t}(t) * \exp\left\{\sigma_k(t) \sum_{j=\alpha+1}^{k} \frac{\rho_{k,j}\tau_j F_j^{\Delta t}(t)\sigma_j(t)}{1+\tau_j F_j^{\Delta t}(t)} \Delta t - \frac{\sigma_k^2(t)}{2}\Delta t + \sigma_k(t)\sqrt{\Delta t}\, Z_k\right\}$$

Where $(Z_{\alpha+1}, Z_{\alpha+2}, \ldots Z_\beta) \sim N(0, \rho)$

$$\begin{bmatrix} F_{\alpha+1}^{\Delta t}(t + \Delta t) \\ F_{\alpha+2}^{\Delta t}(t + \Delta t) \\ \vdots \\ F_\beta^{\Delta t}(t + \Delta t) \end{bmatrix} = \begin{bmatrix} F_{\alpha+1}^{\Delta t}(t) \\ F_{\alpha+2}^{\Delta t}(t) \\ \vdots \\ F_\beta^{\Delta t}(t) \end{bmatrix} *$$

$$\begin{bmatrix} \exp\left\{\sigma_{\alpha+1}(t) \frac{\rho_{\alpha+1,\alpha+1}\tau_{\alpha+1} F_{\alpha+1}^{\Delta t}(t)\sigma_{\alpha+1}(t)}{1+\tau_j F_{\alpha+1}^{\Delta t}(t)} \Delta t - \frac{\sigma_{\alpha+1}^2(t)}{2}\Delta t + \sigma_{\alpha+1}(t)\sqrt{\Delta t} Z_{\alpha+1}\right\} \\ \vdots \\ \vdots \\ \exp\left\{\sigma_\beta(t) \sum_{j=\alpha+1}^{k} \frac{\rho_{\beta,j}\tau_j F_j^{\Delta t}(t)\sigma_j(t)}{1+\tau_j F_j^{\Delta t}(t)} \Delta t - \frac{\sigma_\beta^2(t)}{2}\Delta t + \sigma_\beta(t)\sqrt{\Delta t} Z_\beta\right\} \end{bmatrix}$$

Initial value: $F_{\alpha+1}(0), F_{\alpha+2}(0) \ldots F_\beta(0)$

Our goal is to obtain $F_{\alpha+1}(T_\alpha), F_{\alpha+2}(T_\alpha) \ldots F_\beta(T_\alpha)$. i.e. $F_{\alpha+1}(2y), F_{\alpha+2}(2y) \ldots F_\beta(2y)$
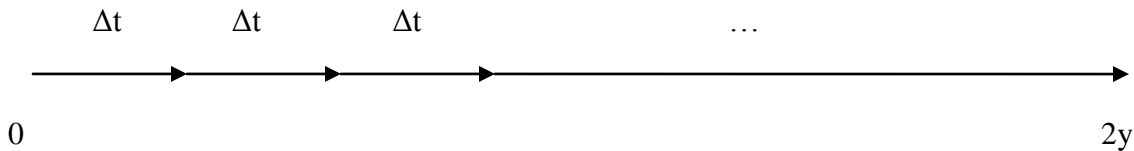
After n^{th} iteration, we can obtain one realization of $F_{\alpha+1}(2y), F_{\alpha+2}(2y) \ldots F_\beta(2y)$

Repeat m times, we can obtain m realizations of $F_{\alpha+1}(2y), F_{\alpha+2}(2y) \ldots F_\beta(2y)$.

7.3.2.2.1 Implied Volatility from Black Scholes Formula

In order to make the comparison with the analytical approach easier, we need to use the Black Scholes formula to get the implied volatility.

The price of Zero-Coupon swaption is written as:

$$MCZCPS = \tau P(0, T_\beta)\ BL(K, F, vol) = \tau P(0, T_\beta)\ BL(F(0), F(0), vol)$$

Here BL stand for Black Scholes Formula, K is the strike swap rate, F is the forward swap rate, and vol is the volatility of swap rates. Both K and F equal to the estimated average forward swap rate over period (T_α, T_β) at time 0: $F(0; T_\alpha, T_\beta)$, which is also noted as F(0). Apply the calculation details of Black Scholes formula,

$$BL(F(0), F(0), vol) = F(0)\varphi(d1(F(0), F(0), v)) - K\ \varphi(d2(F(0), F(0), v));$$

$$d1(F(0), F(0), v) = \frac{\ln\left(\frac{F(o)}{F(o)}\right) + \frac{v^2}{2}}{v} = \frac{v}{2}$$

$$d2(F(0), F(0), v) = \frac{\ln\left(\frac{F(o)}{F(o)}\right) - \frac{v^2}{2}}{v} = -\frac{v}{2}$$

Therefore, $BL(F(0), F(0), vol)$

$$= F(0)\varphi(v/2) - F(0)\ \varphi(-v/2)$$

$$= F(0)\varphi(v/2) - F(0)[1 - \varphi(v/2)]$$

$$= 2F(0)\ \varphi(v/2) - F(0)$$

$$\varphi(v/2) = \{MCZCPS/[\ \tau P(0, T_\beta)] + F(0)\}/(2F(0))$$

As v is the only unknown variable inside the formula, after we fill other variables with numbers, we could know the value of $\varphi(v/2)$. Finally by checking the normal distribution table, we could find the value of the corresponding v.

At the last step, we will compare both the price and the value of $\frac{v}{\sqrt{T_\alpha}}$ from both analytical approach and Monte Carlo simulation, and analyze the relative accuracy in addition to the cost-effectiveness.

7.3.3   General Swaption Pricing

7.3.3.1 Lognormal Forward-Swap Model (LSM)

Assume we have a prototypical interest rate swap (IRS), which is a contract that exchanges payments between two different index legs, as mentioned before. The floating-leg rate is reset at dates T_α, $T_{\alpha+1}$, $T_{\beta-1}$, and paid at dates $T_{\alpha+1}$, … T_β, The payoff at time T_α is expressed as:

$$\sum_{\alpha+1}^{\beta} D(T_\alpha, T_i) T \tau_i (F_i(T_{i-1}) - K)$$

The discounted payoff at time $t < T_\alpha$ is:

$$\sum_{\alpha+1}^{\beta} D(t, T_i) \tau_i (F_i(T_{i-1}) - K)$$

As talked before in Background chapter, the value of such contract could also be written as:

$$PFS(t, [T\alpha, \dots. T\beta], K) = Et\{ \sum_{\alpha+1}^{\beta} D(t, T_i) \tau_i (F_i(T_{i-1}) - K) \}$$

$$= \sum_{\alpha+1}^{\beta} P(t, T_i) \tau_i E_t^i (F_i(T_{i-1}) - K)$$

$$= \sum_{\alpha+1}^{\beta} P(t, T_i) \tau_i (F_i(t) - K)$$

$$= \sum_{\alpha+1}^{\beta} [P(t, T_{i-1}) - (1 + \tau_i K) P(t, T_i)] \qquad (*)$$

So the payoff at time T_α is:

$$\sum_{i=\alpha+1}^{\beta} P(t, T_i) \tau_i (F_i(t) - K)$$

Then the t-discounted payoff will be:

$$D(t, T_\alpha) \sum_{\alpha+1}^{\beta} P(t, T_i) \tau_i (F_i(t) - K)$$

Here we could tell that the price of swaps depends on neither volatility nor correlation of rates. The forward swap rate for the above IRS is a particular fixed leg rate K that makes the contract fair for both payers and receivers. This can be done by setting the present value of the contract equal to 0. Therefore, by setting (*) to 0, we have:

$$K = S_{\alpha,\beta}(t) = \frac{P(t, T_\alpha) - P(t, T_\beta)}{\sum_{i=\alpha+1}^{\beta} P(t, T_i) \tau_i} = \frac{1 - FP(t; T_\alpha, T_\beta)}{\sum_{\alpha+1}^{\beta} FP(t; T_\alpha, T_\beta) \tau_i}$$

$$: = \exp(\Psi(F\alpha+1(t), F\alpha+2(t), \dots F\beta(t)))$$

$$FP(t; T_\alpha, T_\beta) = \frac{P(t, T_i)}{P(t, T_\alpha)} = \prod_{j=\alpha+1}^{i} FP_i(t), \quad FP_i(t) = \frac{1}{1 + \tau_i F_i(t)};$$

Where FP stands for the "forward discount rate", so finally S is represented as:

$$S_{\alpha,\beta}(t) = \frac{1 - \prod_{j=\alpha+1}^{i} \frac{1}{1+\tau_i F_i(t)}}{\sum_{i=\alpha+1}^{\beta} \tau_i \prod_{j=\alpha+1}^{i} \frac{1}{1+\tau_i F_i(t)}}$$

Alternatively, we could rewrite it as:

$$S_{\alpha,\beta}(t) = \sum_{\alpha+1}^{\beta} w_i(t) F_i(t)$$

$$w_i(t) = \frac{\tau_i FP(t; T_\alpha, T_i)}{\sum_{k=\alpha+1}^{\beta} \tau_k FP(t; T_\alpha, T_\beta)} = \frac{\tau_i P(t, T_i)}{\sum_{i=\alpha+1}^{\beta} P(t, T_k) \tau_k}$$

The above expression could be used as a weighted average, and obtain:

$$S_{\alpha,\beta}(t) \approx \sum_{\alpha+1}^{\beta} w_i(0) F_i(t)$$

Finally, the IRS discounted payoff at time t could be written as:

$$D(0, T_\alpha)(S_{\alpha,\beta}(t) - K) \sum_{i=\alpha+1}^{\beta} P(T_\alpha, T_i) \tau_i$$

As we know, the payoff of a swaption is only the positive part of the IRS payoff. Therefore, the swaption price is:

$$D(0, T_\alpha)(S_{\alpha,\beta}(t) - K)^+ \sum_{i=\alpha+1}^{\beta} P(T_\alpha, T_i) \tau_i$$

A swaption is said to be "at-the-money" when its strike price equals the current value $S_{\alpha,\beta}(0)$; for the payer swaption is said to be "in-the-money" when $S_{\alpha,\beta}(0) > K$, and "out-of-money" when $S_{\alpha,\beta}(0) < K$, and it is defines in the opposite way for a receiver swaption.

By assuming the lognormal distribution of the forward swap rate, we have:

$$dS_{\alpha,\beta}(t) = \sigma^{(\alpha,\beta)}(t) \, S_{\alpha,\beta}(t) dW^{(\alpha,\beta)}(t),$$

Where the percentage volatility $\sigma^{(\alpha,\beta)}$ is deterministic and $W^{(\alpha,\beta)}$ is a standard Brownian motion.

The swaption price implied by Lognormal Forward Swap Model (LSM) is proven to be coinciding with the price implied by Black Scholes formula.

7.3.3.2 Monte-Carlo Pricing of Swaptions with the LFM

In addition to the analytical approach presented above, we could also apply the Monte Carlo simulation to calculate the price of general swaptions as we did for the Zero Coupon swaption. Recall again the swaption price:

$$D(0, T_\alpha) \, (S_{\alpha,\beta}(t) - K)^+ \sum_{i=\alpha+1}^{\beta} P(T_\alpha, T_i) \tau_i$$

$$= P(0, T_\alpha) E^\alpha [\, (S_{\alpha,\beta}(t) - K)^+ \sum_{i=\alpha+1}^{\beta} P(T_\alpha, T_i) \tau_i \,]$$

As before, we need to formulate the joint distribution of the spanning forward rates:

$F_{\alpha+1}(T_\alpha), F_{\alpha+2}(T_\alpha), \dots F_\beta(T_\alpha)$

Recall that the dynamics of forward rates is:

$$dF_k(t) = \sigma_k(t) F_k(t) \sum_{j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} F_i(t) F_j(t)}{(1 + \tau_j F_j(t))} dt + \sigma_k(t) F_k(t) dZ_k(t)$$

For k=α+1, …..β, by generating m realizations of $F_{\alpha+1}(T_\alpha), F_{\alpha+2}(T_\alpha), \dots F_\beta(T_\alpha)$, which are consistent with the dynamics. We need to make it discrete with sufficiently small step Δt, in order to reduce the random inputs to the distributional known shocks $Z_{t+\Delta t} - Z_t$.

By Ito's lemma,

$$d\ln F_k(t) = \sigma_k(t) \sum_{j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} F_i(t) F_j(t)}{(1 + \tau_j F_j(t))} dt - \frac{\sigma_k(t)^2}{2} dt + \sigma_k(t) dZ_k(t)$$

This equals:

$$\ln F_k^{\Delta t}(t + \Delta t) = \ln F_k^{\Delta t}(t) + \sigma_k(t) \sum_{j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} F_i(t) F_j(t)}{(1 + \tau_j F_j(t))} \Delta t - \frac{\sigma_k(t)^2}{2} \Delta t + \sigma_k(t) (Z_k(t + \Delta t) - Z_k(t))$$

Then,

$$F_k^{\Delta t}(t + \Delta t) = F_k^{\Delta t}(t) * \exp \left(\sigma_k(t) \sum_{j=\alpha+1}^{\beta} \frac{\tau_i \tau_j \rho_{i,j} F_i(t) F_j(t)}{(1 + \tau_j F_j(t))} \Delta t - \frac{\sigma_k(t)^2}{2} \Delta t + \sigma_k(t) (Z_k(t + \Delta t) - Z_k(t)) \right)$$

Therefore, the method for the simulation of the forward rates at time T_α is exactly like ZCP forward swap rates simulation. The only difference between a general swaption and a ZCP swaption is the payoff function, since ZCP swaption only pays the fixed amount at the very end

but general swaptions pay the fixed leg at the end of each maturity period, at the same time with the floating leg.

To be more specific, instead of using generated $F_{\alpha+1}(T_\alpha)$, $F_{\alpha+2}(T_\alpha)$, …. $F_\beta(T_\alpha)$ for $F_\beta(T_\alpha;T_\alpha, T_\beta)$, now we use them to generate $S_{\alpha,\beta}(t)$ and the formula for $S_{\alpha,\beta}(t)$ is given in the previous section to represent the forward swap rate.

7.4 CALCULATION RESULT ANALYSIS

7.4.1 Analytical Approach Calculation Result for ZCP Swaption
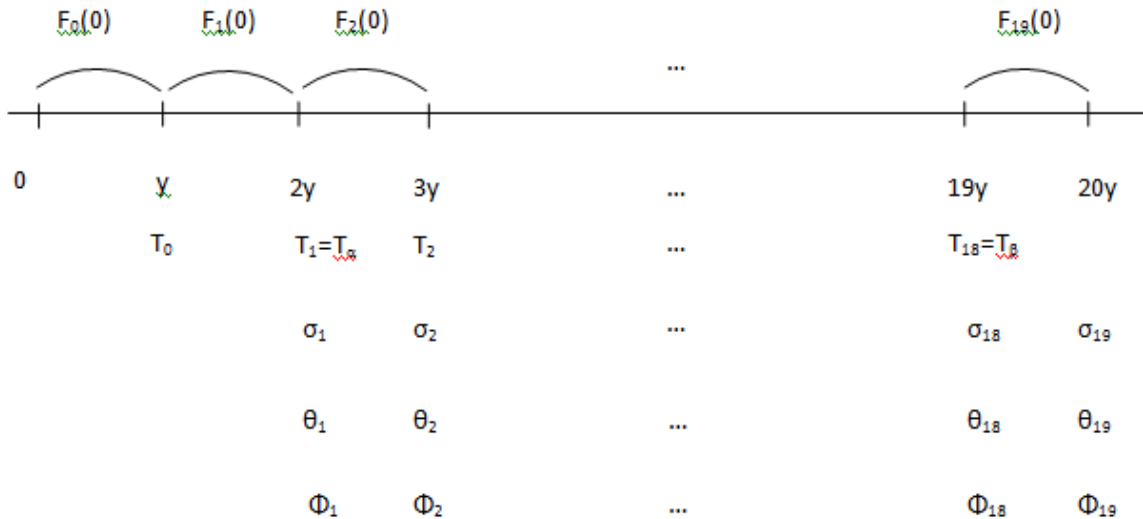
Figure 16: analytical calculation example

To calculate the variance of the forward rates, we use

$$(v_{\alpha,\beta}^{zc})^2 = (\frac{1+\tau F(0)}{\tau F(0)})^2 \sum_{i,j=2}^{18} \frac{\tau_i \tau_j \rho_{i,j} F_i(0) F_j(0)}{(1+\tau_i F_i(0)) * (1+\tau_j F_j(0))} \int_0^{T_1} \sigma_i(t)\sigma_j(t)\,dt$$

The value of each symbol required is provided as below:

$$F_{0-9}(0) = [4.69\ 5.01\ 5.60\ 5.84\ 6.00\ 6.13\ 6.28\ 6.27\ 6.29\ 6.23]$$

$$F_{10-19}(0) = [6.30\ 6.36\ 6.43\ 6.48\ 6.53\ 6.40\ 6.30\ 6.18\ 6.07\ 5.94]$$

All the forward rates are presented as percentage form. Apply the forward rate formula:

$$1+\tau F(T\alpha) = \prod_{\alpha+1}^{\beta}(1+\tau_j F_j(T_\alpha))$$

If we take y=1 for the entire calculation process, we have $\tau = 17y = 17, \tau_j = y=1$ for each j, then

$$F(0) = F_0(T_1) = \frac{\prod_2^{18}(1+\tau_j F_j(T_\alpha))-1}{\tau} = 10.52\%$$

We assume the volatility follows Humped instantaneous volatilities depending only on time to maturity, some negative rank-two correlations. So,

$$\sigma_i(t) = \Phi_i\{[a(T_{i-1} - t) + d]e^{-b(T_{i-1}-t)} + c\}$$

With a=0.1908, b=0.9746, c=0.0808 and d=0.0134;

Φ_i Values are given as the figure 8.1 on page 398 of the book Interest Rate Models (Brigo & Mercurio, 2006).

Φ_{1-9} = [1.0500 1.0900 1.1025 1.1025 1.0913 1.0669 1.0624 1.0611 1.0544]

Φ_{10-18} = [1.0475 1.0386 1.0270 1.0132 0.9975 1.0033 1.0079 1.0119 1.1052]

As to the instantaneous correlation, we use the two factor parametric form in θ on page 391, section 1.a of Interest Rate Models (Brigo & Mercurio, 2006).

θ_{1-8}=[0.0147 0.0643 0.1032 0.1502 0.1969 0.2239 0.2771 0.2950]

θ_{9-16}=[0.3630 0.3810 0.4217 0.4836 0.5204 0.5418 0.5791 0.6496]

θ_{17-19}=[0.6679 0.7126 0.7659]

The two factor parametric form in θ for instantaneous correlation is presented as:

$$\rho_{i,j}^B = \cos(\theta_i - \theta_j), \theta = \theta_1 \sim \theta_{19}$$

Till this part, all the variables are known and could be directly applied to calculate the summation through MATLAB. We chose y=1 as the first experiment:

$$\text{Sumation} = \sum_{i,j=2}^{18} \frac{\tau_i \tau_j \rho_{i,j} F_i(0) F_j(0)}{(1+\tau_i F_i(0)) * (1+\tau_j F_j(0))} \int_0^{T_1} \sigma_i(t) \sigma_j(t) \, dt = 0.0174$$

Finally $\left(v_{\alpha,\beta}^{zc}\right)^2 = \left(\frac{1+\tau F(0)}{\tau F(0)}\right)^2 * \text{Sumation} = 0.0422$

To make the later comparison of volatility easier, we then calculated

$v_{\alpha,\beta}^{zc}/\sqrt{T_1} = v_{\alpha,\beta}^{zc}/\sqrt{2}$=0.1453. The price with notional amount set to 1 is 0.0338

If we take period=0.5, $v_{\alpha,\beta}^{zc}/\sqrt{T_1} = v_{\alpha,\beta}^{zc} = 0.1357$, and the price is shown as 0.0209.

7.4.2 Monte-Carlo Simulation Result for ZCP Swaption

Given the same set of data as in the analytical approach and the initial forward interest rates at time 0, we aim to apply Monte Carlo simulation to estimate the forward rates at time T_α (which is 2y), by breaking down the time period from 0 to T_α.

In the calculation experiment, I took 5000 iterations from time 0 to time T_α, so each step Δt equals 2y/5000. The MATLAB then generate 10000 data at each step following multi variance normal distribution with mean equals to 0 and the variance covariance matrix equals to the correlation matrix from time $T_{\alpha\,to}\,T_\beta$ (2y to 19y in this case), which is a 17*17 matrix starting from the correlation at time $T_{\alpha+1.}$

Once the group of 10000 estimated forward rates at time T_α is generated, they are used to calculate the averaged interest rate over period T_α to $T_{\beta:}$ $F(T_{\alpha,}\,T_{\alpha,}\,T_\beta)$. As before, we have 10000 different values for $F(T_{\alpha,}\,T_{\alpha,}\,T_\beta)$. They are used later to calculate the payoff of the swaption and as expected and will result in 10000 simulated option prices. If taking the average of the prices, we will get the Monte-Carlo simulation price of the swaption at time 0.

For the experiment, we first take y=0.5 (yr), and the swaption price is:

MCZCPS=0.0208, with the implied volatility SDV=0.1320.

Recall the result from using analytical approach:

ZCPS=0.0209 and SDV=0.1357.

If we use y=1, the Monte Carlo method yield a price of

MCZCPS=0.0451, with volatility SDV$= v_{\alpha,\beta}^{zc}/\sqrt{T_1}{=}0.1410$

And the analytical approach has:

ZCPS=0.0338 and SDV=0.1453.

As the y value increases, the difference of the outcomes from both methods also increases. But in the market the maturity period of a swaption between each strips is rarely larger than one year, as the result showed before, when the strip equals 0.5yr, the relative error in pricing from both method are within 0.5%. In nowadays trading, the usual swaption strip is either one month (y=1/12) or three months (y=0.25), and the relative error will be even small than 0.5% when using these two different approaches. This shows that both approaches are quite reliable when apply to business investment.

7.4.3 Application Range Analysis

Monte-Carlo method has its advantages over analytical approach in the range of swaption types it could deal with as it doesn't require a written mathematical formula for the swap rate volatility.

For the more complicated swaptions, it will be hard to come up with a general mathematical formula for the volatility, and without it, the analytical approach could not be used. Therefore, the Monte-Carlo becomes the only way to rely on in those more complicated cases. Because all types of swaptions use the same way to generate the estimated forward rates and the only difference lays within the minor changes of the payoff functions.

As Monte Carlo simulation is independent from the volatility assumption and based purely on the random generation of forwards swap rates under log normal distribution, its accuracy must be checked before being put into business use. After examine the simplest ZCPS, we are now confident to say that Monte Carlo method could yield a satisfied result with same level of accuracy as the traditional analytical approach.

7.4.4 Calculation Time Efficiency Analysis

Although Monte-Carlo could price more types of swaptions than the analytical method and still could maintain a pretty accurate result, the main drawback of this method is the speed of simulations.

As Monte-Carlo methods mainly relies on samples of random variables under a certain distributions, a large enough sample must be collected to ensure the accuracy. In this experiment, a simulation with at least a size 3000 is required to make the output convincing, otherwise the result will likely be biased due to the randomness.

Judging from the MATLAB code, the algorithm of the Monte Carlo calculation for ZCPS is polynomial increasing as sample size increases. Therefore, if we take a sample with size 10000, the calculation will take approximately 10 minutes to calculate, which only takes several seconds for the analytical method. So, unless the speed of Monte Carlo simulation could be improved largely, its usage would still be limited in the industry as the time and monetary cost of the simulation is too heavy.

For a potential improvement of the speed, the implementation of Monte Carlo method should rely on parallel calculation for each scenario of the rates, instead of the sequential calculation of the scenarios as MATLAB program uses. This could at least reduce the algorithm cost from polynomial increasing to linear increasing. Of course, this mainly depends on which programming language is used and it is required for that language to support parallel programming with light program weight.

7. 5 CONCLUSION

Throughout this project, I practiced swaption pricing using both an analytical approach and Monte Carlo simulation approach.

Starting by calculating the prices and variances for the simplest swaption ZCPS in both analytical and Monte Carlo simulation, I compared the ZCPS's price and implied volatilities from the outputs of both methods. It is found that they are quite close when the swaption strip period is less than a year. This result also confirmed that Monte Carlo is a reliable method in simulating prices of swaptions in different scenarios as the only difference between the general swaption and the zero coupon swaption is the pay off functions.

The analytical method and the Monte Carlo simulation have their own advantages and disadvantages:

From the usage availability for different swaptions, Monte Carlo simulation is superior to the analytical approach, since not every type of swaption could be formulated into a single mathematical expression in calculation its volatility. The ZCPS has the simplest payoff function, and is one of the very limited types of swaptions that could be accurately calculated through analytical approach. On the other hand, Monte Carlo simulation could be applied to every other type of swaptions, since all of their forward interest rates are under the lognormal distribution assumption and can be simulated in the same way.

However, when judging from the speed of the calculation, the analytical approach is way more efficient than the Monte Carlo method. To calculate the variance and the price of a ZCPS, the analytical approach only takes several seconds to complete while the Monte Carlo method need ten to fifteen minutes to simulate and out put the final result, for a 10000 sample. If a

pricing of a swaption could be done both ways, the analytical approach is usually chosen due to its simplicity and fast speed.

To further improve the situation, the first step we need is to speed up the Monte Carlo simulation for large size of samples by changing the sequential calculation to paralleled calculation of each simulated forward rates. This requires using a programming language that supports parallel process, which is a hot topic in nowadays computation field and there's still big space for improvement.

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Appendix A: Background of Sponsor

Royal Bank of Scotland (RBS) was established in Scotland in 1727, eventually growing into the major investment bank it is today (The Royal Bank of Scotland, 2009a). Its mission statement shows both a deep commitment to the UK and an interest in global expansion, aiming to return to profitability and "again become one of the world's premier financial institutions" (The Royal Bank of Scotland, 2009b).

We worked with FX Structuring desk within RBS. This desk aims to address the risks in international trade using a variety of financial instruments of varying complexity (The Royal Bank of Scotland, 2009c). The simplest of these are forwards, or agreements to exchange a set amount of currency at an agreed upon exchange rate on a future date, and options, or the ability but not the requirement to do the same.

FX Structuring is primarily a support desk, creating and pricing the structures that salespeople eventually deliver to customers. Recent years have made this job quite difficult as the internal RBS practices have changed too quickly to keep track of everything that occurred. FX Structuring was able to give salespeople enough information to continue to do their job, but there was a large amount of missing information that would allow salespeople to do their job better.

FX Structuring requested our project to gather information and create training programs for salespeople in order to address this lack of information. Delivering these programs should clear up misunderstandings about the current processes. Another benefit comes from the information gathering process itself; we must understand the processes ourselves before we can teach others how they work. A complete understanding of the process allows us to recommend potential improvements.

Without help from FX Structuring our project would not have been possible. The desk provided us computers, office space and access to employees that allowed us to gather the information necessary to complete their request. Employees, especially Tom Richards, frequently offered to check our work to ensure accuracy. We are grateful for the support.

8 Appendix B: RWA/CVA/WWR/CLU Interview Transcripts

Oct-30 2009 Thomas Richards: Senior Trader, FX

Q: How does RWA affect pricing? Why is it important?

A: RWA is risk weighted assets. It adds a minimum profit hurdle onto the sale of structure

RWA is important because it represents the amount of capital required to sell a structure. The RWA hurdle exists because the FX structures desk has a required profit margin per usage of capital.

As the probability of default increases, the amount of capital one needs to hold increases. This total capital is split into two types of risks: unexpected and expected. Expected risk is essentially CVA and is already accounted for. However, as RWA is in primarily a corrective measure to incorporate previously unaddressed "unexpected risk", it eventually begins to lower even as total risk increases. This is because "expected risk" becomes a larger and larger portion of the total risk as the probability of default rises, requiring lesser corrections

Q: How is RWA calculated?

A: RWA = K * EAD * 12.5 * 1.06 ; RWA = Risk weight * Exposure at Default * (a number to compensate for K being expressed as a percentage of exposure) * (error margin)
As it stands this amount does not take into account the period of time the capital will be tied up. It is simply a static value
This is the Counterparty RWA and is the formula that is behind all the spreadsheet calculations

Risk weight is percentage of exposure calculated as the potential unexpected loss. Below is a graph. As total potential loss includes expected loss, this risk weight will ultimately drop as the expected loss portion of total loss increases. Essentially, at some point probability of default will be high enough that unexpected loss begins to decrease.

This change in risk weight as PD (probability of default) rises is demonstrated below. The graph assumes 100% loss given default
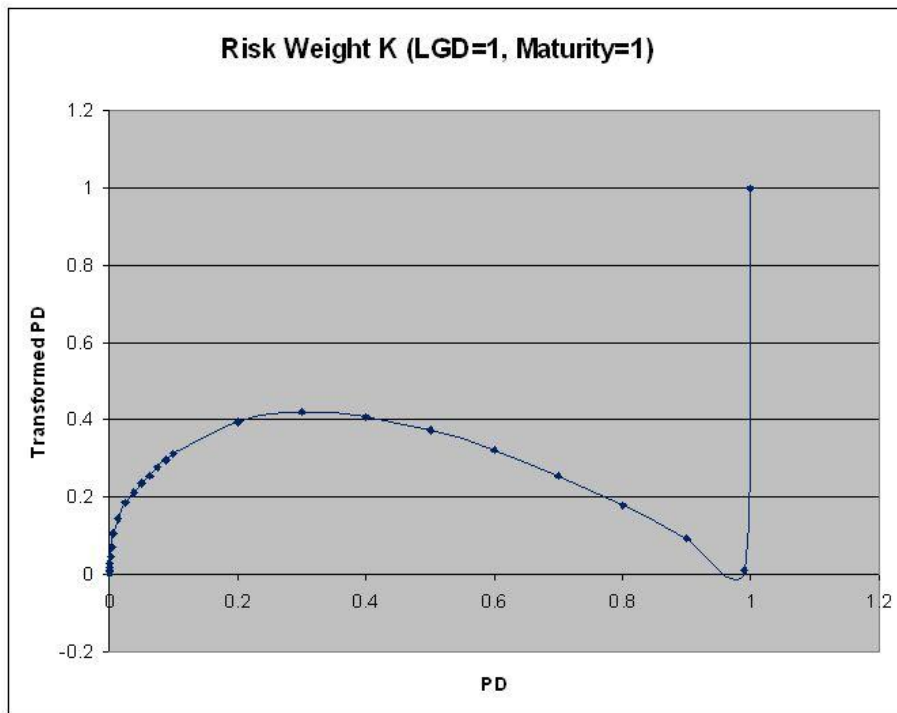
Figure 17: Risk Weight vs Probability of Default
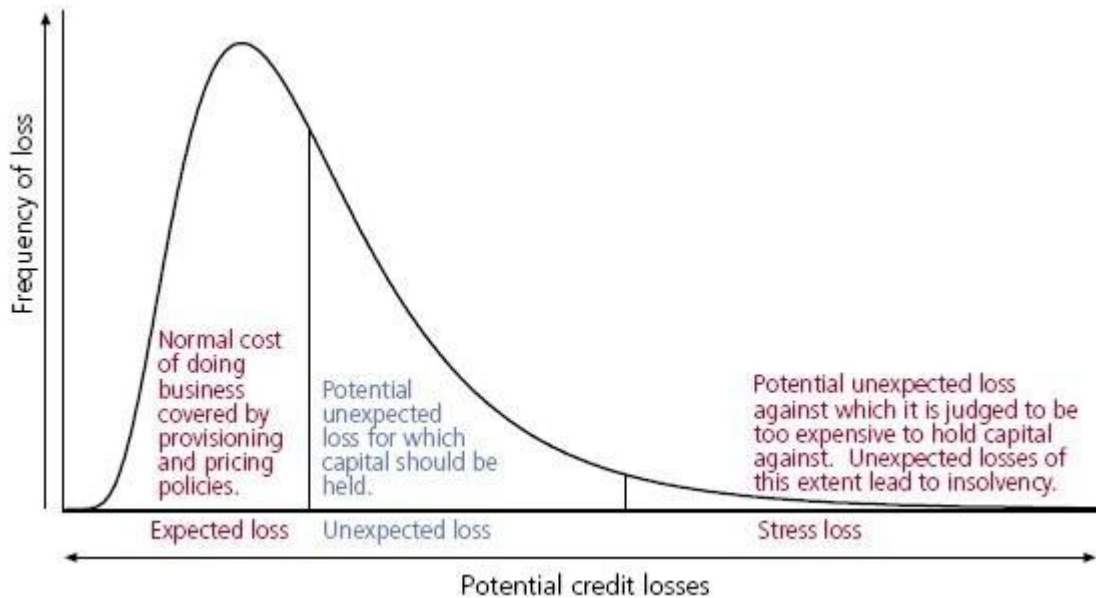
Figure 18: Total Loss in Doing a Deal

Exposure at default is the total amount the counterparty owes the bank at default.
It is calculated by finding the lifetime EPE (expected positive exposure). Lifetime EPE is found using the Monte Carlo method. Essentially, this runs a large number of simulations to fashion a lifetime value curve for EPE. The area under this curve is EAD

Q: How is CVA calculated?

A: CVA = PD * LGD * EAD ; CVA = Probability of Default * Loss Given Default * Exposure at Default

Probability of default is a banks' best guess, subject to certain regulations, of the likelihood of default

Loss given default is also a bank's best guess, subject to regulations, of the proportion of the total assets the bank would lose in the event of a default. It is a number between 0 and 1

Exposure at default is the total amount the counterparty owes the bank at default.

Q: How does WWR affect pricing? Why is it important?

A: It adds another wrinkle to expected losses. This means WWR shows up in the profit/loss section of accounting, representing a cost of doing business.

There exists a possibility of the sovereign nation where the corporation exists defaulting. This would cause the value of the underlying currency to greatly devalue and represents a risk that needs to be accounted for. It is this general type of non-entity, market based risk that WWR takes into account

Q: How is WWR calculated?

A: WWR = Devaluation EAD * Sovereign CDS * T

Devaluation EAD is (1.645 * Vol * sqrt (T))
1.645 sets the value to 95% confidence and is included to balance risk an profitability
Volatility; used the 15 delta vol rather than the ATM vol
T is time to maturity

Sovereign CDS is the cost of insuring against a creditor default

T is time to maturity

Nov-02-2009 Ben Burch: CEM Funding

Q: What is the process that a structure goes through to be dealt?

A: It goes from salespeople to CEM for certain approvals. The tools salespeople have only allow them to see the effects of a single deal in the system.

This is not the way credit charge is finally calculated at the CEM desk. There they use a program called Cremant to do net effect aggregation.

Q: Could you tell us more about CEM?

A: CEM owns CVA/WWR charges for the whole company
It also owns RARoE (risk adjusted return on equity). [Is this the Return on equity hurdle?]

Names that came up for possible followup interviews:

Ronald Van Der heijden and Alan Kung

-FX sales business managers

--They understand the RWA thresholds, possibly set them

Jeremy Bates

-CVA contact

Robert McWilliam

-WWR contact

Donna Chilbers

-RWA contact

Nov-02-2009 William Hassen: Director

Q: Where is the RWA value in Tom's spreadsheet?

A: At the end of the day, the hurdle rate is in the "Required income after CVA and WWR" box

Q: Where is RWA calculated?

A: There are two spreadsheets. Dan's spreadsheet is limited in capability but is preferred by some sales people
Tom's spreadsheet is much more robust and is required for certain structures

There was some bit about RWA only coming out in weekly position updates. This was bad, but I can't remember why

Q: Where is CVA calculated?

A: Cremant. From here traders have access to portfolio check methodology, potentially allowing for the risk of deals to cancel out and result in a 0 credit charge

Q: Where is WWR calculated?

A: It comes from daily emails as a pdf attachment. Salespeople can only calculate WWR for forwards or vanillas on their own, require CEM referrals for anything "exotic"

Q: When a call comes in, what do you do?

A: Source RWA from a spreadsheet, CVA from cremant and WWR from the pdf file. Make a quote based on these numbers

Q: Where does the total credit line come from for companies?

A: For companies with a liquid CDS market it is found in Cremant

For forwards and swaps without a liquid CDS, it is in GRS or a pilot program in its test phase, Phoenix

Options are in NMOSS

--Liquid CDS companies, CEM can take out CDS, effectively raising their credit limits

--Illiquid CDS companies have a hard credit cap

Nov-03-2009 Dean Lockwood: Corporate Risk Solutions

Q: There are two spreadsheets to calculate RWA. Why is the less powerful spreadsheet still in use?

A: It gives an answer faster. Email is annoying, but still faster than searching for a company name

There is actually a third, newer spreadsheet. This one works fine but it is still flawed in that it doesn't take RWA netting into account

Q: How do CVA, RWA and WWR affect business?

A: For forwards less than a year (the vast, vast majority of forwards) there is no CVA

RWA is the major hurdle, and even it is constantly changing. It sets a minimum IoRWA that one has to get in addition to the CVA and WWR credit charges.

Deals tend to be less than 3 months

Overall to get a price, one needs:
- Trader quote
- IoRWA
- CVA
- WWR

All of these come together to make a final price on a forward

RWA netting would lower the RWA requirement, essentially allowing collateralization benefits

Q: What other systems do you have?

A: Dashboard is the newest deal entry system, currently phasing out the older system. It offers: time periods it is ok to offer a forward for (thereby addressing CLU), and allows traders who "own" the account to suggest a spread to trade on.

Q: How does one make a profit?

A: Profit comes in the spread, or the difference between the trader quote and the salesperson quote. Profit = (spread * notional) – credit charge; requiring the forward to stay under the credit limit and over the RWA hurdle

Q: How does a salesperson address CVA when doing a trade?

A: They must adjust the trader quoted rate so the salesperson AV is correct. This is to properly account for what money is profit and what money is credit charge.

Q: What does Cremant show? CVA? WWR?

A: I don't believe it has WWR
It shows both CVA and CDS. CDS is essentially the neutral CVA for the asset, ignoring RBS internal credit and portfolio calculations. This means other banks will be trying to price CDS into their quote, potentially allowing for more AV

Q: What is the current status of RWA? How often is it reported? What is RWA netting?

A: RWA positions come out in a weekly email. Ideally, RWA usage could be tracked and treated as collateral, thereby lowering the RWA. Would allow more business to be profitable

Q: You've been talking about forwards primarily. What about options?

A: Options are different and typically require RWA/CVA

Nov-03-2009 Thomas Richards: Senior Trader, FX

Note: This interview was primarily a review of the transcript from the previous interview. Minor adjustments were made to arrive at this version

Q: How does RWA affect pricing? Why is it important?

A: RWA is risk weighted assets. It adds a minimum profit hurdle onto the sale of structure

RWA is important because it is the amount of capital required to deal a structure. The RWA hurdle exists because GBM has a required profit margin per usage of capital.

As the probability of default increases, the amount required to properly account for the risk increases. This total risk is split into two types: unexpected and expected. Expected risk is already accounted for in credit charges. "Unexpected risk" is addressed by a capital requirement, RWA, and strangely enough it eventually begins to lower even as total risk increases. This is because "expected risk" becomes a larger and larger portion of the total risk as the probability of default rises, requiring lesser corrections

Figure 19: Total Loss in Doing a Deal 2

Q: How is RWA calculated?

A: Spot RWA = K * EAD * 12.5 * 1.06 ; RWA = Risk weight * Exposure at Default * (a number to compensate for K being expressed as a percentage of exposure) * (error margin) This is the Counterparty RWA and is the formula that is behind all the spreadsheet calculations The capital hurdle for a deal comes from lifetime RWA, built off of the spot RWA formula seen here by drawing expected spot RWA over the lifetime of the deal as a curve and calculating the area under this curve. This lifetime RWA is then multiplied by the required return on capital, resulting in the hurdle.

Risk weight is percentage of exposure calculated as the potential unexpected loss. This will increase under most conditions. However, as total potential loss includes expected loss this risk weight will ultimately drop as the expected loss portion of total loss increases. Essentially, at some point probability of default will be high enough that unexpected loss begins to decrease.

Exposure at default is the total amount the counterparty owes the bank at default.

The calculation is dependent on the complexity of the deal. For deals involving simpler, non-path dependent structures it is calculated by finding EEPE (effective expected positive exposure). This ignores all money the bank would owe the counterparty (which would still be paid given default), summing the total amount the counterparty would owe the bank at default, with some adjustments.

For path dependent deals RBS uses a MTM + add-on. This add on is desk specific with FX Structures using 1% for deals under a year, 5% for 1 to 5 years and 7.5% for over 5 years

Q: How does CVA affect pricing? Why is it important?

A: CVA is usually the largest portion of the credit charge the CEM desk charges to insure any deal. It assumes there is no correlation between the strength of the underlying currency and the counterparty

Q: How is CVA calculated?

A: CVA = PD * LGD * EAD ; CVA = Probability of Default * Loss Given Default * Exposure at Default
This is the most general form of the formula and represents RBS internally calculating the amount required to protect against the expected cost of default.

For counterparties with active CDS markets, this cost becomes more definite. In such cases:
CVA = CDS * T * EAD; CVA = Credit default swap * time to maturity in years * EAD

Probability of default is a banks' best guess, subject to certain regulations, of the likelihood of default

Loss given default is also a bank's best guess, subject to regulations, of the proportion of the total assets the bank would lose in the event of a default. It is a number between 0 and 1

Exposure at default is the total amount the counterparty owes the bank at default. Strangely, this value is calculated differently from EAD for RWA.

CDS is credit default swap and it is a deal where someone else takes responsibility for the possibility of default

Q: How does WWR affect pricing? Why is it important?

A: It adds another wrinkle to expected losses. This means WWR shows up in the profit/loss section of accounting, representing a cost of doing business.
The primary difference between CVA and WWR is WWR addresses positive correlations between the probability of default of a counterparty and market risk factors.

Q: How is WWR calculated?

A: WWR = Devaluation EAD * Sovereign CDS * T

Devaluation EAD is (1.645 * Vol * sqrt (T))
1.645 sets the value to 95% confidence and is included to balance risk and profitability
Volatility; used the 15 delta vol rather than the ATM vol
T is time to maturity

Sovereign CDS is the cost of insuring against a creditor default

T is time to maturity

For G-10 nations, RBS assumes no WWR

Q: So what constitutes the overall credit charge? Is it WWR + CVA = Credit charge?

A: You should ask CEM

Nov-03-2009 Stuart Alden: Manager

Q: When there is a CVA charge, the proper way to book it is to treat the spread as smaller by that amount. Why?

A: Need to show credit adjustments in the profits. I think the proper way to book that is a hypothetical deal in NMOSS to get from the trader quote to the CVA adjusted quote, then input the CVA adjusted quote and the one the client accepts into the trade booking system.

Two deals done, sort of. Quotes go as Trader -> CVA adjusted -> client

Q: What do you use to calculate CLU?

A: GRS for forwards and NMOSS for options

Q: How does the RWA hurdle actually work?

A: It largely interferes with business. The way FX works, for the most part, is clients have a larger volume of smaller margin deals that they use to create a banks ranking. Then from those the company takes some amount of their top ones and gives them the strategic business. This is higher margin business and makes up for the earlier minor losses in RWA

For example, 10 trades done at -100 each allow the salesperson to book a deal at 200,000 later [What types of deals are the cheap ones? What types of deals are the high margin ones?]

Nov-04-2009 Ceire O'Rourke: FX Sales

Q: What are the implications of the revised funding methods?

A: For collateralized counterparties, nothing.

For uncollateralized, the formula requires correction that can be calculated in NMOSS using either net rho or trigger digitals

Q: How do you do these calculations?

A: For net rho: In NMOSS, enter the Greeks display and then find the difference between the two rho values

Q: What instances will it matter?

A: It will matter any time money is flowing out. It technically matters when it is flowing in as well, but sales people will tend to keep that amount as AV

Specific instances: When you are calculating spot value premium on vanilla options or when you are closing out a (typically in the money) forward contract. This close out is handled in one of two methods:

-lump sum of the NPV of all forwards

-equal and opposite contracts that expire along with the current contracts

--you are locking in the new spot rate, making the profit between the booked rate and current spot

Q: What is the difference between spot rate and forward rate?

A: Spot rate is the current premium, calculated by adjusting black-scholes a bit so it reflects vol (volatility). Forward premium is the amount to be delivered at the end of the contract, treating the sum as though the premium was paid on the day the spot premium would have been.

Q: Any other times you are required to make an adjustment?

A: In a forward deal, one must take into account the lending rate for that counterparty. This is given by the business

It must also take into account the funding rate. This is found by taking the current spot of whatever currency is needed

Q: What types of business are low AV? What types are high AV?

A: The goal is to do spot forward and occasionally option deals to get into the top 3 (or some number) list of a counterparty. This counterparty gives their higher AV, strategic business to these banks

The higher AV includes M&A, rights issues, divestments and balance sheet hedging

Q: Does RWA interfere with this business model?

A: It could, if RWA was done on a trade by trade basis. RWA is currently aggregated by desk, though, so it does not interfere with this business model

Q: What do you use CLU for?

A: I check to see if the CLU will push the counterparty over their forward limit

Q: What do you need to price a trade?

A: Spot, Forward points, RWA, CVA, and CLU. Sometimes WWR

Nov-04-2009 Dan Eisen: FOCM

Q: How does your spreadsheet work?

A: Our job is to provide RWA, CVA and CLU numbers to salespeople. These requests were very frequent, so we created a process to automate the most common types of request
The spreadsheet automates what was once an email request process. The process now works as:
Front end info -> email to hub computer -> hub contains all needed information, calculates -> email to salespeople (cloud computing!)

Q: Ok, but where do the formulas come from?

A: They are created by GMB Exotic Deal Clearance. This is somewhat of a legal requirement, front office desks aren't really allowed to create pricing formulas on their own [true?]

Q: We've seen CLU utilization before but are unsure on its exact meaning. Could you explain?

A: Total CLU doesn't have to be the sum of the individual CLUs. What is actually done is a curve is drawn for each CLU, with the sum of all CLU at each point creating a different curve. This concept is the driver behind Dashboard showing what length of deal is authorized before calculations
[Sure, but how does this end without a CLU sum?]

Q: If you can calculate CVA, why is Cremant used for it?

A: Cremant owns CVA. It's a political reality that FOCM is not allowed to touch it

Q: Why can't salespeople calculate CLU on their own?

A: They could, in theory, but the calculation requires fairly involved Monte Carlo simulations and while it works as fast as possible, this still takes a long time. Presumably it is too long for sales purposes

Q: So between CEM and FOCM/TCRM, who owns RWA/CVA/CLU/WWR?

A: CEM owns CVA and WWR; TCRM owns CLU and RWA.

RWA made be moved elsewhere in time, though

Nov-04-2009 Grainne O'Toole: Euro CEM

Q: We understand CEM to be the central hub for both RWA and credit charge within the company. If either is not the case please just ignore that portion of any question that references it

A: We price CVA. RWA is calculated by the FOCM team.

Q: When a FX structuring salesperson requests a credit charge and RWA quote, what is the process CEM goes through to create it? We're primarily interested in what programs are used and what information they require

A: The system we use for calculating CVA is called Cremant. See Quick Pricing guide attached in my previous email. It would be a good idea for you to get access to this - you can request this via the GBM Console.

Trade details required for CVA quote are as per screenshots below:

Currency Swap:

Figure 20: Cremant Interface for Currency Swaps

FX Forward:

Figure 21: Cremant Interface for FX Forward

Currency Option:

Figure 22: Cremant Interface for Currency Option

If we do not manage the counterparty in question, we will also require the LGD and the MGS.

Q: What are the specifics of the mathematical formulas running behind the programs used to generate credit charge and RWA?

A: For CVA - see below and Valuation Model attached.

Q: The online form mentioned portfolio effect CDS. Could you explain in more detail the current way RBS addresses this?

A: The Portfolio Effect occurs when two trades have opposite effect on the overall exposure to the particular counterparty. For example if in one trade we are receiving USD and in another we are paying USD to the same counterparty, there will be a netting effect. Hence the incremental effect of a trade is used rather than just the standalone value.

Q: We have found that there are two internal formulas for calculating CVA: CVA = PD * LGD * EAD and CVA = CDS * T * EAD
As we understand it, the CDS formula is better? Is there a case when the CDS formula can be used where RBS prefers the PD * LGD method?

A: The calculation for CVA is ......Expected Positive Exposure x Probability of Default x (1-Recovery Rate). This is the only formula used.

Q: Why can't salespeople calculate WWR for exotic options on their own? Presumably this is because the process is too complicated, but what we're after here is the specific reason why it's too complicated or otherwise infeasible

A: There is no reason why a Salesperson cannot calculate this themselves.

Q: What is needed to add a counterparty to the system? What's the process? Similarly, how should a salesperson handle this situation?

A: Sales person needs to email the CEM team requesting the name transfer. The transfer requires a set of approvals (see completed form for Nordstrom attached) Often the Salesperson will chase up the approvers if they want to speed up the process.

Q: When a client defaults, a loss seems likely. In the event of this loss, what happens? Does CEM reimburse the trader for the loss on his book?
The essential issue behind this question is how much the front desk should worry about a CVA value. Can they totally trust CEM, as at the end of the day it has to pay?

A: Yes, CEM reimburses the trader when a loss occurs.

Finally, two points of clarification:
Q: CEM is responsible for the final price for both WWR and CVA? Or more generally, it owns everything that goes into the credit charge?

A: Correct

Q: We attached one of the daily WWR calculation sheets used by FX salespeople. The bottom left box represents the correct WWR formulas?

A: Yes, the equations are the ones that are now being used for calculating the WWR charge on new transactions

Q: Does your spreadsheet formula come from Exotic Deal Clearance?

A: No, but we both base our formulas off of the RWA spot rate

Q: Why did you originally create your spreadsheet?

A: Really, no one has an exact idea of what the RWA hurdle is supposed to be. My program allows one to sanity check the RWA provided by TCRM

Q: So of CEM and FOCM/TCRM, what are they responsible for?

A: CEM clearly owns CVA and probably owns WWR

TCRM probably owns CLU

It is unclear who owns RWA. Possibly either

Q: Why is buying an option from a collateralized counterparty helping out funding?

A: When you buy an option from a collateralized counterparty, no money goes out the door.

RBS would take the option, give the premium and then get the premium right back in the form of collateral

This improves the funding situation because RBS is in essence borrowing the premium value of the account.

It is required to pay interest on the premium at "Overnight Index Swap", or OIS. This is currently about 20bp less than LIBOR

This amount is lower than RBS' normal funding rate, currently LIBOR + 40-50

Q: How does uncollateralized work?

A: If RBS were to buy an option, it would pay the premium and lose access to those funds for the length of the option. The formula to calculate this premium has the borrowing rate at LIBOR; this is no longer the case. It is currently LIBOR +40-50bp.

Therefore, the premium is wrong some amount and buying this option would result in a net loss

Similar applies for RBS selling an option. It is in effect borrowing the premium from the client at a rate cheaper than the pricing formula assumes. This means the option should cost less, potentially creating more AV and other opportunities

Nov-11-2009 Pavel Andreichenko: Counterparty Credit Risk Methodology

Q: How is RWA calculated?

A: There are really two RWA calculations. There is the daily RWA compilation and the pre-deal RWA calculation

The daily RWA is looking at the RWA required that day due to what RBS owns. It is a definite number and is calculated by Hawk and owned by Finance

The pre-deal RWA is owned by EDC. They run models to simulate the expected RWA that will be required

Q: So what is the RWA formula used by EDC?

A: There is no formula. The calculation is too complicated and requires a model.
However, both do depend on curves that change daily

Q: Well, what can you tell us about how EDC calculates RWA?

A: It is a different formula for different types of assets. Some assets qualify for an IMM waiver, allowing them to be calculated using Estimated Expected Positive Exposure. If the asset does not qualify for this waiver, RBS uses more simplistic MTM + %

RWA is calculated using a model that has existed for years. This model is calibrated using numbers from my department, MCRM (market and credit risk methodology)

Q: So then what does EDC do to simulate?

A: What EDS essentially does is replicate the more complex formulas. This means they make some key assumptions and simplify the more complex Hawk models down into spreadsheets. RBS is not aware of a case where the actual Hawk numbers and the EDC spreadsheets materially differ.

Q: Why not just use Hawk?

A: There are some plans to, but I do not know how far along they are. The project is named "acceleration" and you would have to ask IT people how far along it currently is.

Q: Within the CLU formula, where does the vol come from?

A: Well, that's a funny question. When it comes to CLU, the formula reacts in different ways to different things
When the trade is more OTM, MTM becomes the major driver
When the trade is with an uncollateralized counterparty the vols are the major drives

As for vols, those are set monthly by my group (MCRM) on a monthly basis. We do it a variety of ways: it is first set as either historic pr market-implied, but back-testing may show too many exceptions which results in rates being overridden (so call "overwrites")

Q: What situations does MCRM apply which rate?

A: For FX vols:
Floating currencies: based on 3y historic vols.
Pegged and managed-floating - allow for potential de-pegging (normally the vol is increased from the historic negligible to a more reasonable number). Both sets subject to overwrites agreed at CMC

Implied rates: market implied for major 5 (USD, EUR, GBP, CHF, JPY). Historic for other currencies. Once again both sets subject to OW.

I think Warick Leung from your area should be more or less up to speed with the approach used.

Nov-13-2009 Justin Pendlebury: Head of Exotic Deal Clearance

Q: How does the CLU calculation work?

A: Different for collateralized vs. uncollateralized counterparties.

For uncollateralized counterparties the whole structure is at risk. We therefore use the maximum MTM of the structure

For uncollateralized counterparties we do periodic calls for collateral when the MTM of the structure moves. However, the counterparty can dispute our valuation or use other similar methods that delay payment. We therefore calculate maximum unprotected MTM over 10 business days.

The primary variable in this calculation is vol

The formulas are:
-For the up, or 95th percentile: exp (1.645 * vol * sqrt(t))
-For the down, or 5th percentile: exp (-1.645 * vol * sqrt(t))

1.645 is one tail standard distribution

Vol represents change in (underlying) rates

T is time to maturity. Represented as (days of structure)/365

Q: How does the RWA calculation work?

A: The actual calculation is EAD * (risk weight) = RWA

This formula is given by BIPRU 13.6

Risk weight is a function containing PD, LGD and M

M is the same as T in the above case

EAD = EEPE * constant

-for non-path dependant deal

EEPE == average of non-decreasing EPE profile over 1 year; it is found by calculating EPE over the portfolio of deals with that counterparty for one year. It works like this:
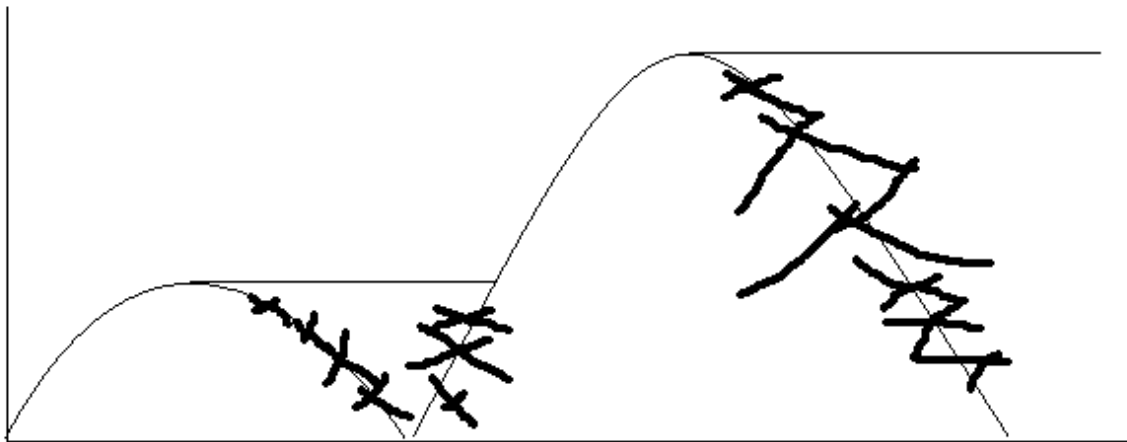
Figure 23: Example of Non-Decreasing Exposure

EAD = MTM + add-on

-for path dependant deals

For such deals you find the max MTM over one year and tack a percentage onto it

This value is found in a chart provided by EDC

Q: So this RWA value is the one salespeople see?

A: No, salespeople see lifetime RWA. This is spot RWA

Nov-17-2009 Ben Nicklin: FX Structuring

Q: So how is RWA handled? How firm is the hurdle?

A: It is handled on a deal by deal basis by default, but that doesn't necessarily make sense.

Q: Would it be feasible to check it by desk and by counterparty?

A: Yes, I would think that would make the most sense

Q: So then could you make it deterministic? Set a maximum value RBS is willing to spend on a counterparty to get to their strategic business?

A: No, I don't think that would be viable. The best we can do is to encourage salespeople to create counterparty specific policies that over a, let's say one year average, meet a net RWA hurdle.

Q: Who has the authority to grant this?

A: As it stands now the managers of each salesgroup has the authority. People like Lee Bulman need to authorize individual trades for them to go under-hurdle but have the discretion to change the rules for a specific salesperson/counterparty pairing

Q: So how firm is the RWA hurdle?

A: That's up in the air. It's unclear who is responsible, how and for what

Nov-20-2009 Mandeep Uppal: Credit Measurement Analyst

Q: Is this a correct definition for CLU:

CLU is potential future exposure of the deal

Found by simulating spot rate underlying the deal to the 95th percentile. This rate is then applied to RBS' exposure to a counterparty resulting from a single deal or a portfolio of deals. The point of maximum exposure represents the CLU value, or the RBS projection for maximum loss RBS could have from these deal(s).

A: No, not quite.

CLU is found by taking the forward rate and shifting it to the 95th percentile of maximum exposure for different points in time until maturity. The maximum value among these is the CLU value

CLU is therefore the 95th percentile of the maximum potential exposure

9 Appendix C: Funding Interview Transcripts

Nov-05-2009 Adrian Campbell-Smith: Currency Options Trader

Q: So why does net rho fix the funding issues?

A: Rho is the sensitivity of the premium of a structure to the change in spot rate. As the solution to the funding problem is to change rates, one can use rho to find the net effect of a change of one basis point and multiply this by the overall bp change

Q: Why does a triggered digital fix the funding issue?

A: A digital is a structure that is a commitment to pay if the spot rate ever touches a certain point. A triggered digital means the spot hit this trigger, creating the liability
This is essentially a future cash flow out of the business and therefore properly accounts for funding

Q: What is the funding rate?

A: It already takes into account RBS funding issues. To fix this you could take:

(customer lending rate – NMOSS rate – RBS funding bid)

Q: Generally speaking, what does this guide hope to accomplish?

A: I have a sheet that is my first attempt at this guide. I'll forward it to you

Appendix D: Appropriateness Interview Transcripts

Nov-09-2009 Chetan Shah: Currency Structuring

Q: What are time and intrinsic value?

A: Intrinsic value is the value of the option if the trade was done now. If this value is negative, the option won't be exercised and the value is in effect 0.

Time value is attaching a value to the time left for the option to move. This value is larger the closer spot value gets to the strike rate.

Q: Why is it important for the spreadsheet to be able to split them?

A: The two accounting standards (FAS 133 for America and IAS 39 for most of the rest of the world) work differently. One difference is that IAS allows only the intrinsic value of the option to be put on the balance sheet while FAS allows both the time and intrinsic value onto the balance sheet.

Q: Why is accounting important at all? What's the point?

A: In the world of business accounting there is both balance sheets and profit and loss (P/L) statements. Business analysts are many times more sensitive to P/L movement than they are to balance sheet movements.

In the past the hedge was treated an asset. As its mark-to-market value increased or decreased, accountants were required to report this change in the P/L statement. The value of the hedge was variable and arrived before the value of whatever it was hedging, increasing P/L volatility and discouraging business from hedging. This was an undesirable outcome and led to the creation of the new accounting standards

The new standards leave the overall hedge in the balance sheet, sending the pertinent portion of the hedge into the P/L when the action that was hedged occurs. This greatly reduces volatility.

[Chet then showed us how to use the FAS/IAS spreadsheet and explained the general issues with it]

Nov-10-2009 Chris McHale: Treasury Manager

Q: What factors go into determining if a deal is appropriate?

A: Three main concepts. You want to determine why a client is hedging and how they are currently hedging. Then you want to create a flexible hedging profile (a portfolio of structures) that adheres to the first two points

Q: What goes into the first two considerations?

A: An important consideration is the client's margin. Typically a client is more risk tolerant if they're uneducated or have larger margins. An educated, small margins client will generally be very risk averse

Q: What is the goal of hedging?

A: Generally speaking, it attempts to give a floor to a transaction (aka a maximum loss) while still allowing the client to be flexible (aka participate in favorable rate movements, restructure the deal etc…)

Interestingly, offering a flexible structure (options) is better for RBS. The real margins come about from the more complex structures and profit essentially comes from the volume of deals

Q: What is appropriateness? Why bother?

A: It is primarily a legal protection. There is a list of things you are required to do to avoid getting sued

Q: What structures make up a portfolio? How does it work?

A: Typically a portfolio is largely spot and forward deals with some (more risky and higher margin) options.

This is set by the "flexible hedging profile". It sets the % risky or option type structures and the % of more safe spot or forward type structures

Legally, this section needs to be justified. There needs to be a why, a reason behind these allocations

Q: How do you judge their appetite for risk?

A: It's an art, not a science. You use what the client says to get a general feel for what they are trying to accomplish. You're interested in what their current structures do, for instance, and aim to help them accomplish this goal. For example, if the client is dealing mostly forwards they are demonstrating a total aversion to risk. This means something as risky as a knock-in would not be acceptable

Q: What is a historic rate rollover?

A: A person comes in and asks to push a delivery of cash back some period of time. Previously this was sometimes used to cover up company losses. At times these losses were hidden while a company was being sold, sticking the new owners with a heavy tab.

New rules require the client to take the current MTM (whether it be a loss or a gain) or the current deal before they roll the deal forward. This nets the same amount as if the client settled at the end of the transaction; it just forces them to eat the value now

This serves to increase transparency

Q: What is gearing? Who is it appropriate for?

A: Everyone can use it. It essentially works by doubling the notional if spot moves to a rate that is very favourable for the client to trade at. The client is then locked into receiving currency at

that rate and for a higher notional, with RBS getting a larger profit on the difference between spot and strike due to the increased notional. Everyone is happy

Q: How rigid is the flexible hedging profile?

A: Its main purpose is to encourage the client to do deals. RBS makes its margin mostly on deals, so it is interested in having there be more deals overall
The profile is designed to not stand in the way of the client making an obviously favorable deal.

Q: How is the flexible hedging profile set?

A: Some serious analysis. It is a combination of risk aversion and how much loss the client can take

Q: Is there a baseline amount of information you have to give a client to do a deal?

A: Yes, compliance provides minimum requirements. You need a written proposal for a trade that contains:
-Balanced argument for and against a deal
-A CLU demonstrating RBS' 95% certainty projection for the maximum loss the client could take on the deal
-3 alternatives (typically a spot deal, a forward and the complex structure RBS is pitching)
-If a restructure, need to disclose the current MTM of the current deal

Q: How is a credit line setup? Is it a barrier to a deal?

A: That really depends on the credit quality of the client. The process is handled by a bank manager and can be quite easy if the client has a strong credit quality.

Nov-11-2009 Paul Samuels: FX Sales

Q: What is considered when you look at why the client is hedging?

A: The salesperson is trying to find the motivation behind their view. You want to try and separate out the natural human desire to get the best price and to determine the most logical, best course of action given their unique requirements
Sometimes this is means you don't hedge at all

Q: So what factors affect this?

A: Profit margin is a very important consideration. If the client can't afford to take heavy opportunity costs if spot moves significantly higher, they should not enter into a forward
If a client can't afford to pay for an option given their profit margins, it's possible no hedging is the correct choice

Essentially, you take a structure and test it against extreme rate movements in both directions. If either of these result in an outcome that greatly hurts the business, the structure is a bad fit
You look at the case of rates dropping to test the protection and the case of rates rising to test the obligation

 Other factors include competitiveness of their market, how frequently they change their prices, potential business risks, regulatory risks and supply chain risks.

Q: What do you do with a first time client?

A: I walk them through three options. What happens if they do nothing, enter into a forward or enter into an option and proceed from there.

You have to remember, a hedge is an insurance policy. The client should never really want it to trigger. If the client doesn't want to pay for this insurance with money, they have to pay with a commitment or an adverse rate adjustment

Q: What is gearing? How would it work on a deal?

A: It simply means multiplying the notional that could potentially move in a deal

Q: So what does a client need to know?

A: They need to be fully aware of a position and the risks resulting from entering into it. Customers need to understand the implications of the actual deal.

A big problem is clients who focus only on the rate of the deal. If their strike is higher than spot, the client thinks their option is worth money. If this value was paid for by shorting vega, this isn't the case

Q: Could you talk a bit about the regulatory side of things?

A: A salesperson needs to be clear, not misleading and honest
That idea is owned by Reg-Risk, you should really go talk to them

I'd ask them:
The extent to which financial promotion rules apply to trade ideas sent to corporates
About rules dealing with the methods used to do deals
The three types of counterparties
-Retailers: the most protected and the type RBS deals with most often
-Professionals: the mid-level and large companies. RBS deals with them sometimes
-Eligible: Governments, other banks, federal banks. Receive minimal protection

Ask about what I think is called the "11 statements of principle" and the "7 principles of business"

There is a strict way to communicate a trade idea to a customer. This is done using a termsheet

Nov-13-2009 Mark Rowe: Compliance Manager

Q: Does the non-reliance 5 point test (section 3.4 pg. 8) require a statement to contain all 5 elements or only 1 to count as "advice"?

A: I would not be as specific as that although generally the 5 elements would need to be triggered for it to be defined as 'investment advice' in accordance with the rule. To be consistent I would include in your guidance the format used in the manual including 'what can you say and not say to to avoid giving investment advice?'

Q: Within the non-reliance test, what type of person can you give advice to? The phrasing of the third bullet point was confusing
-Specifically, could you define "financial adviser" and "investment manager"?

A: "financial adviser" - Financial advisers (also known as personal investment firms) usually give individuals or businesses advice on their financial circumstances and needs.
"investment manager" - A firm acting on behalf of a client who manages investments on a discretionary or non-discretionary basis

Overall, we understand the issues as:
-How you sell the structure
-What structure you are selling as some structures are simple enough to not require appropriateness checks
-Who you are selling to as the rules are different for the different classes of counterparty

Q: What is covered in appendix 9 of the CSA compliance supplement?

A: Record keeping requirements when categorizing clients. As a general note, the Currency Structuring team will not deal with Retail Clients.

Q: What is a categorization letter?

A: Letter sent to the client by New Counterparty Unit to inform the client of their categorizations therefore protections gained / lost.

Q: What is a "terms of business"?

A: See 3.2 p7.'When we have a new client, the FSA require that we provide it with a terms of business document setting out the basis on which we will do business. A Retail Client must sign and return the terms before we do business with it and a signed copy must be kept on the client file. A Professional Client must be sent the terms before conducting business.

Q: What is a "consent from client"?

A: Express confirmation from client in writing that they agree to RBS's categorization ie opt up/opt down.

Q: Do you need to prove appropriateness for an eligible counterparty? The document suggested you did not

A: No you do not.

Nov-14-2009 Mark Rowe: Compliance Manager

Q: Who is ultimately responsible for the client categorization?

A: The new deal team does the actual categorization and the paperwork. RBS really doesn't want to deal with retail clients.

The salesperson should gather enough information to generally determine if the counterparty is a professional client. If not, they should gather more information to determine to try and have the counterparty opt-up into professional

If a retail counterparty elects to stay retail, RBS probably won't deal with them

Q: How can you tell if a client within a company is authorized to deal within the company? How can you check if their parent company (if they have one) is on board with this strategy?

A: There is no formal process to check or prove this. You can make your best attempts, including simply asking those questions, but there is no formal method of proof

Q: How do you prove the customer understands and agrees to the deal?

A: You ask

Q: Yes, but in a legal situation. Say the deal goes badly, what then? What do you reference to show you got the ok?

A: There are two main things: a written proposal and the recording of the final deal

You send out a written proposal to the counterparty. This proposal contains a scenario analysis, risk warnings and a trade explanation/justification. This can only contain indicative pricing and is intended to give the client a general sense of how the structure works.
-Make sure the client understands their exposure
-Explain the trade
-Scenario analysis with maximum potential delivery and term highlighted
-comparison against alternatives (advantages/disadvantages of all listed)

When the counterparty agrees to this deal, you give the final live price over the phone. This is done over a recorded line. The actual process is to refer to the structure, verbally run through the scenario analysis again and then ask if they understand and wish to commit to the deal. If yes, you close.

Q: How are deal valuations handled?

A: They are offered whenever the client asks for them. Most frequently this is month end or fiscal year end. Whether they ask varies depending on accounting practices and corporate policy, things like that

Q: Can a deal exist where a client never asks for a quote?

A: Yes

Nov-20-2009 Peter Donnelly: FX Options

Q: How would you recommend salespeople find credit limit and current credit utilization?

A: In the NMOSS vanilla pricer, enter in a mock option and calculate. It is the credit tab. This will display in the base currency

I prefer to adjust by manual currency conversion because it's faster than re-entering the whole option.

It is important to note that the limit applies to time as well. Not all counterparties can be lent to for over a year. Essentially, the goals of these numbers:

-Don't break the credit line

-Lines are set in the base currency. Adjust how you wish

In the credit line calculator in NMOSS, the CLU is the largest NPV. You can't sort, you're forced to simply look through the list for the highest value. However, it is frequently at the end

Q: What is an ISDA?

A: International Swap Deals Association Agreement.

It's a standardized rule set to allow for faster deals. It defines things like "spot" so that everyone knows what everyone else is talking about.

ISDA is run by legal. To create one you call them up and provide them with some key contact details. This process could

ISDA has some specialty portions that can be amended onto the deal

Q: What is a CSA?

A: Credit Swap Annex

It is an amendment to CSA. It creates rules for collateralization of a counterparty. Specifically:

-minimum transfer amount

-threshold that needs to be originally passed to require posting

-frequency of valuation

Nov-23-3009 Daren Blaker: CRS UK FX

Q: So what is the general company HRR policy?

A: There's a large reputational risk for the bank attached to allowing clients to move profits/losses around to where they choose to realize them. HRR are one method for doing them and are one that RBS really does not like

Q: What are legitimate reasons for doing an HRR?

A: If the counterparty needs to move around delivery of the currency and doesn't have the flows currently to meet its contract it can push the delivery forward a bit

For example, if a company is buying another but does not yet have it finalized, it could roll their hedge forward a few weeks until it has completed the purchase and has the new flows

Q: What is the RBS process for doing an HRR?

A: Salesperson gets the call and should then check with their line manager to see if the manager agrees it is ok.

Salesperson then contacts compliance, who gives it a go-ahead
Salesperson then contacts the client, asking for a relatively high up member of the client to justify the business reason for why they wish to do the HRR
An upper level manager in RBS then gives it the ok. Gary Cole should be high enough

Nov-23-2009 Jeremy Maw: FX Sales

Q: When does the counterparty need to sign an ISDA?

A: The only time it's required is when signing a CSA. That's because a CSA is an amendment to an ISDA

Q: What factors push for the counterparty to sign an ISDA, then? Should a salesperson be pushing for the counterparty to sign it?

A: The ISDA offers RBS the highest level of protection on deals. However, it is not feasible in all cases. The smaller corporations don't want to be going out and spending £2k or £3k on a document review.

Many factors affect how strongly a counterparty will be encouraged to sign an ISDA. These factors fall into two classes: size of company and type of deal. The larger the company, the more likely it is to sign an ISDA. The longer dated, higher frequency and higher value the deals become the more likely an ISDA becomes.

It would be easy to get a large corp to sign an ISDA regardless of deal type. It would probably require high value, long dated deals to push a small corp to sign an ISDA.

Q: How does RBS protect itself without an ISDA?

A: In the "terms of business" sent out it typically includes portions of an ISDA. This is required for smaller counterparties and provides less protection for RBS than a full ISDA, but for practical reasons it is sometimes the only protection RBS can get

Nov-23-2009 Martin Merryman: Regional Director

This was an email conversation:

Q:
-How can you check (and later prove) that the person the salesperson is talking to is authorized by the company to deal with RBS?
-How can you ensure that senior management is aware of the deal and is ok with it (as we understand it, this issue comes up when dealing with subsidiaries of larger companies)

A:
2 good questions as this is an area that can often be assumed by a salesperson which can lead to issues in the future and we do not accept company mandates.

Our terms of business that have to be issued initially ahead of dealing should always go to an officer of the company (board member)

A key question that should be introduced by a salesperson without offending their contact is to determine what the decision making process of the company is particularly if your contact is not an officer of the company e.g. Financial controller, Treasurer, accountant, FX dealer.

If dealing with a subsidiary of a larger company then it is only right that the above should be put to the contact to ensure that they have authority and autonomy from the parent.

A good salesperson will deliver any or all of the above in a way that supports his relationship. The answers to the questions will be protection for the contact at the company as well as the salesperson going forward.

If any of this does not make sense then please feel free to call me

Nov-23-2009 Neil Tandy: Manager

Q: Can a CSA exist without an ISDA?

A: No, it's an amendment so it requires the master document

Q: The CSA is an agreement that deals with collateral procedures?

A: That is correct

Q: How is it run in RBS?

A: IT is owned by the collateral team. Alex Soane is the contact for that team, he heads it.

Q: So the CSA is an industry standard?

A: Seems so, yeah. On the one I've dealt with the counterparty only pushed back on the threshold levels, not on the contractual process itself.

Q: Can a client be collateralized without a CSA?

A: It doesn't appear so

Q: What does a salesperson really need to know about CSA?

A: They need to understand it exists as an option. When RBS has no appetite for credit and the deal requires it, CSA is an option for pushing the deal forward.

Q: So it goes hand in hand with ISDAs?

A: Yes. A recent development is Corporate Credit pushing for counterparties to sign ISDAs.

Corporate credit is pushing for ISDAs; they set the credit line with RMs

Nov-23-2009 Paul Samuels: FX Sales

Q: So as I understand the process, the end goal is to try and match a client to a strong flexible hedging profile?

A: Well, we are on a strict "no advice" mandate on this desk. We don't try and force any policy on the client, but we can suggest them

Q: So is there any sort of general concepts? General categories of structures?

A: Not really. Any attempt to offer structures on a menu like that doesn't seem to work

Q: If categories matched to client attributes won't work, what will?

A: You have to understand the four building blocks of structures. There are spot deals, forward contracts, FX swaps and currency options.

FX swaps work by effectively transferring the cash flow to a later date. Say for instance the client needs dollars for a few months and has some extra pounds. They would agree to sell pounds now for dollars and to sell dollars in the future for pounds, assuming that their dollar cash flow would come through later and remove the need for dollars

Q: So can you run a deterministic system?

A: No, that can't work. If it could, sack us all and replace us with well written programs. That time may be coming but it isn't now

Q: Is the basic process: facts on the counterparty -> basic parts -> complex products?

A: That's the way I prefer

Nov-23-2009 Stuart Alden: Manager

Q: What needs to be done before a salesperson can do a deal with a client?

A: They need a KYC, an RM for the client's sector and a credit assessment (credit line)

Q: What parts of that process is the salesperson involved in?

A: They get the phone call from a client that is not in the system and would check for the appropriate relationship manager for that sector. The RM would then handle the KYC, counterparty classification and credit assessment

At times the salesperson will work with the RM to do this, but it is not required.

Q: So the salesperson has to wait for those three things to clear before doing business with a counterparty?

A: A salesperson can't do a deal before a KYC is out. However, based on industry feel and perceived quality of counterparty it is possible to begin to gather information on the specifics of their deal before all the clearance is in

I wouldn't go so far as to send an indicative proposal, but gathering the information on client needs is ok

10 Appendix E: XPortfolio Interview Transcripts

Nov-12-2009 Lee Rushforth: Project Manager, Currency Options Technology

Q: So what will be included in the first release?

A: The first release is more of a technical, proof of concept step. We will roll out dual currency deposit functionality as well as test the systems ability to attach to all the other relevant systems

Q: What's coming up next? What follows the initial release?

A: A list of big exciting new features? Easy enough

Ability to create composite products (the new word for structure)
-In NMOSS you can only make structures by building it from the most basic building blocks. This can be worked around using NMOSS wizards that simplify the inputs for types of structures. However, wizards are complicated to create
--Prodigy allows for the multiple columns of basic blocks to be easily combined into composite products. This also allows for easy externalization

-It will integrate all the stand alone portions of RBS: M into a single area. It currently stands as self-contained units, which clients don't like

-It will integrate into XPortfolio

-It will centralize the scattered excel spreadsheets and NMOSS components into one location

-In release 2 there will be dealer intervention. In the past if a requested deal was not quotable external customers would need to call RBS and internal salespeople would need to mind-align or

walk over. Prodigy would automate informing structurers that the request was made and allows them to respond quickly

-Multi-currency products are in the future

-Having the external and internal users on the same program allows for more specific conversations

-NMOSS is tied to echo, a system that will soon be retired. This upgrade will need to happen anyway

-white labeling: re-brand the RBS system with another company's name. Allows a company to remove the RBS name from the product and add their own name

-XPortfolio will slowly claim all pricing functions from the scattering of systems defined in the "project scope". RBS: M DCD is the first system

-Prodigy will allow a pricing matrix that shows the price for lots of pairs of currencies at different rates. The user can then double-click the one they like the best, taking them to that structure

Nov-26-2009 Lee Rushforth: Project Manager, Currency Options Technology

During this meeting we presented our plan on what would be in the training guide for internal users. Lee had some comments:

- At the beginning of demonstrating how to price the products, reference the FX structuring product guide. For each product, attach the sections that show how to price it to the specific page it is on in the guide

- Within the pricing grid there is more than the ability to show multiple structures and to combine these structures into a single entry. It can also price multiple versions of a structure inside a single grid entry, but in the current version only one of these can be dealt

- Ensure that the guide links properly with XPortfolio, including using a similar look and feel. This is especially important in the "reports" section of the guide as this is building off of XPortfolio. There is already robust training guide describing functionality that needs to be checked to see if it is current and correct and then linked to

- There is already a strong explanation of the products being dealt in the "additional details". This is a plain English description of the product

Q: As a final question, how should we be referring to Prodigy in our report? What is the official terminology? Is there a most correct way to refer to it?

A: A difficult question. I guess the most correct way to refer to it is to say the Prodigy project delivered pricing functionality into XPortfolio
Prodigy is not the system, the system is XPortfolio. Prodigy is only to be used to refer to the project

11 Appendix F: MATLAB Code for Analytical Approach

11.1 variance.m

```matlab
function variance(period)
%The file is written to use the analysis approach to calculate the
%voaltility of a swaption first, and then apply it to Black Scholes formula
%to get the swaption price.


%theta values to calculate correlation
Thetas=[0.0643, 0.1032, 0.1502, 0.1969, 0.2239, 0.2771, 0.2950, 0.3630, 0.3810, 0.4217, 0.4836, 0.5204, 0.5418,
0.5791, 0.6496, 0.6679, 0.7126];
%forward rate matrix starting after 2y(T3 to T20)
Forward=[5.60, 5.84, 6.00, 6.13, 6.28, 6.27, 6.29, 6.23, 6.30, 6.36, 6.43, 6.48, 6.53, 6.40, 6.30, 6.18, 6.07]/100;
%Phi values used for volatility over a single period.
Phis=[1.0900 1.1025 1.1025 1.0913 1.0669 1.0624 1.0611 1.0544 1.0475 1.0386 1.0270 1.0132 0.9975 0.9979
1.0033 1.0079 1.0119];


%Getting the entire forward rate from the single rate over each period.
temp=1;
for k=1:17
    temp=temp*(1+Forward(k)*period);
end
discount=1/(temp*(1+4.69/100*period)*(1+5.01/100*period));
frate=(temp-1)/(17*period);



%Calculating the integration of the product of two single volatility over
%period 0 to 2*period
a=0.1908;
b=0.9746;
c=0.0808;
d=0.0134;
Sig2=zeros(17);
```

```
steps=5000;

deltat=2*period/steps;

n=steps;

for i=1:17

    for j=1:17

        time=0:deltat:(2*period);

        height=zeros(1,n);

        for k=1:n

            temp=((a*((i+1)*period-time(k))+d)*exp(-b*((i+1)*period-time(k)))+c)*((a*((j+1)*period-
time(k))+d)*exp(-b*((j+1)*period-time(k)))+c);

            height(1,k)=temp*Phis(i)*Phis(j);

        end

        Sig2(i, j)=sum(height)*deltat;

    end

end


%summation process: prepared to add up the correlative effects.

sum1=0;

for i=1:17

    for j=1:17

        correlation=cos(Thetas(i)-Thetas(j));

        cor=period^2*correlation*Forward(i)*Forward(j)/(1+period*Forward(i))/(1+period*Forward(j))*Sig2(i, j);

        sum1=sum1+cor;

    end

end


% Calculate the varience using the forward rate and summation prepared:

var=((1+17*period*frate)/frate/17/period)^2*sum1;

sdv=sqrt(var)/sqrt(2*period);

d1=sdv/2;

price=discount*17*period*frate*(2*normcdf(d1)-1);

fprintf('the analytical standard deviation of the zero-coupon swaption is %g.\n',sdv);

fprintf('the price of the zero-coupon swaption is %g.\n',price);
```

12 Appendix G: MATLAB Code for Monte-Carlo Simulation

12.1 montecarlo.m

```matlab
function frates=montecarlo(steps, repeat, period)
%This file is the monte caralo method to simulate the forward rates
%estimated at time 2y using the estimations at time 0.
%Input:
%steps-The number of steps to finish the simulation
%repeat-the number of simulations you want to have
%period-how long (in years) y is.
%output: the forward rate vector from timei alpha and beta.


% The forward rate at time i(i>2y) estimated at time 0.
Initialrates=[5.60, 5.84, 6.00, 6.13, 6.28, 6.27, 6.29, 6.23, 6.30, 6.36, 6.43, 6.48, 6.53, 6.40, 6.30, 6.18, 6.07]/100;


%Thetas usedto calculate correlation
Thetas=[0.0643, 0.1032, 0.1502, 0.1969, 0.2239, 0.2771, 0.2950, 0.3630, 0.3810, 0.4217, 0.4836, 0.5204, 0.5418,
0.5791, 0.6496, 0.6679, 0.7126];


%set up correlation matrix
%according to thetas, correlation = cos(theta(i)-theta(j))
Cor=zeros(17);
for i=1:17,
    for j=1: 17,
        Cor(i, j)=cos(Thetas(i)-Thetas(j));
    end
end


%prelocate array Sum, which is prepared for next step.
Sum=zeros(17,1);
```

```matlab
%initialize the simulation rate matrix, with each column equals to the
%initial rate, and the number of column equals to the simulation times.
Ratematrix=zeros(17, repeat);
for col=1:repeat,
    Ratematrix(:,col)=Initialrates;
end
%for each step of delta(t), we have to simulation again because the forward
%rate movement is assumed to be Brownian motion. we need to start from time=0, and repeat this
%process until reaching 2y.
time=0;
deltat=(2*period-time)/steps;
% define the mu aray:
mu=zeros(17, 1);
for k=1:steps,
    % simulate random vector under multivariant normal distribution, with mean value
    % equls to 0 and standard deviation equals to the correlation matrix
    ndistri = mvnrnd(mu,Cor, repeat);
    trans=ndistri';
    %as the single volatility of a certain period will change according to
    %time, updating the single volatility is also necessary
    Sig=singlevol(time, period);
    for col=1:repeat,
        %get the forward rate of each simulation in last iteration
        FR=Ratematrix(:, col);
        %calculate the summation to prepare for the multiply factor which
        %will be used later.
        for i=1:17,
            temp=0;
            for j=1:i,
                temp=temp+Cor(i, j)*period*Sig(j)*FR(j)/(1+period*FR(j));
            end
            Sum(i)=temp;
        end
        %updating the forward rate by using the lod rate multiply a factor
        factor=exp(Sig.*Sum*deltat-1/2*deltat*Sig.*singlevol(time, period)+sqrt(deltat)*Sig.*trans(:,col));
```

```
        Ratematrix(:,col)=FR.* factor;
    end

    time=time+deltat;
end

%return the simulated ratematrix, shows the expectedrates at 2y.

frates=Ratematrix;
```

12.2   swaption.m

```matlab
%This function gives the price of a swaption using the monte carlo
%simulation
function getPhi=swaption(repeat, period)
Forward=[4.69, 5.01, 5.60, 5.84, 6.00, 6.13, 6.28, 6.27, 6.29, 6.23, 6.30, 6.36, 6.43, 6.48, 6.53, 6.40, 6.30, 6.18, 6.07,
5.94]/100;
step=5000;
frates=montecarlo(step, repeat, period);
forward2=zeros(1, repeat);
discount3=zeros(1, repeat);
for j=1:repeat,
    product=1;
    for i=1:17,
        product=product*(1+period*frates(i, j));
    end
    discount3(1,j)=1/product;
    forward2(1, j)=(product-1)/17/period;
end
%The forward rate is generated without % sign.




%calculate the strike swaprate K. K is F(0) in this case
srate=1;
for k=3:19,
    srate=srate*(1+Forward(k)*period);
end
strike=(srate-1)/17/period;


%calculate the average forward rate F(0, 0, 19y)
temp1=1;
for m=1:19,
    temp1=temp1*(1+period*Forward(m));
```

```
discount1=1/temp1;


%calculate the average forward rate F(0, 0, 2y)
temp2=1;
temp2=temp2*(1+period*Forward(1))*(1+period*Forward(2));
discount2=1/temp2;


%Calculate sweption price using forward rates and strike
sum2=0;
for k=1:repeat,
    payoff=[forward2(1, k)-strike 0];
    sum2=sum2+discount3(1, k)*max(payoff);
end



%Give the price of the swaption
price=discount2*(17*period)/repeat*sum2;
fprintf('the Monte-Carlo price of the zero-coupon swaption is %g.\n',price);


%Get the implied Phi(volatility) value through Black Scholes formula.
getPhi=(price/discount1/period/17+strike)/2/strike;
```

12.3 singlevol.m

```
function sig=singlevol(time, period)
%This function is used to return the volatility matrix with volatility at
%period i, estimated at time t.
Phis=[1.0900 1.1025 1.1025 1.0913 1.0669 1.0624 1.0611 1.0544 1.0475 1.0386 1.0270 1.0132 0.9975 0.9979
1.0033 1.0079 1.0119];
Sig=zeros(17,1);
a=0.1908;
b=0.9746;
c=0.0808;
d=0.0134;
for i=1:17,
    Sig(i)=Phis(i)*((a*((i+1)*period-time)+d)*exp(-b*((i+1)*period-time))+c);
end
sig=Sig;
```