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Portfolio Optimization of Credit Line Utilization

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Royal Bank of Scotland

OPTIMIZATION OF CREDIT LINE UTILIZATION

Worcester Polytechnic Institute – Wall Street MQP

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10/01/2011

1

Abstract

This project was the creation of a prototype for the current RBS system to provide better insight into the credit aspects of a portfolio especially for credit-constrained counterparties. We developed an excel-based tool that provides three methods for optimizing the use of credit in portfolios and invented our own additional strategy. The tool will be used as a desktop application for salespeople with a goal of finding further trade opportunities. An initial trial of our tool revealed an astonishing ten million pounds trade opportunity that current RBS systems would not have been able to detect.

Executive Summary

Analysts at the Currency Structuring desk of Royal Bank of Scotland realized the usage of credit in their client's portfolio was not very efficient. Since the financial meltdown in the year 2008, credit has become a scarce resource and as such RBS decided to introduce a qualitative analysis for the credit information that was only quantitative.

Our end product was a desktop application for salespeople that work in the Global Banking and Markets division of RBS that can recognize trade opportunities with clients that have portfolios with credit constrains. Until now, clients that had a full use of their credit line could not keep trading with RBS until their trades expired. This generated a problem given that expiry dates of trades would not come before several months, leaving corporate clients with no coverage for their businesses and having RBS lose profit opportunities. The creation of our tool provided a solution to these portfolios, opening a new range of trading opportunities for the bank.

The project consisted into three main parts: understanding the calculation of credit line utilization, examining the current credit line utilization limitations and developing a portfolio optimization of credit line utilization tool. We first understood the nature of credit and how the current systems of RBS convey credit data. Secondly, we analysed the flaws that the current systems have and suggested a few system enhancements. And finally, we produced a working excel tool that includes three different credit efficient strategies that give the salespeople ideas on new trades that their clients might want to do.

The focus of our project was the creation of our tool. It consists of an excel based prototype that includes VBA code as well as other excel functionality and acts as a daily workflow tool in the operations of the currency structuring desk. The three main strategies for portfolio optimization are: portfolio restructuring, new vanilla options and deposits. Not only were we able to provide a different approach to credit but we were also able to create the basis for a fourth credit optimization strategy based on the given deltas of a portfolio.

This project signified a major challenge for its authors in various ways. Beginning with its nature, it was a project developed remotely between two different locations: RBS in London and Worcester Polytechnic Institute. Secondly, we faced obstacles with the technical skills required for VBA coding and moreover, the credit aspect was complex and involved a two week review of statistical analysis application to the nature of the deals and trades with clients.

Acknowledgements

The following is a list of people who provided guidance, support and overall gave us the tools we needed to succeed in our project. We thank all their contributions and efforts to improve our skills and to keep us motivated in the search for excellence:

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Table of Contents

List of figures

11

52. Screenshot of the 15 delta (graph & comparison)

53. Screenshot of the 3rd part of the "table of contents"

54. Screenshot of the details behind the deposits tab

55. Screenshot of the deposits tab

56. Screenshot of the Strategic example

57. Screenshot of the Portfolio Restructuring analysis performed on Ipeco

1. Project Definition and Introduction

What options do people have whenever they want to buy an item but do not hold the required liquidity? How can big financial institutions perform currency transactions when they do not have available funds? The existence of credit allows for the borrowing of a certain amount of money that can be used to fulfil present needs and can be repaid in the future with a specific amount of interest rate.

Credit is one of many important factors that affect transactions between financial institutions and their counterparties.   It is used in different magnitudes depending on the nature of the client, ranging from individual use of credit cards to big credit amounts from large derivative transactions that involve high levels of liquidity.

The concept of Credit Line Utilization is present in market news on a daily basis. According to the Wall Street Journal, ICBC agreed to raise its credit line to $500 million from $200 million to support Russian imports from China. This means that credit line usage extends beyond individual or institutional clients, it has a macro level presence as well.

Before extending any amount of credit, an extensive analysis needs to be performed on the specific client. The bank in charge of extending this credit ensures that the counterparty has a sufficient level of credibility in order to mitigate risks. Credit issues have been an ongoing hot topic ever since the global financial crisis in 2008 and their importance kept increasing over the past three years in the financial services industry.

In Foreign Exchange trading (FX), credit plays an important role given the fact that part of their focus is on corporate clients which are generally uncollateralized. Since there is no

collateral set aside for specific transactions. Therefore, a credit line is assigned to ensure that an overall constraint is placed upon all trades between the counterparty and the bank.

Whenever a trade is executed, it occupies a certain portion of the credit line assigned to the counterparty. The counterparty can only trade if there is space available within its credit line utilization. When a credit line is full, it signals the bank that no more transactions can be processed for that particular counterparty. However, it is in the interest of both the client and the bank to engage in FX transactions. From the client perspective, FX transactions are an opportunity to offset the risk associated with importing or exporting activities denominated in foreign currencies. From the banks perspective, these transactions represent profit from the foreign exchange service they provide both from charging a fee and from hedging risky positions. In order to increase the trading volume, the bank has to perform adjustments. These can take the form of restructuring or closing of existing trades with the purpose of freeing credit line usage.

Currently, the FX restructuring desk at RBS has performed an initial analysis of Credit Line Utilization (CLU). On a specific portfolio, the term Credit Line Utilization refers to the maximum usage of credit on the maturing date out of the entire portfolio. As of today, the information available consists of only an overall picture determining if the credit line utilization for a specific counterparty is full. This information is incomplete when performing trade adjustments for freeing up credit space because it does not provide any measure to determine if the credit line usage is efficient.

It is possible for counterparties to free up some credit line space by paying premiums. Nevertheless, even if premium is paid, it is still difficult to determine how much credit should be taken out for the Credit Line Utilization of an aggregate portfolio.

This leads to propose the development of a zero-cost tool that offers analysis on CLU of the counterparty on each different maturing date. Especially, we want to know what are the components that make up the CLU as well as the components from other maturing dates of one aggregate portfolio. The idea is to expand on the current credit analysis available giving more colour to the meaning of CLU. Through this project, we will have the opportunity to discover how CLU calculation is performed and how it is netted in a portfolio basis. Moreover, we will be performing this analysis by working with Salespeople and creating a working demonstrator that will display CLU calculation in an efficient way. Our analysis will be used for all FX Portfolios and will consist of a desktop application that Salespeople will have access to.

One of the main benefits of our project will be the ability to determine the CLU efficiency of existing transactions. If existing transactions can be restructured to consume less credit line for the same valuation, the client will be able to increase its trading volume with RBS at no additional cost bringing additional trade opportunities with the firm.

We see an opportunity through this project for our professional development. Our contribution will help us gain an exposure to the RBS Global Markets division as well as an understanding of the way the restructuring desk operates. It will also help us enhance our problem solving and critical thinking skills.

2. Background

Royal Bank of Scotland (RBS-Global Portal)

Royal Bank of Scotland is a financial services firm that provides assistance to institutional, businesses and individual clients. Founded in 1727, the RBS group has been in business for over 280 years, having a worldwide exposure to 40 million customers in total. The RBS group is composed of 6 different divisions that provide specific financial services to clients. Those divisions are comprised of: UK Personal, RBS Insurance, EMEA Retail & Commercial, UK Corporate, US Retail & Commercial and Global Banking and Markets (GBM).

The GBM division is in charge of providing services to significant and influential corporations and financial institutions around the world. They deliver financial solutions for different types of businesses ranging from debt financing, asset management, risk management & trading, investing, transaction services and industry expertise. We will be working with the currency structuring desk for the Foreign Exchange department within Global Banking and Markets. This desk sits between sales and trading facilitating all transactions that involve any complex restructuring and providing support and assistance to salespeople.

Historic Background on RBS

The economic situation for RBS has seen a major shift over the past months given that major events in the British Banking history have occurred. Starting with the crisis that generated in the US Market around the year 2008 with the fall of Lehman Brothers, the UK Banking Industry has also suffered tremendous impact which led to the decision during the month of

16

October 2008 that three major banks would be bailed out by the British Government, one of them being RBS.

After its acquisition of ABN AMRO, RBS was distracted and mismanaged leading with the injection of £20 billion from taxpayer's money to recapitalize the bank. Since then, RBS is government owned by a stake of 84%. This move led its Chief Executive Fred Goodwin to resign and total job losses of 16,000. During the first quarter of the year 2009, the government installed a second measure in place to convert the preferred shares owned into regular shares.
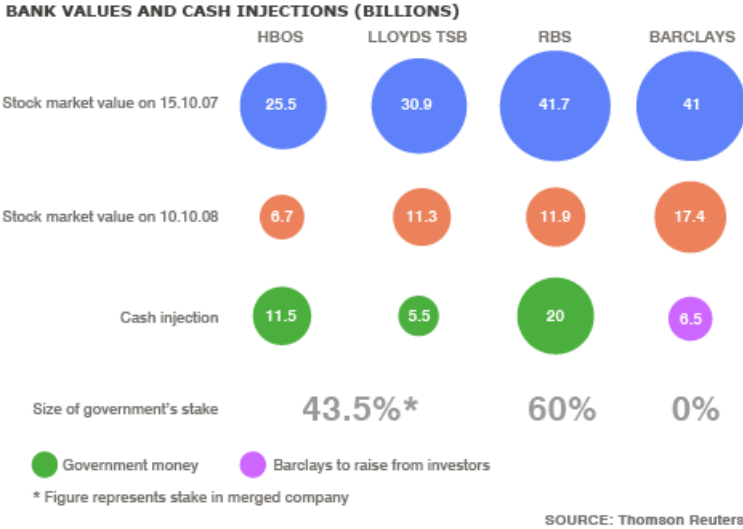
Fig1. Bank Values and Cash Injections (Billions)

Under these circumstances, the bank has suffered consequences of their partnership with the government. On the macro level, the pay has become more political given that now it comes from the taxpayers money. There are still many uncertainties in regards to the pay: Should the bank pay bonus? Should salaries be art market rate or less? Another consequence is that being government owned has brought many constraints in the lending policies. The government has pressed RBS to extend their lending to a wider range of businesses but RBS is not in a position to lend if several guidelines are not met and if businesses will default at some point.   On the

17

micro level, employees have been internally affected by the new culture that was enforced. Because the company was nationalized, employees now resemble the government, so their expenditure behaviour had to change as well as their reward events. The future for RBS is extremely uncertain since they would have to end their nationalization and become private at some point.

During our time here, RBS announced its Q3 results appearing as "the fourth bank by capital strength after UBS, Credit Suisse and Citigroup" (RBS internal website). 34% of the banks operating profit came from the GBM department and its income was lower than in Q2. Another good measure was the fall of their total costs by 3% and the growing of their balance sheet by 5%.

Currency Structuring Desk Needs

Corporations are one of the main clients that our desk focuses on. Our desk supports salespeople in finding the right instruments and solutions for corporate clients. The business of corporations is based on import and export activities from different parts of the world to meet the demand of consumers. RBS takes part of one of the three types of contracts that corporations might need to provide assistance with the risk involved in using different types of currencies for their import and export activity. For the better understanding of the role that RBS plays in the economy, we would like to describe the following example:

A company in the US needs raw materials from a UK supplier in a year from today; therefore the corporation takes advantage of this need to facilitate this exchange and to secure a profit from the currency rate between dollars and pounds.

18

There are three contracts that occur in this simple example. The first one is between the corporation and the UK supplier: the supplier will provide the corporation with the goods and the corporation will give the suppliers their pay in pounds. The second one happens between the corporation and the US Company: the corporation will provide the raw materials bought from the UK supplier to the US Company and will receive a pay in dollars. And finally, the corporation needs to offset the difference between the pounds they paid the UK supplier and the amount of dollars received from the US Company. If the exchange rates were static, there would be no need to enter into any contract with financial institutions. The reason why financial institutions enter into this picture is because the exchange rate at the time when the corporation bought the raw materials in pounds might not be the same as the rate at the time in which they received their payoff in dollars, meaning the corporation is at risk of either losing or gaining money depending if one currency has gone up or down.

The corporations have a risk exposure to the exchange rate between dollars and pounds and they enter into a contract with firms such as RBS to offset this risk. This contract is meant to secure a specific rate at which they will exchange both types of currencies. If they decide a price for the currency exchange of GBPUSD 1.6 (one pound worth 1.6 dollars), this means that they will buy pounds from RBS at 1.6 dollars per pound, they will pay the UK supplier and they will receive 1.6 dollars from the US Company. If the dollar price has gone up to GBPUSD 1.7, then the corporation will have a gain of 100,000. The above example was the essence of a forward contract between RBS and a specific corporation.

There are several concepts that are crucial to the understanding of our project. The following are the most important definitions we will be working with:

19

Foreign Exchange Products

Spot Rate

      Foreign exchange spot rate (forex) is the current exchange rate at which a currency pair can be bought or sold. The spot forex rate differs from the forward rate in that it prices the value of currencies compared to foreign currencies today, rather than at some time in the future. The spot rate in forex currency trading, is the rate that most traders use when trading with an online retail forex broker (Investopedia.com). It is in essence the current market price for a currency exchange.

Strike

      The strike is the set price in the contract at which both counterparties agree to exchange the specific currencies based on the individual terms of the contract and the payoff profile. This is the amount that will be compared to the spot rate in order to determine which side has a favourable situation in the contract.

Forward Contract

      Forward Contract is a cash market transaction in which delivery of the commodity is deferred until after the contract has been made. Although the delivery is made in the future, the price is determined on the initial trade date (Investopedia.com). A detailed example on the forward contracts that we enter into with was introduced in the earlier part of the background.

Option

      An option is a financial instrument that represents a contract sold by one party (option writer) to another party (option holder). The contract offers the buyer the right, but not the obligation, to buy (call) or sell (put) a security or other financial asset at an agreed-upon price

(the strike price) during a certain period of time or on a specific date (exercise date).

Call options give the option to buy at certain price, so the buyer is betting that the underlying asset will go up. Put options give the option to sell at a certain price, so the buyer is betting that the underlying asset to go down (Investopedia.com).

Vanilla Options

A plain vanilla option is the standard form of the Option contract. It gives the buyer the right but not the obligation to buy or sell a specific amount of a given stock, commodity, currency, index, or debt, at a specified price during a specific period of time.   Vanilla options tend to be either European or American and have a defined strike price, underlying asset and expiration date/maturity.

Exotic Options

Exotic Options are contracts that have complex characteristics that differentiate them from a plain vanilla option. Their strike price, underlying assets and contractual amounts change according to the specific option type. These contracts are mainly traded over-the-counter (OTC) and can vary from butterflies and straddles to barriers and choosers.   At the desk we learned the behaviour of the following instruments:

Digital Options

A digital option is a type of option where the payoff is either a fixed amount of some asset or nothing. Digital option's moneyness simulates a normal distribution curve and its mean is at the current spot.
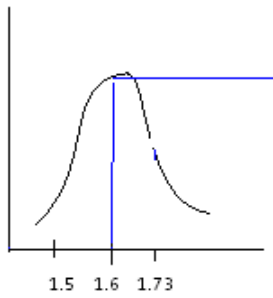
Fig2. Digital Option 1.6 spot graph   Fig 3. Digital Option 1.73 spot graph
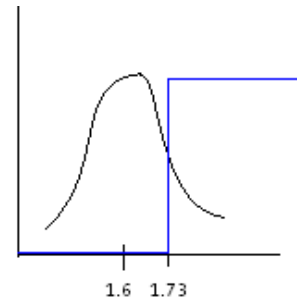
As shown in the first figure, a digital call with strike right at 1.6 is now 50% in the money. In the second figure, a digital call with strike at 1.73 is 25% in the money.
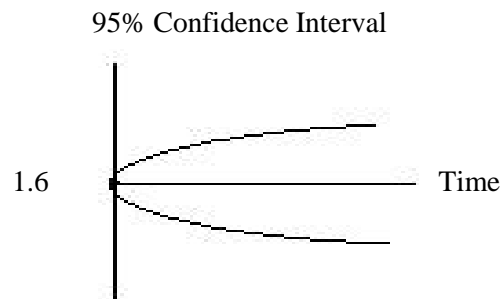
Fig4. Upper/Lower bound of GBPUSD 95th confidence interval =Outright forward rate* exp(+/-1.645*Volatility*Sqrt(Time))

Digital options' payoff distribution is used to predict the extreme movements of spots across time within the 95% confidence interval based on the spot rate today.

Counterparties

The term counterparties refers to corporate entities who transact Foreign Exchange products for the purpose of hedging underlying exposures and reducing business risk related to exchange rates. These entities are uncollateralized and thus the Credit Utilization consumed by

their transactions is a primary concern for us and indirectly for them. To illustrate the above mentioned term, we would like to show a graph of the payoff profile of a counterparty that buys a call option from RBS:
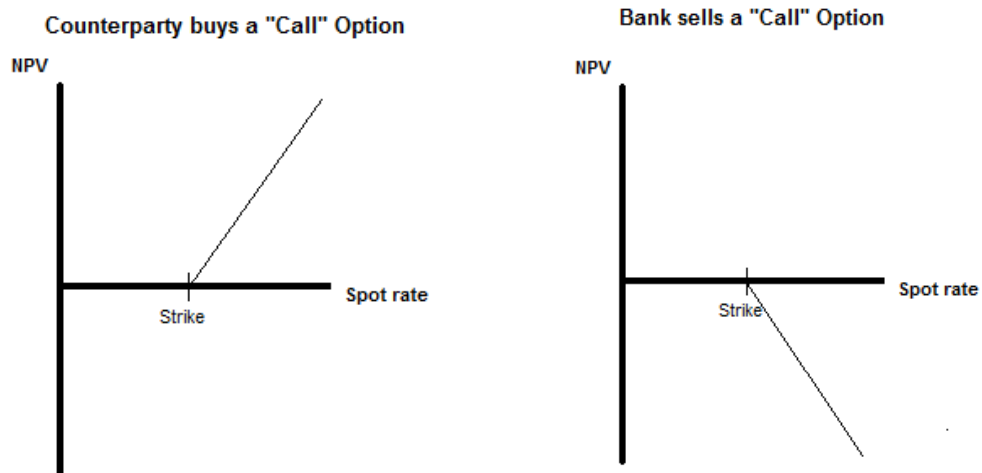
Fig5. Buying/Selling a Call Option Payoff graphs

In this example, the bank does not have any credit concerns given the fact that the counterparty has no possible loss. If the spot rate is above the strike, the counterparty will exercise the option and earn a profit. If spot rate is below the strike, the counterparty will not exercise the contract.

The bank starts to have credit concerns whenever the client has a loss. Specifically in the following forward example:
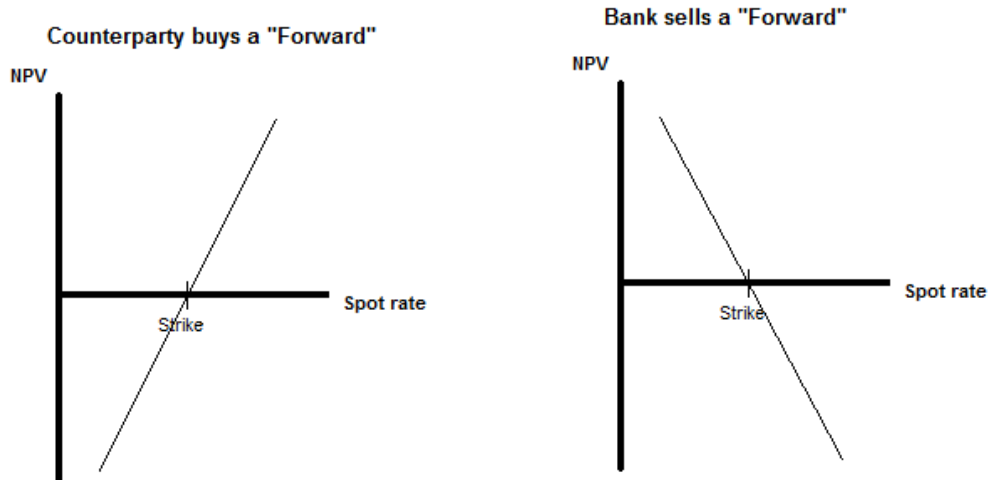
Fig 6. Buying/Selling a Forward Payoff Graph

In this case, if the spot rate is below the strike, the counterparty loses money and the bank earns a profit. At expiry, the counterparty needs to make a payment to the bank for a specific amount depending on the strike and spot values, but there is a risk of this counterparty not being able to provide the payment, an uncertainty of the counterparty defaulting.

The bank has a need to protect itself from this default, which is why they extend a credit line for specific transactions to each counterparty.

Credit Line

Credit Line is a specific amount of credit that is allocated to particular counterparties in foreign exchange transactions. It determines the capacity of trades that can be processed by each individual counterparty. The assignment of credit line is performed by the credit department and takes many variables into account such as the counterparty's reputation, number of accounts with the bank,   financial health as well as economic and political situations from its location that

24

influence its financial performance. Credit line assignment is updated dynamically since it depends on many variables that change over time.

Net Present Value

Net Present Value is the price of an option as of today. It is determined by the Black-Scholes formula The Garman-Kohlhagen model. It varies with different inputs of the formula.

$$C(S,t) = Se^{-r_b T}N(d_1) - Ke^{-r_t T}N(d_2)$$

Fig7. The Black-Scholes Formula

Where $$d_1 = \frac{\ln(\frac{S}{K}) + (r_t - r_b + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}} \qquad d_2 = d_1 - \sigma\sqrt{T}$$

S=Spot   K=Strike   rb=foreign risk free simple interest rate rt=domestic risk free simple interest rate

Credit Line Utilization

The CLU is the maximum value in favour of the bank that an instrument can have within a 95% confidence interval of spot. According to the credit dates, every instrument has a specific value at each single spot rate on each specific future date. We calculate the 95% confidence interval in which we are confident that spot will move in the given length of time to maturity. Based on this interval, we look at the NPV the trade has on each projected future date with the extreme move of spot rate and that is the maximum value of the trade within the 95% confidence interval on that specific day. For a portfolio of trade, the CLU is found by summing up the contribution of NPV for each specific date and the total NPV that corresponds to date that has the most contribution is the CLU of this portfolio.

Aggregate Portfolio

An aggregate portfolio is the portfolio that has all trades made by each customer within a specific time period. The aggregate portfolio holds the collection of trades from this customer.

25

Firm wide Systems & Applications

NMOSS

Quote

NMOSS is an internal application used to provide pricing information on FX products based on various inputs such as product type, strike, expiry date and notional.

Figure 8. NMOSS Inputs

After filling in all the necessary inputs, we are able to calculate the NPV of such option (shown in field "NPV") and credit calculation that shows the NPVs of such instrument at different future dates.

Vanilla Pricer

When salespeople want to process a new trade with a specific counterparty, he would be able to view the current credit line usage and credit limit of this counterparty from an application in NMOSS called Vanilla Pricer.

26
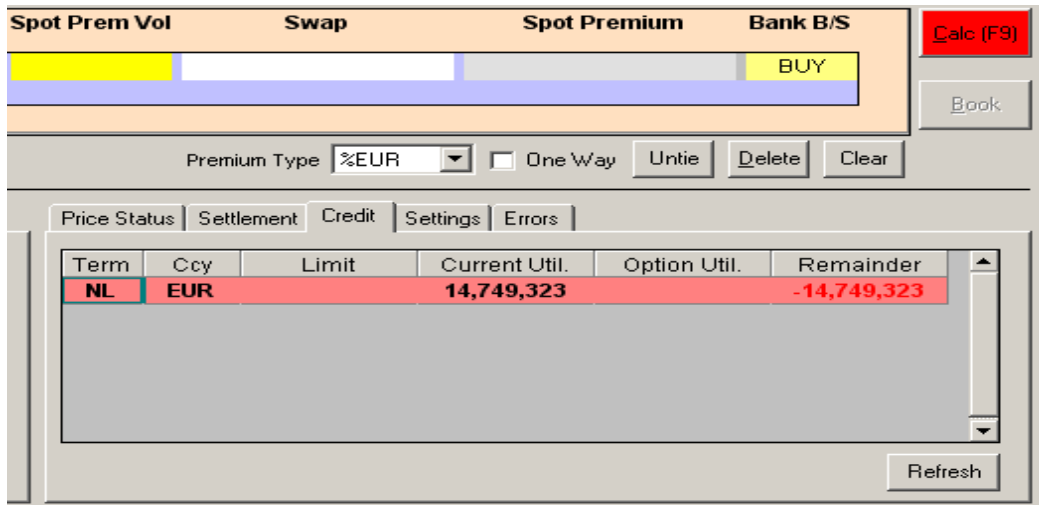
Fig9. Screenshot of the Vanilla Pricer in NMOSS

RBS Marketplace

RBS Marketplace is an application that allows trading functionalities and other functions for RBS clients and employees. From our perspective, we used RBS Marketplace as a platform that consolidates all available trade data from three different systems into one. Currently, there are three booking systems that the firm uses in the FX business dependent on the product, but RBS Marketplace allows retrieving all existing trade details on these three systems through another tool called XPortfolio that allows for reporting functionality.
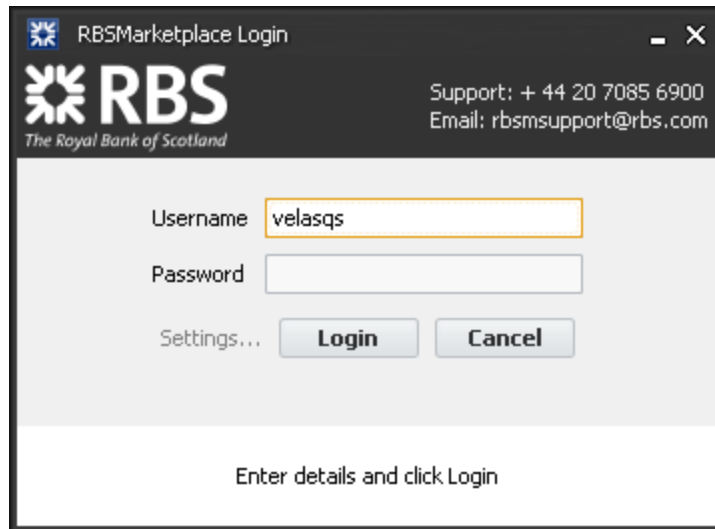
Fig10. RBS Marketplace Login Screen

XPortfolio

This application has the ability to provide consolidated reporting of FX transactions on the same place. Employees can customize the reports they need based on trade date, expiry, counterparty and many other categories. We worked with this application in obtaining portfolio information of the specific counterparty in which we applied our credit line utilization analysis.

XPortfolio shows various foreign exchange trades for different currency pairs. The following table outlines the most common currency pairs that counterparties transact with RBS:

Abbreviation	Currency Name
GBP	Sterling Pound
USD	American Dollar
NOK	Norwegian Corone
AUD	Australian Dollar
CHF	Swiss Franc
TRY	Turkish Lira
SEK	Swedish Corona
INR	Indian Rupee
CNY	Chinese Yuan
NZD	New Zealand Dollar
ZAR	South African Rand

Fig11. Table of currencies and their abbreviations

The FX Option portfolio Report link on our XPortfolio toolbar gave us the ability to
create our own reports according to the data needs related to our project. Once it is opened, it
directs the user through a selection criterion of the categories that are useful for trade
information. Reports can be created based on the following criteria: Counterparty, Deal
Reference, Deal/Structure Ref, Expiry Date, Headline Rate, Instrument Code, Strike, Structure
Name, Structure Ref, System, Trade Date, ABN Reference, Amended DateTime, Archive
Included, AV (added value), Book, Booked by (X Only) (this refers to system X), Booking
System, Broker, Call/Put, Cash Settled, Client CIS Code, Complex Type, Counterparty Code,
CTV, Currency, Currency Pair, Cut, Deal Origin, Delivery Date, Description, Downstream Ref,
DSL Event Date, EOD PV Currency, EOD PV Delta, EOD PV Gamma, EOD PV Rho
(Domestic), EOD PV Rho (Foreign), EOD PV Theta, EOD PV Value, EOD PV Vega, External

Counterparty Code, Forward Rate, Instrument Type, Interest Rate, Lower Barrier, Max

Maturity Date, Min Maturity Date, MTM at booking, NDF Fixing Date, NMOSS Quote, Off-

System Deposit (X Only), Portfolio, Premium, Premium Currency, Principal (Base), Principal

(Term), RBS Buy/Sells, Rebate, Rebate Currency, Salesperson, Salesperson Code, Side, Spot

when Traded, Status, Structures Only, Swap Leg, Time Option Date, Trader with no AV,

Trading Centre, Trigger Date, Triggered, Upper Barrier and Value Date.

Fig12. XPortfolio report generation screen

An important distinction to make is the difference between a "deal level" report and a "structure level" report. The term "deal" refers to every single trade or transaction that has been agreed with a specific counterparty, whereas "structures" are a combination of individual deals grouped in a way that satisfies certain characteristics that are agreed between the bank and the customer. A report on the deal level is more extensive than a report on the structure level, given that the deal level list includes all the legs of every structure and transaction.

Once the criterion has been selected, there are columns that the report can show. These are the most commonly used: Counterparty, Currency Pair, Deal Reference, PV Currency, PV Value, Expiry Date, Headline Rate, Instrument Code, Strike, Structure Name, Structure Ref, System, Trade Date, Deal/Structure Ref.
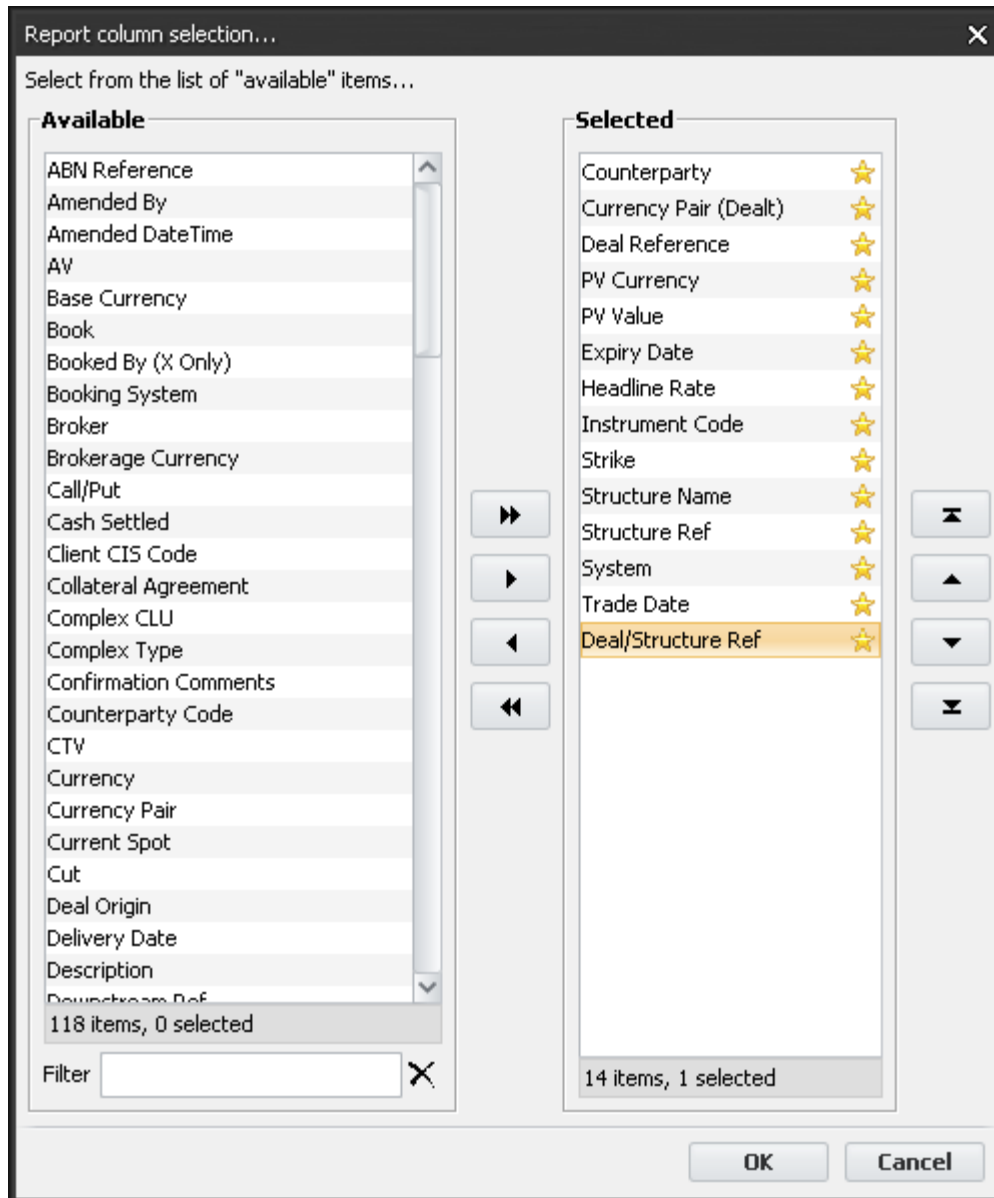
Fig13. XPortfolio report column selection

For our project purposes, we needed to source specific information regarding all trades
existing in portfolios with Counterparties that had credit concerns. We used XPortfolio to select
and capture data sourced through counterparty name and picked several counterparties as our
experimental data.

Once a report is created, there is an option available through selecting all existing trades that allows the user to have access to a Cash flow analysis of all the deals that appear on the report. This is a screenshot of one of the reports we used for analysis:

Fig14. Portfolio Structure Level Report for counterparty Ipeco Holdings Limited

This report has been created by using the Counterparty name: Ipeco Holdings Limited and shows their current transactions with RBS. All these trades involve an exchange of two different currencies, in this case pounds (GBP) and dollars (US).

The Cash flow analysis portrays how this currency exchange will occur in the future: on which dates, at which rate and for which amount.
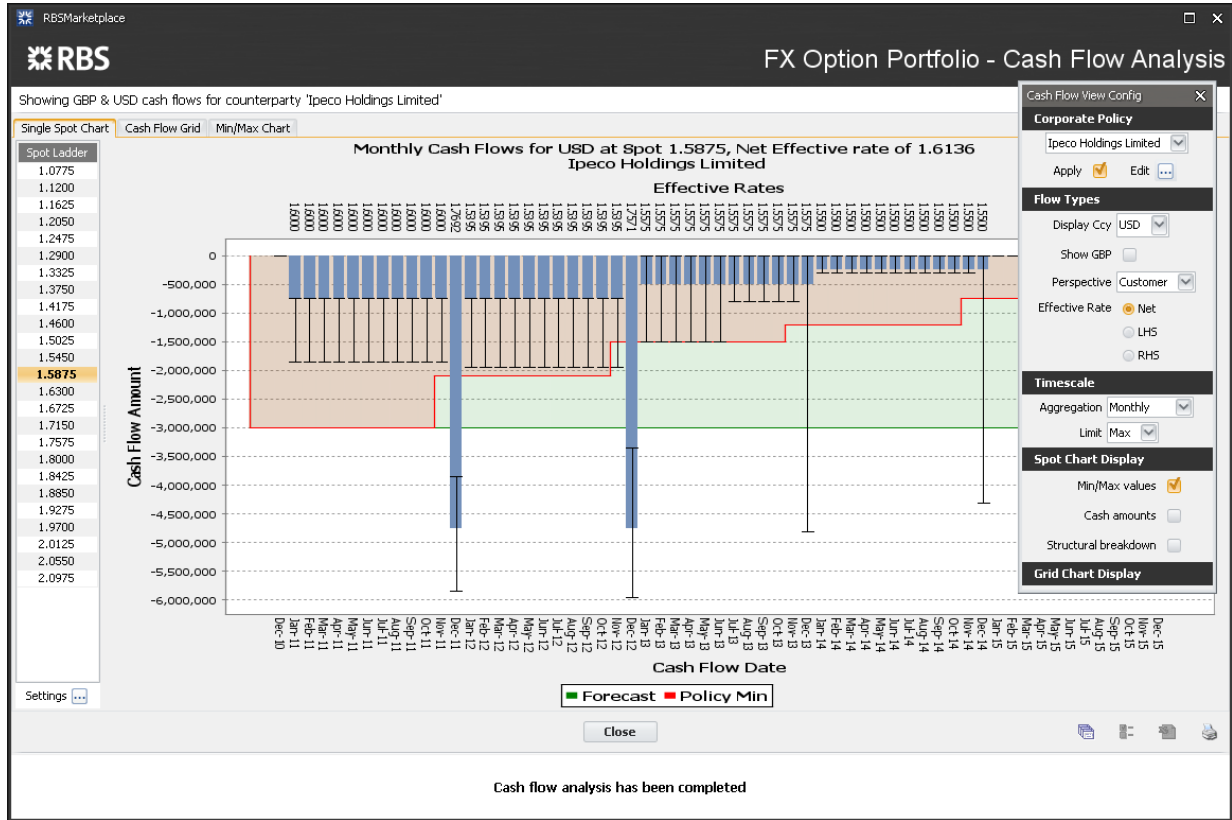
Fig15. Cash flow Analysis screen for counterparty Ipeco Holdings Limited

This application also has the functionality to show the sensitivity of cash flows to changes in spot movements according to a specified spot ladder that appears on the left. The cash flow grid is the data sourced for producing these graphs and it can be exported into an excel format.

Booking Systems

The FX industry has many legacy systems depending on the specific product being traded. RBS currently operates in three different systems for booking all FX transactions. Spots and forward deals are booked into one system called GFX, vanilla options are booked into the System X and complex options (which may include barriers) are booked into EcoRisk. Trade booking is dependent on industry innovations and the strategy is to consolidate the number of systems used for booking FX trades as much as possible to reduce risk and provide a better booking flow.

3. Methodology

Goals and Overall Project Plans

The goal of our project is to expand upon the current analysis of credit line utilization that the restructuring desk at RBS Global Banking and Markets division currently has. Our plan is to provide additional information on the meaning of credit line utilization for easiness of restructuring process and for helping the salespeople in their decision making process on credit constrained portfolios. The following is a project plan for our 7 weeks on site.

	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	⊟ Week 1/2	5 days?	Mon 10/25/10	Fri 10/29/10		
2	⊟ **Understanding team functions**	5 days?	Mon 10/25/10	Fri 10/29/10		**John,Ben**
3	Meeting appropiate people	5 days?	Mon 10/25/10	Fri 10/29/10		John,Ben
4	Understanding concept of CLU calculat	5 days?	Mon 10/25/10	Fri 10/29/10		John,Ben
5	⊟ **week 3/4**	15 days?	Mon 11/1/10	Fri 11/19/10		**John,Ben**
6	Implementation of method 1	5 days?	Mon 11/1/10	Fri 11/5/10	2	John,Ben
7	Implementation of method 2	5 days?	Mon 11/8/10	Fri 11/12/10	6	John,Ben
8	⊟ **Applying strategy 1 to excel analysis**	10 days?	Mon 11/8/10	Fri 11/19/10		**John,Ben**
9	Testing Strategy 1	5 days?	Mon 11/8/10	Fri 11/12/10		John,Ben
10	Reviewing strategy 1 with salespeople	5 days?	Mon 11/15/10	Fri 11/19/10	9	John,Ben
11	⊟ **week 5/6**	10 days?	Mon 11/22/10	Fri 12/3/10		
12	initial draft of MQP paper	10 days	Mon 11/22/10	Fri 12/3/10		Silvia,Yutong
13	⊟ **Applying Strategy 2 to excel analysis**	10 days?	Mon 11/22/10	Fri 12/3/10		**John,Ben**
14	Reviewing Strategy 2 with desk and sa	10 days?	Mon 11/22/10	Fri 12/3/10		John,Ben,Sales
15	Testing Strategy 2	10 days?	Mon 11/22/10	Fri 12/3/10		John,Ben
16	⊟ **week 7/8**	**10 days**	**Mon 12/6/10**	**Fri 12/17/10**		
17	Prepare final presentation	3 days	Mon 12/13/10	Wed 12/15/10		Silvia,Yutong
18	Install additional strategy analysis as needed	9 days	Mon 12/6/10	Thu 12/16/10		Silvia,Yutong
19	Deliver final presentation	1 day	Fri 12/17/10	Fri 12/17/10		Silvia,Yutong

Fig16. Microsoft Project Plan shown as a Gantt chart

Currently, we know that CLU is calculated by modelling the extreme possible future movements of the Exchange Rate according to a Confidence Interval using a volatility - or standard deviation – determined by the RBS Credit department. However, in order to expand our analysis, we have identified areas of focus for our project:

1. Gaining an understanding of the CLU calculation and how it is netted on a portfolio basis

2. Work with salespeople   to determine the optimal way of displaying CLU as a function of individual trade and future date

36

3. Using Excel to produce a working model that will focus on a portfolio of trades, calculate all the CLU's and display the results in such a way that the contribution from any individual trade can be isolated.

The final outcome of our project will be a tool incorporated in the bank's sales systems and available at each Salesperson desktop. In order to achieve this outcome, we will describe our initial project approach through explanations of our goals.

1. Gaining an understanding of the CLU calculation and how it is netted on a portfolio basis

As we have mentioned before, Credit Line Utilization is the maximum value in favour of the bank that a trade has at the 95th percentile of the spot movement that the market will experience in a specific time period. The CLU concept is a very complex idea since it varies according to many parameters. The nature of CLU is very particular given its dependency on each unique trade's credit consumption and maturity date. We will start explaining the credit line utilization concept by analysing different aspects that together form Credit Line Utilization.

The Credit Line Utilization puzzle was composed of many pieces that affect each specific trade. First, we dug on to the Across Time Ladders that provided a meaning to the time dependency of a trade. Secondly, we viewed the sensibility of a trade to the market moves. Moreover, we took into account the Credit Nature of a Portfolio to complete the basis for understanding the concept of Credit Line Utilization and finally we understood the insights of the statistical confidence interval analysis.

Time dependency - Across Time Ladders

Every trade has specific values throughout their maturity. Whenever a trade is performed, the values for that trade through time if viewed from today would differ from the values that the trade will have through time if viewed one month from now. The reasons behind this statement are related to the time value of money and the fluctuations of market prices, interest rates and price volatilities for various transactions.

To understand the time value of a trade, we use a financial product called an "Options Contract". This is a very simple and standard instrument that our desk trades and we analysed four different aspects of this contract: the bank buying a call, the bank selling a call, the bank buying a put and the bank selling a put.

Our first example is the situation where the bank buys an option to sell a specific currency at a predetermined price in a set future date; we would have the following profit and loss graph from the bank's perspective:
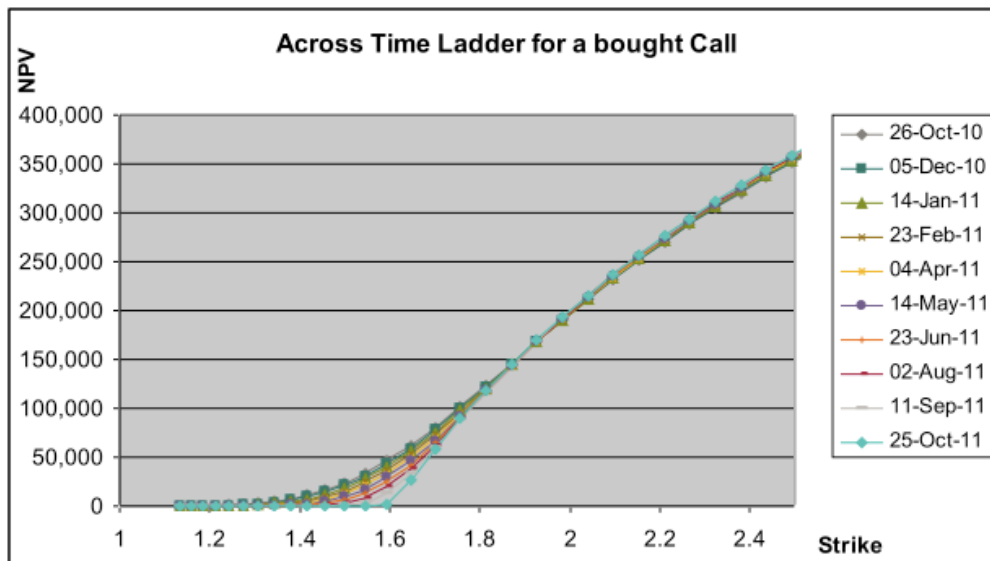
Fig17. Across Time Ladder Graph for a bought call including all maturity dates

This is an options contract with a one year maturity. The different curves on the graph explain us how the contract value is changing throughout the time that this contract is held for and also throughout the different movements in the strike price.

We can understand through this visual representation that as we increase time, the values of an option will be less skewed and will be more close to the resemblance of one half of a normal curve. On the next graph, we can appreciate this concept better as we have isolated the value of this option today and the value of this option in a year's time. The area between these two curves is referred to as "Added Value" (AV) and this is the extra profit brought to the firm by this options contract.
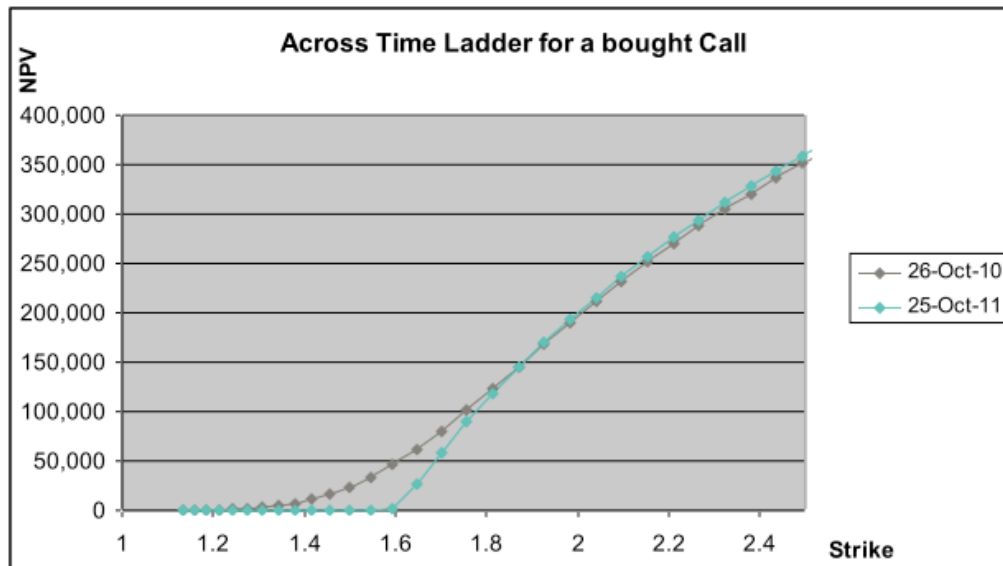
Fig18. Across Time Ladder Graph for a bought call with only two maturity dates

If we look at the other side of the transaction, from the customer's perspective, the contract's payoff profile will have the following pattern and it will have a similar behaviour to the previous graph whenever we isolate the maturity of the contract today and in a year's time:
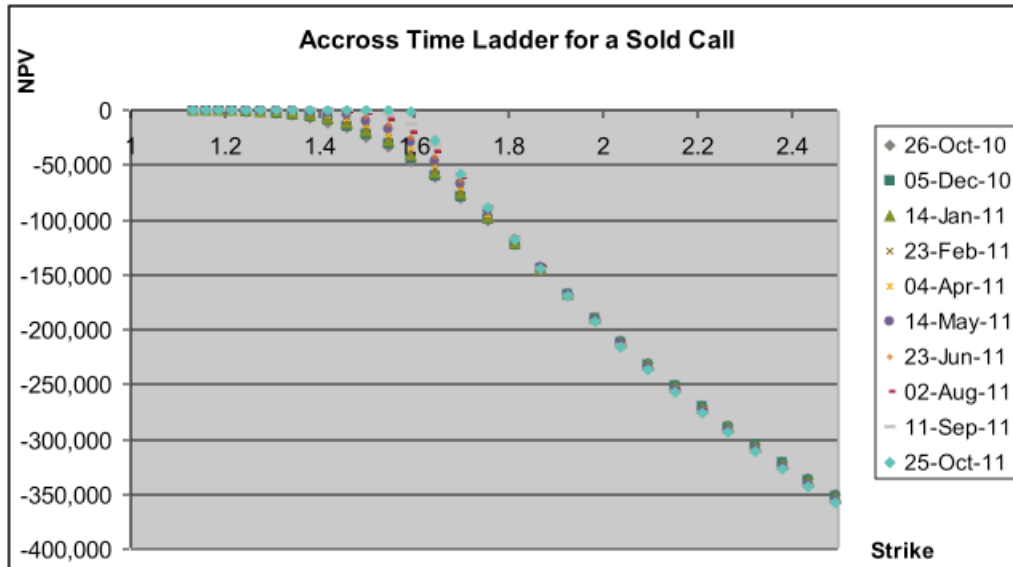
Fig19. Across Time Ladder Graph for a sold call including all maturity dates

Time Dependency- Maturity/Tenor Analysis

Continuing with the effect that time has throughout the maturity of a trade, we introduce a new variable into the Credit Line Utilization analysis which is the change in the Net Present Value of a trade throughout the market moves, which is what we refer to with the term Spot.

Whenever there is a trade with a given maturity, the value of this trade will vary according to the spot movements. If two sides of a trade agree to exchange two currencies at a given price, the value of this contract is subject to how much the market will pay for exchanging these two currencies. If the price agreed in the contract is less than what exchanging these currencies in the market will cost, then the value of the trade will be less than if the price agreed were higher than what the market agrees upon.

A transaction Net Present Value is subject to market moves. We will explain this statement on the following example:

This transaction is to exchange one million pounds to dollars at an agreed strike price of GBPUSD 1.5. It has a one year maturity. Whenever the market price for this exchange is exactly at 1.5, the value of this trade will only be of 23,261 pounds. It is a very low value considering a one million notional because we are predicting that the market will stay at the same value, so it is a contract that exactly "at the money". Whenever the market starts to move up to 1.55 and 1.6 we can see how the Net Present Value of this trade increases slowly, because now, this option will be more "in the money" and will be more likely to have a set price higher than the agreed 1.5 strike. Whoever has this contract and exercises, will earn much more than if the market price were to be 1.5 because now, they are only paying a rate of 1.5 for this exchange through this contract, rather than a rate of 1.7 for this exchange if they were to do it in the market.

Spot	NPV
1.5	23261
1.55	34626
1.6	48996
1.65	65848
1.7	84406

Fig20. Table of NPV values for each spot move
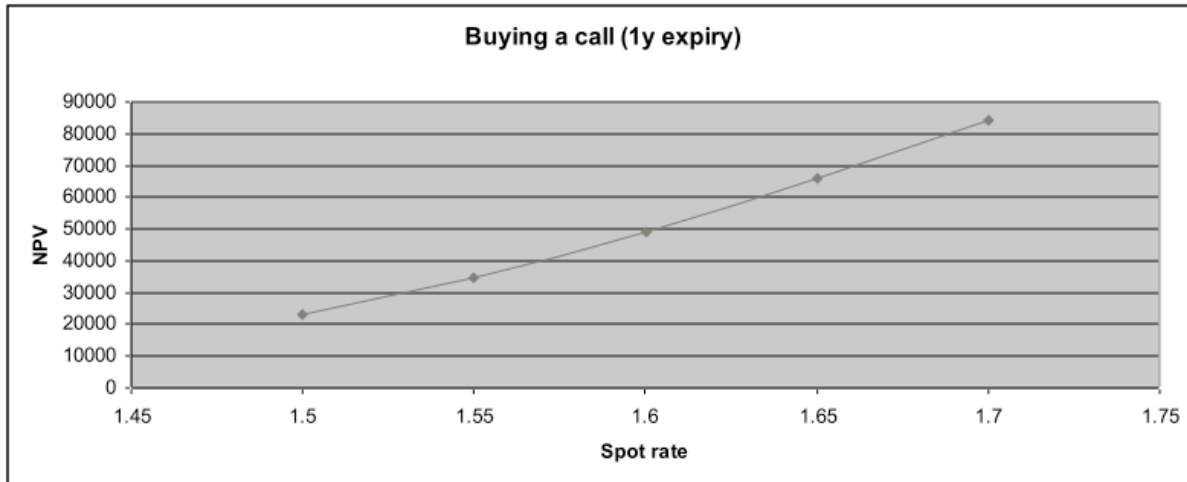
Fig21. Buying a call (1y expiry) graph

This graph shows us how with an increase in the spot rate, the Net Present Value of the contract increases as well. The value is higher because with an increase in spot, the side that will make a gain is more likely to experience the gain given that the market price is completely above the price they have agreed in their contract.

Portfolio Credit Nature

Given that we refer to the term Portfolio as a collection of trades, we would agree that any analysis we make in a portfolio would be the sum of the same analysis made on each individual trade that exist in this portfolio. This idea could be true when calculating overall profit but it is not the basis for the Credit Portfolio Calculations.

Each unique trade has a specific Credit Utilization, which is given by the highest Net Present Value that this trade will have with a 95% confidence interval of its spot movement, but this Credit Utilization is unique of that specific deal. If we are trying to get a value for the credit

consumption of a Portfolio, we could not add each individual trade credit consumption given the nature of credit.

The credit of a portfolio is not calculated by the addition of each single trade's credit consumption. The appropriate way to calculate the credit consumption of a portfolio is by considering the portfolio as one unique trade and thinking about the values of this "trade" throughout its maturity as the addition of all the trade values on each unique date. In other words, getting each single trade's credit contribution per each specific date of the portfolio and finding on which date is the highest Net Present Value.

Statistical Confidence Interval Analysis

One of the exercises we performed in our search for understanding the Credit Line Utilization concept was the Statistical Analysis behind all credit calculations. The NMOSS system provided us with Net Present Value calculations for every trade that we input. We used the values of a European Call and a European Put to figure out how their statistical behaviour affected the values of the CLU.

We have mentioned that the CLU is calculated based on the values of the spot movements across a 95th confidence interval. In the following example, our goal was to illustrate how given all the values of spot, the credit consumption of a trade follows a specific pattern across time as it reaches its credit line utilization.

The payoff profile of buying a European call will always have a positive slope, whereas the values for buying a European Put will have a negative slope. The nature of this two

instruments will guarantee that we will achieve the complete picture when graphing the spot movements across time and identifying the 95th percent confidence interval.

On NMOSS, we priced a European Call and a European Put with various notional amounts and various maturities and we recorded the spot values across our different theoretical experiments. The values are presented in the following table:

	EC	EP	EC	EP	EC	EP
	25000	25000	125000	125000	250000	250000
	95%		75%		50%	
	UL	LL	UL	LL	UL	LL
1 month	1.713	1.486	1.6657	1.5382	1.6392	1.5671
2	1.7658	1.4357	1.695	1.5129	1.6545	1.555
3	1.806	1.401	1.717	1.495	1.6685	1.546
6	1.9	1.324	1.768	1.4745	1.6985	1.539
9	1.981	1.268	1.808	1.428	1.7215	1.514
1 year	1.993	1.251	1.819	1.429	1.73	1.5035

Fig22. Table of confidence interval spot moves across time

We selected notionals of 25,000, 125,000 and 250,000 since these are the Net Present Values of European Calls for the given confidence intervals of 95%, 75% and 50%. This means that in a given contract of a European call for GBPUSD 1 million and a strike of 1.6 for a one year contract, if we want the Net Present Value of the trade to be 250,000, we would need the spot to be at 1.993. It is a reverse way of finding the Net Present Value of a trade so that we can understand its statistical meaning. With the values from this table, we are able to gather the following spot values for the different confidence interval curves at maturities of one, two, three, six, nine and twelve months.

Confidence Interval graphs

	1	2	3	6	9	12
UL 95	1.713	1.7658	1.806	1.9	1.981	1.993
LL 95	1.486	1.4357	1.401	1.324	1.268	1.251
UL 75	1.6657	1.695	1.717	1.768	1.808	1.819
LL 75	1.5382	1.5129	1.495	1.4565	1.428	1.429
UL 50	1.6392	1.6545	1.6685	1.6985	1.7215	1.73
LL 50	1.5671	1.555	1.546	1.528	1.514	1.5035

Fig23. Consolidated table of confidence interval graphs

For a 50% confidence interval of spot movement, this is the graph we would obtain based on the values that appear on Figure 24:

50% Confidence Interval

	1	2	3	6	9	12
UL	1.6392	1.6545	1.6685	1.6985	1.7215	1.73
LL	1.5671	1.555	1.546	1.528	1.514	1.5035

Fig24. 50% Confidence Interval Table
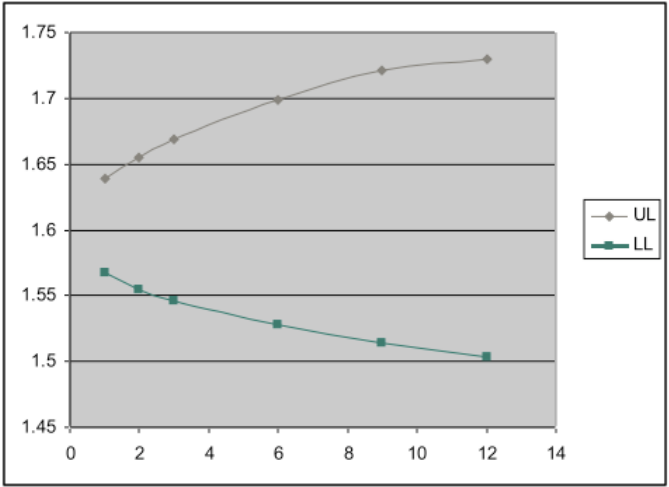
Fig25. 50% Confidence Interval Graph

The different dots are representations of Net Present Values that the trade is experiencing across time. The lines depict the spot movements across the different maturities of the trade. We have built in this previous graph a 50% confidence interval that tells us, in this specific example, that we have a 50% certainty that the spot will be at 1.651 when the trade has a two month tenor. The UL (Upper Limit) values are the ones from the European Call and the lower limit values are the ones from the European Put.

If we extend our analysis into a 75% confidence interval, these are the values we would see:

75% Confidence Interval graph						
	1	**2**	**3**	**6**	**9**	**12**
UL	1.6657	1.695	1.717	1.768	1.808	1.819
LL	1.5382	1.5129	1.495	1.4565	1.428	1.429

Fig26. 75% Confidence Interval Table
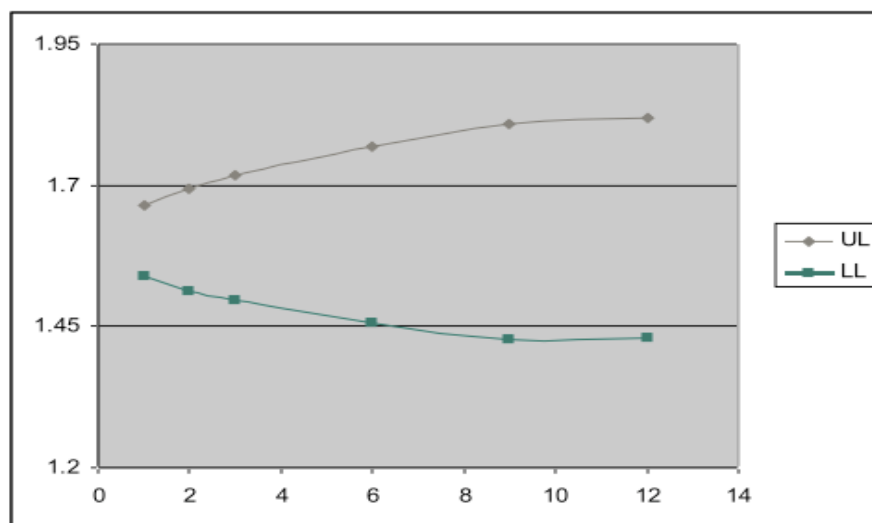
Fig27. 75% Confidence Interval Graph

And these are the values for a 95% confidence interval:

95% Confidence Interval						
	1	2	3	6	9	12
UL	1.713	1.7658	1.806	1.9	1.981	1.993
LL	1.486	1.4357	1.401	1.324	1.268	1.251

Fig28. 95% Confidence Interval Table
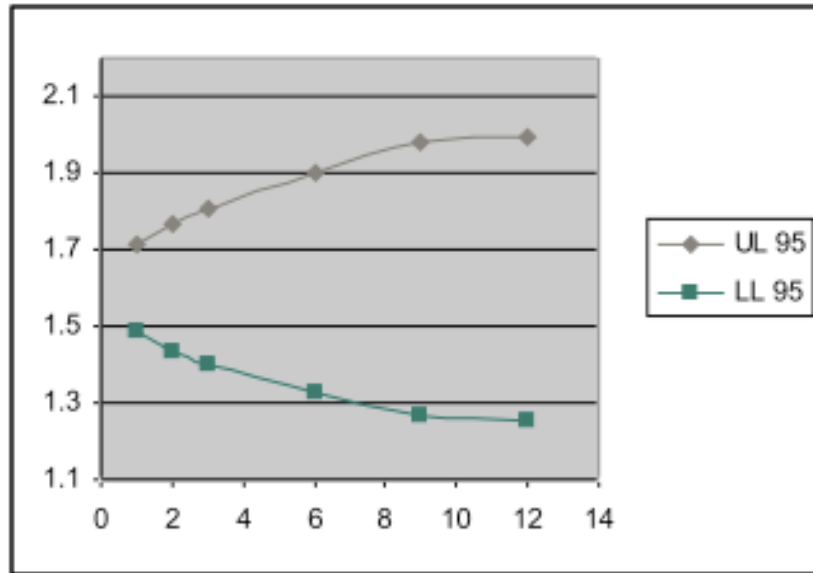
Fig29. 95% Confidence Interval Graph

For credit calculations, we use a 95% confidence interval, given that it provides us with a broader picture of how the market will behave. Consolidating all previous graphs into one, we would get the following representation:

47
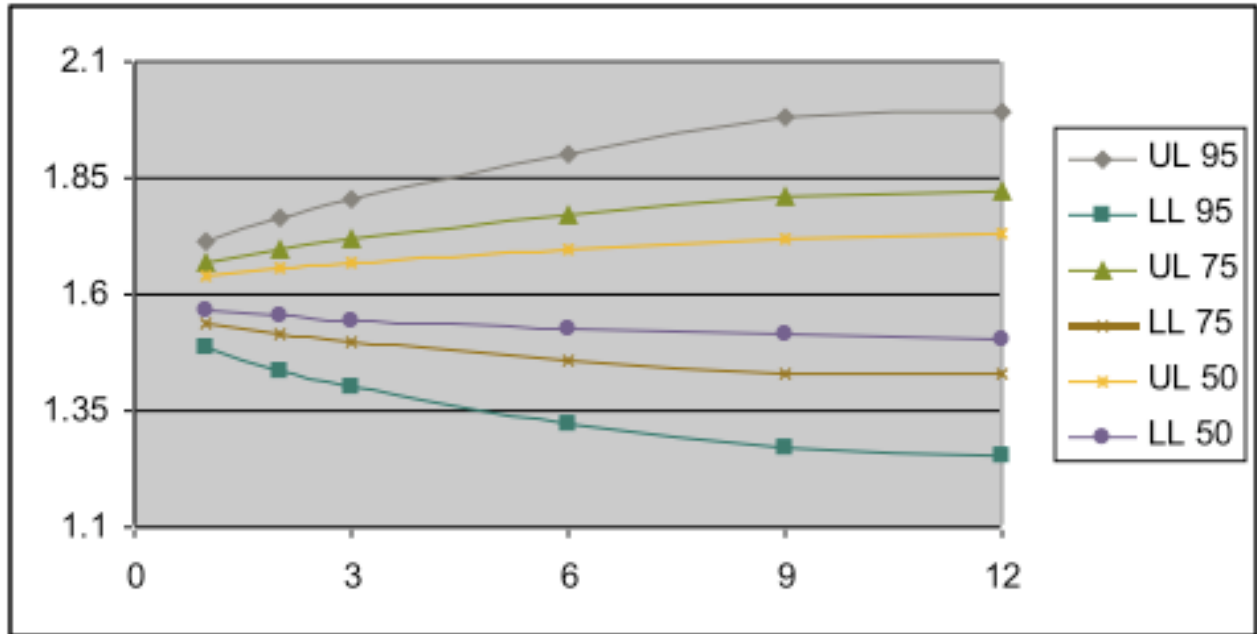
Fig30. Consolidated Graph Including all confidence interval paths

Here we see how the spot will vary according to the maturity of a given trade. The credit line Utilization for a one year contract will be the final dot on the UL 95 line for a European Call which will show a specific Net Present Value, in turn meaning the Credit Line Utilization.

For gaining a better understanding of CLU calculation, we decided to provide an analogy related to a linear programming function which we called "the juice analogy".

Juice Analogy

In the juice analogy, we consider a portfolio that consists of two trades with three maturing dates. A trade can be any kind of liquid, such as water, juice, milk, etc where each type of liquid corresponds to a different Foreign Exchange (FX) product.   A bucket with a capacity of ten gallons is assigned to this counterparty on each of the three dates. Each trade fills up certain space in each bucket. The volume in each bucket is equivalent to the credit usage. The

48

amount of maximum usage out of the three buckets is considered the Credit Line Utilization of this counterparty. Whenever one of the three buckets reaches its maximum capacity, no more transactions can be done since the Credit Line Utilization is full. The idea of this analogy is to portray in a much more didactic manner what are the current CLU issues and possible solutions.

Issue

As shown in Figure 2 for the current circumstance, Trade one fills one gallon of the first bucket, five gallons of the second bucket and three gallons of the third bucket while Trade two fills four gallons of the first bucket, five gallons of the second bucket and two gallons of the third bucket. The CLU is equal to the volume of the second bucket that has the most amount of liquid (ten gallons). In this case, the CLU has reached its limit.

However, current analysis does not display these facts in an easy way. The only thing data displayed would be the maximum volume of the bucket, which is ten gallons. The reason for this resides on the large data amount involved and complicated process to research on further details on the specific information on the contribution of the CLU peak dates. We are not able to tell what the components of the maximum bucket are and what the credit usage of the other buckets.

In the following graph, you can see the three buckets with specific amount of credit line utilization for each trade. Trade one is represented in blue whereas trade two is represented in red.
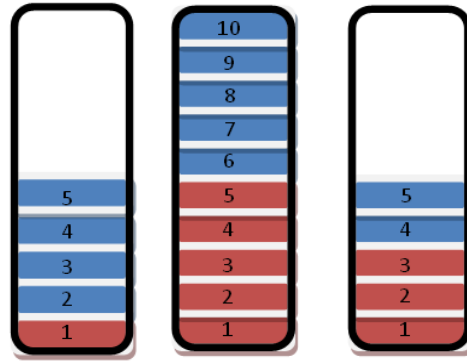
Fig31. Initial Credit Line Utilization on trades one and two

Solution

If we are able to research more on the specific components of this portfolio, we would see how each trade occupies certain space in each bucket. This will provide more information for the basis of possible restructuring evaluation of the whole portfolio. We would like to find out that trade one only fills one gallon in the first bucket but it occupies five gallons in bucket two. This piece of information will be critical in the analysis of moving part of trade one from the second bucket to the first one.
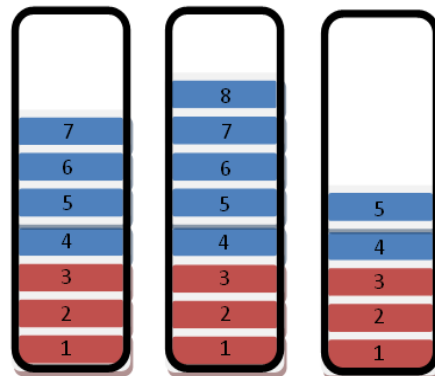
Fig32: Final Credit Line Utilization of Trades one and two after restructuring

Impact

In Figure three, we can see how we moved two gallons of trade one from the second bucket to the first bucket. Now, we have a new portfolio, where trade one fills three gallons on each of the three buckets while trade two remains the same. The total usage of the three buckets now becomes seven gallons, eight gallons and five gallons. This restructuring has made the CLU go from ten to eight gallons. Currently, we have freed up some space for another possible trade that can take three gallons on the first bucket, two gallons on the second bucket and five gallons from on the third bucket.

If the Credit Line Utilization of a counterparty is full, the bank can not do any more transactions with this customer. The customer loses coverage on important cash flows that will now be at risk of the market move and RBS loses business with the customer as well as possible trade opportunities. After our analysis, we will be giving RBS a better view of the credit contribution of each single expiry date and that will provide RBS with a way to free up Credit Space and be able to keep doing transactions with the customer and keep bringing revenue to the firm without having any credit obstacles.

2. Working with Salespeople to determine the optimal way of displaying CLU as a function of individual trade and future trade

After we investigated the CLU concept and all its variables, we then started to build our project prototype by taking into consideration three Portfolio Optimization of CLU strategies. We then consulted with different salespeople their opinion on these strategies as we also looked for additional strategies they used for lowering the CLU of a Portfolio.

Another aspect that was mentioned during our talks with Salespeople was in regards to the existence of Credit Teams and relationship managers for each specific client. These people would work in conjunction with the salesperson to identify if an exception could be made for a specific client in terms of its credit consumption or if additional credit could be extended to the counterparty for any additional trade.

Our tool was more focused to the Structure's goal, so we decided to narrow our search to include strategies only from a restructuring perspective and these were the three we discovered:

1. Portfolio Restructuring

2. Buying New Vanilla Options

3. Deposits

Details on each strategy and an extensive explanation of our tool will appear in our Data and Analysis section.

3. Using Excel to produce a working model for depicting our Credit Line Utilization Analysis

Our project outcome will take the form of an excel spread sheet analysis. We incorporated VBA functionality, macros and formulas if needed as well as other tools within excel to ensure an easy Graphical User Interface (GUI) for Salespeople to use in providing a better service for the client and bringing as much profit as possible for the firm.

Our project shows an analysis of the current CLU for every specific trade date as well as details and components of other trades on other dates giving a better explanation to the measurement behind credit line utilization on each specific date.

We started by working with two strategies developed by the desk and applied them to a counterparty. Additionally, we developed a new approach to analysing CLU which turned into an additional Portfolio CLU Optimization strategy.

The excel workflow tool we built is divided into three main categories which are the three CLU optimization strategies:

The first strategy we found for lowering the Credit Line Utilization of a portfolio is based on the relationship between the portfolio CLU and the notionals of each unique trade. There are various inputs that could be change in every trade, but the one that had a direct relationship with the portfolio CLU was the notional amount.

We discovered through our NMOSS exercises that whenever we lowered the notional amount of a trade by a certain amount, the portfolio CLU would also be lowered by a specific amount because there was a direct relationship between the Net Present Value of a specific trade and the CLU of the entire portfolio.

In order to illustrate this point, we will use the following example: a portfolio is composed of two trades, both with a one year maturity and with different Net Present Values.

4. Data and Analysis
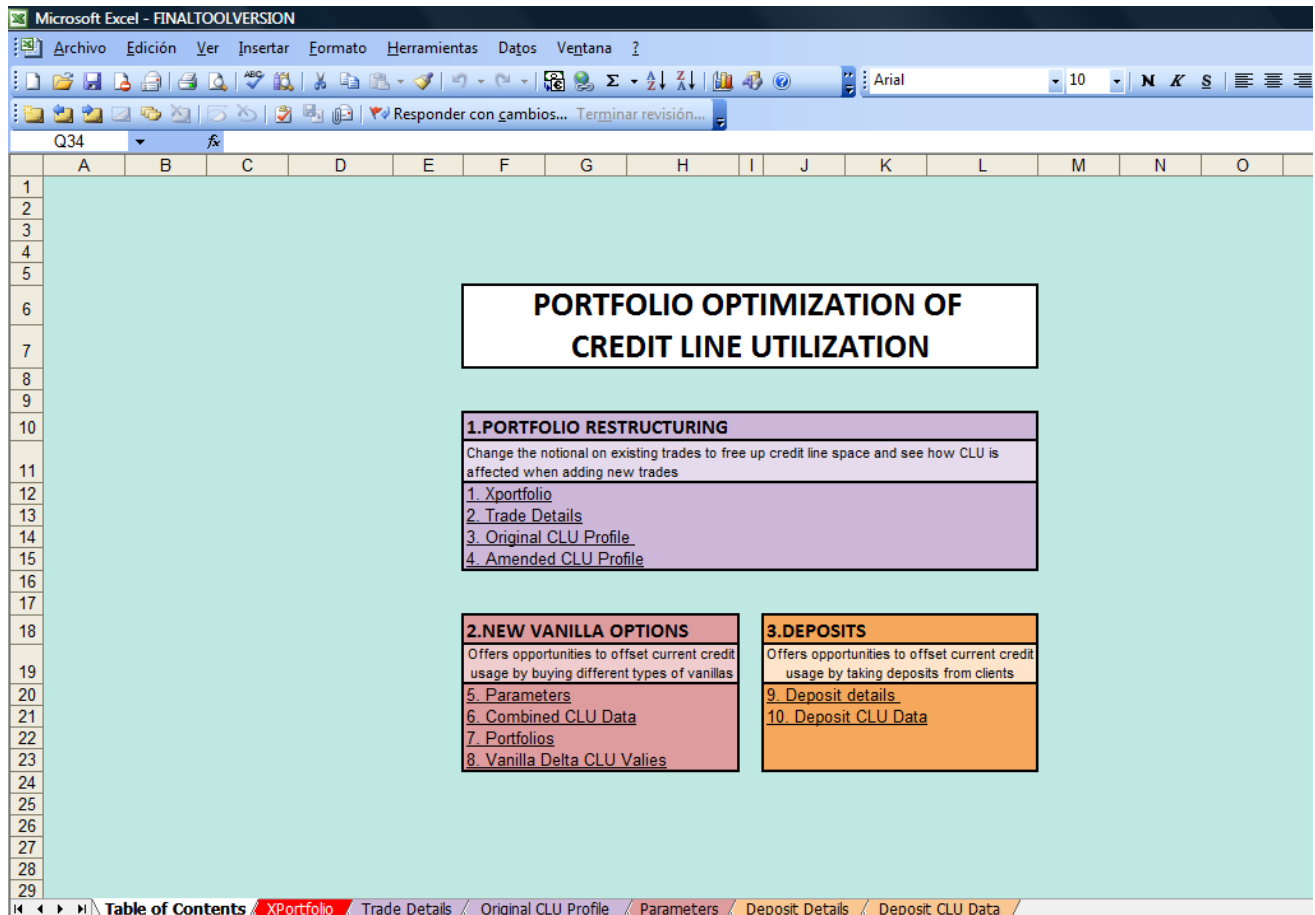
Fig33. Screenshot of the Table of Contents tab from our tool

This is the main interface of our tool. This panel shows the three main strategies which are hyperlinked to each specific tab. Each colour represents a different strategy that uses certain indicators to show information in a clear way.

Data Sources

The two main data sources of our tool are XPortfolio and NMOSS. We selected these two programs for many reasons including the fact that they provide real time CLU data and also help create reporting on all deals for a specific counterparty.

NMOSS has the ability to show CLU contribution for a specific deal but we needed to compile every single deal done with a specific counterparty. Adding each deal on to NMOSS and pricing all the deals was not a feasible solution to source data from our tool, given that it would have been very time consuming to add all the details and each leg encompasses different characteristics. This is why we decided to use data straight from XPortfolio and we took advantage of the cash flow analysis application that this system provides.

We first ran a structure level report from XPortfolio to obtain a list of all the different contracts that we had for a specific counterparty. One of our main obstacles was the lack of CLU information available on NMOSS. NMOSS only shows CLU data from an overall portfolio, but this application did not have the ability to show the contribution from each specific trade. Having this CLU contribution breakdown was an important requirement for our main restructuring strategy since we needed to show CLU for each specific expiry date on our portfolio. A screenshot of this report is shown in Figure 12.

Once we had this initial structure level report from XPortfolio, we obtained a cash flow analysis for this specific counterparty. This analysis showed all the different currency exchanges that would occur with this counterparty for all different spot movements across a specific spot ladder at any date in the future. The graph shows specific cash flow amounts and their strike price and uses data on the hedging policy for a specific counterparty. Please refer to figure 13 for more detail. All the data that appears in the cash flow graph is also shown in a table format in the cash flow grid tab of the cash flow analysis. This tab has an option to export data into an excel file. This was the end file used for our tool.

With this information, we set up a single NMOSS file to encompass all information from a given portfolio. In our analysis, the file had the following characteristics:
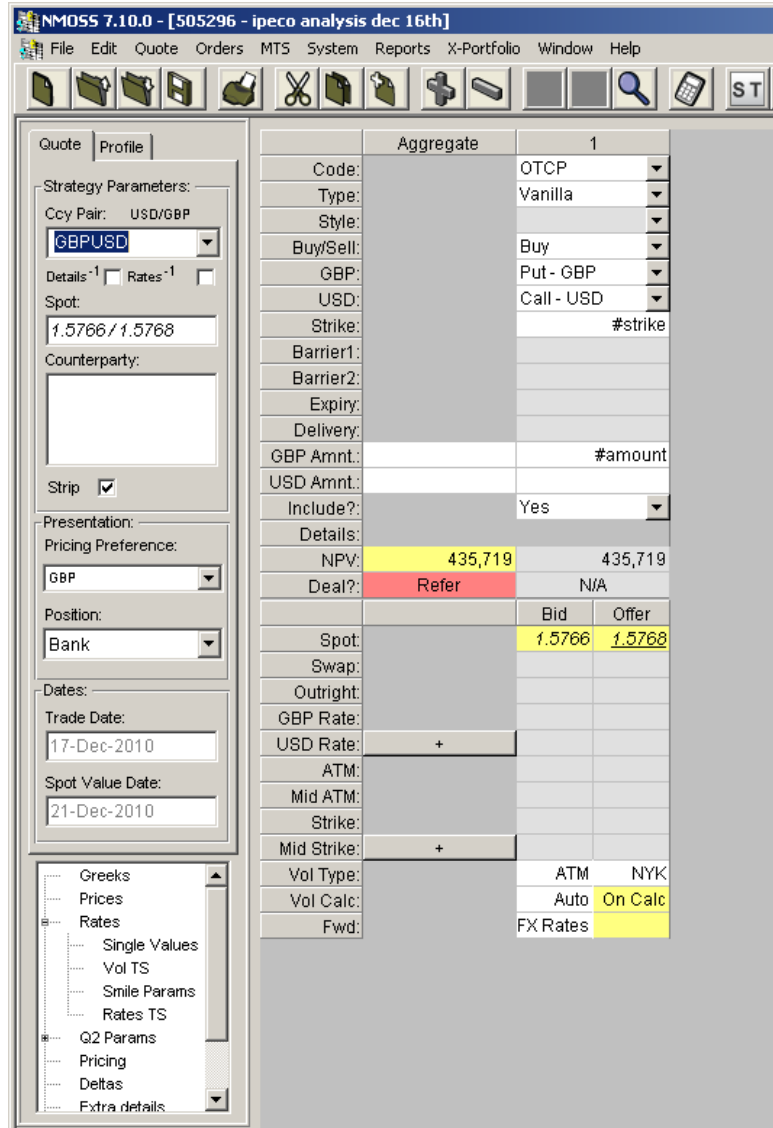
Fig34. NMOSS Screenshot of Ipeco Analysis

Our main example was using the client Ipeco and they generally trade the GBPUSD currency pair. We set them up to buy a put on with different strikes and different notional amounts. These actions are represented by using #strike and #strike on those fields.

NMOSS has a functionality called "Strips" in which you can tell the system to breakdown any data according to notional, strikes or any other data input. We took advantage of this functionality to include data extracted from XPortfolio of each specific strike and notional amount and that way NMOSS could show us individual CLU contributions for each specific expiry date. The following is a screenshot of our strip screen

NMOSS 7.10.0 - [505296 - ipeco analysis dec 16th]

Expiry	Delivery	strike	amount (GBP)	Swap Bid	Swap Offer	Base Bid	Base Offer	Quote	NPV	Delta	Gamma	Vega	Th
Tue 04-Jan-2011	Thu 06-Jan-2011	1.6060	0.0100	-0.0002	-0.0002	0.5290	0.5290	-0.0	0	0	0	0	
Fri 04-Feb-2011	Tue 08-Feb-2011	1.6060	0.0100	-0.0006	-0.0005	0.5481	0.5481	0.1	0	0	0	0	
Fri 04-Mar-2011	Tue 08-Mar-2011	1.6060	0.0100	-0.0009	-0.0009	0.5716	0.5716	0.2	0	0	0	0	
Mon 04-Apr-2011	Wed 06-Apr-2011	1.6060	0.0100	-0.0013	-0.0013	0.6348	0.6348	0.3	0	0	0	0	
Wed 04-May-2011	Fri 06-May-2011	1.6060	0.0100	-0.0018	-0.0017	0.7130	0.7130	0.3	0	0	0	0	
Mon 06-Jun-2011	Wed 08-Jun-2011	1.6060	0.0100	-0.0024	-0.0023	0.7813	0.7813	0.4	0	0	0	0	
Mon 04-Jul-2011	Wed 06-Jul-2011	1.6060	0.0100	-0.0030	-0.0028	0.8516	0.8516	0.4	0	0	0	0	
Thu 04-Aug-2011	Mon 08-Aug-2011	1.6060	0.0100	-0.0037	-0.0035	0.9436	0.9436	0.5	0	0	0	0	
Mon 05-Sep-2011	Wed 07-Sep-2011	1.6060	0.0100	-0.0043	-0.0041	1.0166	1.0166	0.6	0	0	0	0	
Tue 04-Oct-2011	Thu 06-Oct-2011	1.6060	0.0100	-0.0050	-0.0047	1.0798	1.0798	0.6	0	0	0	0	
Fri 04-Nov-2011	Tue 08-Nov-2011	1.7474	0.0100	-0.0058	-0.0055	1.1446	1.1446	0.6	0	0	0	0	
Mon 05-Dec-2011	Wed 07-Dec-2011	1.6060	0.0100	-0.0065	-0.0061	1.1964	1.1964	0.7	0	0	0	0	
Wed 04-Jan-2012	Fri 06-Jan-2012	1.5543	0.0100	-0.0072	-0.0067	1.2282	1.2282	0.7	0	0	0	0	
Mon 06-Feb-2012	Wed 08-Feb-2012	1.5543	0.0100	-0.0080	-0.0074	1.2441	1.2441	0.7	0	0	0	0	
Mon 05-Mar-2012	Wed 07-Mar-2012	1.5543	0.0100	-0.0087	-0.0079	1.2566	1.2566	0.7	0	0	0	0	
Wed 04-Apr-2012	Tue 10-Apr-2012	1.5543	0.0100	-0.0095	-0.0086	1.2708	1.2708	0.7	0	0	0	0	
Fri 04-May-2012	Wed 09-May-2012	1.5543	0.0100	-0.0102	-0.0092	1.2821	1.2821	0.7	0	0	0	0	
Mon 04-Jun-2012	Thu 07-Jun-2012	1.5543	0.0100	-0.0109	-0.0098	1.2928	1.2928	0.7	0	0	0	0	
Wed 04-Jul-2012	Fri 06-Jul-2012	1.5543	0.0100	-0.0116	-0.0104	1.3029	1.3029	0.7	0	0	0	0	
Mon 06-Aug-2012	Wed 08-Aug-2012	1.5543	0.0100	-0.0124	-0.0110	1.3138	1.3138	0.8	0	0	0	0	
Tue 04-Sep-2012	Thu 06-Sep-2012	1.5543	0.0100	-0.0131	-0.0116	1.3229	1.3229	0.8	0	0	0	0	
Thu 04-Oct-2012	Tue 09-Oct-2012	1.5543	0.0100	-0.0139	-0.0122	1.3327	1.3327	0.8	0	0	0	0	
Mon 05-Nov-2012	Wed 07-Nov-2012	1.5543	0.0100	-0.0146	-0.0128	1.3410	1.3410	0.8	0	0	0	0	
Tue 04-Dec-2012	Thu 06-Dec-2012	1.7144	0.0100	-0.0153	-0.0134	1.3489	1.3489	0.8	0	0	0	0	
Fri 04-Jan-2013	Tue 08-Jan-2013	1.5823	0.0100	-0.0160	-0.0139	1.3804	1.3804	0.8	0	0	0	0	
Mon 04-Feb-2013	Wed 06-Feb-2013	1.5823	0.0100	-0.0166	-0.0144	1.4233	1.4233	0.9	0	0	0	0	
Mon 04-Mar-2013	Wed 06-Mar-2013	1.5823	0.0100	-0.0172	-0.0148	1.4633	1.4633	0.9	0	0	0	0	
Thu 04-Apr-2013	Mon 08-Apr-2013	1.5823	0.0100	-0.0179	-0.0153	1.5086	1.5086	0.9	0	0	0	0	
Mon 06-May-2013	Wed 08-May-2013	1.5823	0.0100	-0.0185	-0.0158	1.5484	1.5484	1.0	0	0	0	0	
Tue 04-Jun-2013	Thu 06-Jun-2013	1.5823	0.0100	-0.0192	-0.0162	1.5855	1.5855	1.0	0	0	0	0	
Thu 04-Jul-2013	Mon 08-Jul-2013	1.5569	0.0100	-0.0198	-0.0167	1.6252	1.6252	1.1	0	0	0	0	
Mon 05-Aug-2013	Wed 07-Aug-2013	1.5569	0.0100	-0.0205	-0.0172	1.6611	1.6611	1.1	0	0	0	0	
Wed 04-Sep-2013	Fri 06-Sep-2013	1.5569	0.0100	-0.0211	-0.0177	1.6960	1.6960	1.1	0	0	0	0	
Fri 04-Oct-2013	Tue 08-Oct-2013	1.5569	0.0100	-0.0217	-0.0182	1.7320	1.7320	1.2	0	0	0	0	
Mon 04-Nov-2013	Wed 06-Nov-2013	1.5569	0.0100	-0.0224	-0.0186	1.7638	1.7638	1.2	0	0	0	0	
Wed 04-Dec-2013	Fri 06-Dec-2013	1.7583	0.0100	-0.0230	-0.0191	1.7957	1.7957	1.2	0	0	0	0	
Mon 06-Jan-2014	Wed 08-Jan-2014	1.5500	0.0100	-0.0236	-0.0195	1.8335	1.8335	1.3	0	0	0	0	
Tue 04-Feb-2014	Thu 06-Feb-2014	1.5500	0.0100	-0.0240	-0.0197	1.8691	1.8691	1.3	0	0	0	0	
Tue 04-Mar-2014	Thu 06-Mar-2014	1.5500	0.0100	-0.0243	-0.0199	1.9027	1.9027	1.3	0	0	0	0	
Fri 04-Apr-2014	Tue 08-Apr-2014	1.5500	0.0100	-0.0248	-0.0202	1.9413	1.9413	1.4	0	0	0	0	
Mon 05-May-2014	Wed 07-May-2014	1.5500	0.0100	-0.0252	-0.0205	1.9744	1.9744	1.4	0	0	0	0	
Wed 04-Jun-2014	Fri 06-Jun-2014	1.5500	0.0100	-0.0256	-0.0207	2.0078	2.0078	1.5	0	0	0	0	
Fri 04-Jul-2014	Tue 08-Jul-2014	1.5500	0.0100	-0.0261	-0.0210	2.0426	2.0426	1.5	0	0	0	0	
Mon 04-Aug-2014	Wed 06-Aug-2014	1.5500	0.0100	-0.0264	-0.0212	2.0734	2.0734	1.5	0	0	0	0	
Thu 04-Sep-2014	Mon 08-Sep-2014	1.5500	0.0100	-0.0269	-0.0215	2.1077	2.1077	1.6	0	0	0	0	

		strike	amount (GBP)	Swap Bid	Swap Offer	Base Bid	Base Offer	Quote	NPV GBP	Delta USD	Gamma USD	Vega GBP	Theta GBP
Aggregate:		77.9012	2,216,066.4800	-0.7422	-0.6201	71.5232	71.5232	47.9	435,719	2,621,988	37,540	16,562	
Average:		1.5898	45,225.8465	-0.0151	-0.0127	1.4597	1.4597	0.9	8,892	53,510	766	338	

Fig35. NMOSS Strips of the Ipeco Analysis

The delivery dates correspond to the dates on the cash flow screen aggregated monthly and strikes are also similar. To obtain each individual date contribution, we set up the specific notional amount for a specific date and used a notional of 0.0100 for the rest of the dates. This

way, whenever we ran the CLU screen, we would obtain the Credit consumption of the specified

date with its specified notional amount.

Data Feeding

Based on the two data sources, we are able to get necessary inputs for the tool. With

XPortfolio, we are able to provide all inputs that users will need to get credit calculation of each

leg in the portfolio from NMOSS. After inputting in NMOSS, users will get credit calculation of

each leg and then feed this information in our tool to get indicator results.

| C2		fx	Total															
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Back			0.99	0.99	Strikes	Abs. Strike		Delivery Date	PV Value	PV Ccy	PV Delta		Agg. Delivery Agg. PV					
		Total	48,063,532	-78,200,000				20-Jan-11	-9,382	GBP	47,428		Agg. Delivery	Agg. PV		Assumptions:		
		Dec-10	0	0				20-Jan-11	-341	GBP	-26,545		Delivery Date	PV total				
	1	Jan-11	902,859	-1,450,000	-1.6060	1.6060		20-Jan-11	6	GBP	9		20-Jan-11	5486	1. Cash flows from the Customer's perspective			
	2	Feb-11	902,859	-1,450,000	-1.6060	1.6060		20-Jan-11	15,203	GBP	-380,437		26-Jan-11	5157	2. Current spot of 1.5 on cash flow analysis			
	3	Mar-11	902,859	-1,450,000	-1.6060	1.6060		26-Jan-11	-1,631	GBP	-100,185		2-Feb-11	4930	3. Cash flow values considering the least spot can			
	4	Apr-11	902,859	-1,450,000	-1.6060	1.6060		26-Jan-11	6,788	GBP	-183,948		17-Feb-11	9326	4. Data on column D is for the GBP currency			
	5	May-11	902,859	-1,450,000	-1.6060	1.6060		2-Feb-11	-2,110	GBP	-111,956		24-Feb-11	4247	5. Data on column E is for the other currency			
	6	Jun-11	902,859	-1,450,000	-1.6060	1.6060		2-Feb-11	7,040	GBP	-178,036		2-Mar-11	4082	6. Assumes cashflows have a timescale daily aggr			
	7	Jul-11	902,859	-1,450,000	-1.6060	1.6060		17-Feb-11	-6,387	GBP	-25,258		17-Mar-11	11615				
	8	Aug-11	902,859	-1,450,000	-1.6060	1.6060		17-Feb-11	-1,040	GBP	-47,411		28-Mar-11	3371				
	9	Sep-11	902,859	-1,450,000	-1.6060	1.6060		17-Feb-11	63	GBP	1,200		4-Apr-11	3180				
	10	Oct-11	902,859	-1,450,000	-1.6060	1.6060		17-Feb-11	16,690	GBP	-338,508		19-Apr-11	13876				
	11	Nov-11	3,118,925	-5,450,000	-1.7474	1.7474		24-Feb-11	-3,553	GBP	-136,546		28-Apr-11	2546				
	12	Dec-11	902,859	-1,450,000	-1.6060	1.6060		24-Feb-11	7,800	GBP	-165,657		4-May-11	2453				
	13	Jan-12	1,254,621	-1,950,000	-1.5543	1.5543		2-Mar-11	-3,903	GBP	-141,006		18-May-11	15287	Aggregate NPV's for unique dates			
	14	Feb-12	1,254,621	-1,950,000	-1.5543	1.5543		2-Mar-11	7,985	GBP	-163,403		26-May-11	1932				
	15	Mar-12	1,254,621	-1,950,000	-1.5543	1.5543		17-Mar-11	-5,040	GBP	-18,200		2-Jun-11	1791				
	16	Apr-12	1,254,621	-1,950,000	-1.5543	1.5543		17-Mar-11	-1,750	GBP	-58,787		17-Jun-11	16720				
	17	May-12	1,254,621	-1,950,000	-1.5543	1.5543		17-Mar-11	211	GBP	6,546		27-Jun-11	1316				
	18	Jun-12	1,254,621	-1,950,000	-1.5543	1.5543		17-Mar-11	18,194	GBP	-315,549		5-Jul-11	1174	Clear NPV values			
	19	Jul-12	1,254,621	-1,950,000	-1.5543	1.5543		28-Mar-11	-5,418	GBP	-156,326		19-Jul-11	18157				
	20	Aug-12	1,254,621	-1,950,000	-1.5543	1.5543		28-Mar-11	8,789	GBP	-155,625		26-Jul-11	725				
	21	Sep-12	1,254,621	-1,950,000	-1.5543	1.5543		4-Apr-11	-5,830	GBP	-159,680		2-Aug-11	594				
	22	Oct-12	1,254,621	-1,950,000	-1.5543	1.5543		4-Apr-11	9,010	GBP	-153,910		17-Aug-11	19306				
	23	Nov-12	1,254,621	-1,950,000	-1.5543	1.5543		19-Apr-11	-3,939	GBP	-14,959		26-Aug-11	143				
	24	Dec-12	3,470,687	-5,950,000	-1.7144	1.7144		19-Apr-11	-2,550	GBP	-67,250		2-Sep-11	26				
	25	Jan-13	947,960	-1,500,000	-1.5823	1.5823		19-Apr-11	444	GBP	15,548		19-Sep-11	20592				
	26	Feb-13	947,960	-1,500,000	-1.5823	1.5823		19-Apr-11	19,921	GBP	-298,288		27-Sep-11	-346				
	27	Mar-13	947,960	-1,500,000	-1.5823	1.5823		28-Apr-11	-7,202	GBP	-169,084		4-Oct-11	-454				
	28	Apr-13	947,960	-1,500,000	-1.5823	1.5823		28-Apr-11	9,748	GBP	-149,067		19-Oct-11	21636				
	29	May-13	947,960	-1,500,000	-1.5823	1.5823		4-May-11	-7,414	GBP	-170,288		26-Oct-11	-790				
	30	Jun-13	947,960	-1,500,000	-1.5823	1.5823		4-May-11	9,867	GBP	-148,427		2-Nov-11	-890				
	31	Jul-13	513,851	-800,000	-1.5569	1.5569		18-May-11	-3,515	GBP	-9,835		17-Nov-11	22576				
	32	Aug-13	513,851	-800,000	-1.5569	1.5569		18-May-11	-3,194	GBP	-72,190		25-Nov-11	-1219				
	33	Sep-13	513,851	-800,000	-1.5569	1.5569		18-May-11	667	GBP	22,581		2-Dec-11	-1310				
	34	Oct-13	513,851	-800,000	-1.5569	1.5569		18-May-11	21,329	GBP	-288,066		15-Dec-11	360591				
	35	Nov-13	513,851	-800,000	-1.5569	1.5569		26-May-11	-8,560	GBP	-176,349		19-Dec-11	23572				
	36	Dec-13	2,729,917	-4,800,000	-1.7583	1.7583		26-May-11	10,492	GBP	-145,249		29-Dec-11	-1584				
	37	Jan-14	193,548	-300,000	-1.5500	1.5500		2-Jun-11	-8,877	GBP	-177,826		4-Jan-12	-1676				
	38	Feb-14	193,548	-300,000	-1.5500	1.5500		2-Jun-11	10,668	GBP	-144,461		19-Jan-12	24540				
	39	Mar-14	193,548	-300,000	-1.5500	1.5500		17-Jun-11	-3,804	GBP	-75,880		26-Jan-12	2690				
	40	Apr-14	193,548	-300,000	-1.5500	1.5500		17-Jun-11	3,078	GBP	7,800		31-Jan-12	2070				

Table of Contents / XPortfolio / Trade Details / Original CLU Profile / Parameters / Deposit Details / Deposit CLU Data

Fig36. Screenshot from the XPortfolio tab of our tool

The screen shot above is the data sourcing tab "XPortfolio" that extracts and processes

data from the XPortfolio application. In column C, D and E, users enter cash flow analysis data

from XPortfolio, including dates and cash flow in both currencies, and the tool automatically

calculates the average spot rate by dividing one currency over the base currency (i.e. For a

currency pair GBPUSD, the base currency is GBP, average spot is calculated by dividing the USD amount by GBP). The average spot is equivalent to the concept of strike of each leg because that is where each leg will actually be "exercised" according to the cash flow report, as shown in column G. As the cash flow is displayed daily, all the dates that appear on the cash flow analysis are unique "delivery dates" where currency exchange occurs. In order to quote in NMOSS, users need to know the amount traded, in other words, the notional of each leg. By getting the deal-level report of this same counterparty, users can view all deals traded between RBS and this counterparty including information about delivery dates and present value of each trade. One point must be made clear here is the term "trade" differs from what we call as "leg". In column I and J and raw data from deal level report, different trades that have different PV values can expire on the same dates. That is why we can see duplicate dates in the picture.

However, each leg is really the total amount of trades that expire on that same unique date and it does not need to specify which trade but rather emphasize on the total cash flow. In order to aggregate the present values of multiple trades into the present value of one leg, we developed a macro. The macro was coded with the idea of using pivot tables to extract the dates and PV values from column I and J, to sum all PV values for duplicate dates and to paste the new "leg" present values corresponding to unique dates in column N and O. Each leg that is summed by aggregating unique dates matches perfectly with each date in the cash flow analysis input. All inputs are now provided for users to proceed with our tool. (Code in Appendix)

Portfolio analysis

Strategy 1: Portfolio Restructuring

1.PORTFOLIO RESTRUCTURING
Change the notional on existing trades to free up credit line space and see how CLU is affected when adding new trades
1. Xportfolio
2. Trade Details
3. Original CLU Profile
4. Amended CLU Profile

Fig37. Screenshot of Part one of "table of contents" tab

This strategy focuses on changing an existing portfolio in order to free up credit space, mainly by changing notional amounts of each unique expiry date. Even though credit information of a leg can vary significantly as any input(i.e. strike, expiry, notional) changes, portfolio restructuring only considers a change in the notional taking into account the technical feasibility and customers acceptability because the old trade must be cancelled and a new trade should be placed when changing either expiry date or strike.

Portfolio restructuring considers a decrease in CLU when a leg notional is reduced. The purpose is to show the various aspects of the cost and CLU reduction relationship from two indicator metrics.   In portfolio restructuring, users are able to view portfolio performance with a change in notional and trade addition dynamically. They are also able to use specific CLU information of each leg in the portfolio so that they have a better idea as to what extent a change in individual leg can impact the portfolio CLU. Consequently, this strategy offers an opportunity for users to spot a chance to either decrease CLU with minimal notional decrease or to not affect CLU with the greatest notional increase. We will go over the reasoning and functionality of this

strategy in the order of data tabs used.

Original CLU Profile

This tab sources major credit calculations from NMOSS and accurately calculates the portfolio CLU and its corresponding peak date at the time of analysis; it contains all raw CLU data of this portfolio in which the following three types of strategic analysis will be based on.

Fig38. Screenshot of Original CLU Profile tab w/o new trade

As shown in row 1 to row 4, the tool automatically feeds in for users the inputs needed for NMOSS from the "XPortfolio" tab, including initial notional, initial value, strike and delivery

dates. Based on this information provided, users will quote one by one in NMOSS and obtain credit calculation of each leg as explained in our data sourcing section. As they get a credit calculation across time, which usually increases in one direction and decreases in the other, they need to paste the projected raw CLU dates down from Cell A9 and all the positive NPVs (which act in favour of RBS) of each leg from Column H all the way to the right.

Now, all the raw data is ready for the analysis to be done. As we have mentioned before, the portfolio CLU is found first by summing the NPVs of each leg on each CLU dates (Column C) and then looking up the greatest total value (Cell C1). The peak date (Cell C2) is the CLU date that corresponds to the greatest total. For users' convenience, we developed a macro to enter all the formulas and extract the maximum amount. Users are able to obtain the Portfolio CLU by clicking the "Get Portfolio CLU" button.

	A	B	C	D	E	F	G	H	I	J	K
1	Back	Portfolio CLU	10,807,241	Initial Notional				902,859	902,859	902,859	902,859
2		Peak Date	13-Oct-11	Initial Value				5,486	5,157	4,930	9,326
3	Get Portfolio CLU			Strike				1.6060	1.6060	1.6060	1.6060
4		ccy used:		Delivery				1-Jan-11	1-Feb-11	1-Mar-11	1-Apr-11
5	Clear All Fields	GBP									
6				Individual CLU	0	0	0	67,525	23,587	116,669	126,006
7		CLU Dates	Total	CLU	Trade 1*	Trade 2*	Trade3*	1	2	3	4
8	Input Raw CLU Dates				Input CLU of PROPOSED TRADES here			Input ORIGINAL CLU of each expiry date			
9	Thu 16-Dec-2010	16-Dec-10	4,238,033	10,807,241				18,902	23,587	27,868	31,773
10	Fri 17-Dec-2010	17-Dec-10	4,583,384	10,807,241				28,282	16,553	35,337	38,925
11	Sat 18-Dec-2010	18-Dec-10	4,731,486	10,807,241				32,499	13,947	38,656	42,068
12	Sun 19-Dec-2010	19-Dec-10	4,847,525	10,807,241				35,839	12,100	41,305	44,577
13	Mon 20-Dec-2010	20-Dec-10	4,946,260	10,807,241				38,708	10,633	43,598	46,741
14	Tue 21-Dec-2010	21-Dec-10	5,032,182	10,807,241				41,271	9,342	45,609	48,639
15	Wed 22-Dec-2010	22-Dec-10	5,114,624	10,807,241				43,612	8,280	47,512	50,432
16	Thu 23-Dec-2010	23-Dec-10	5,189,039	10,807,241				45,756	7,143	49,251	52,060
17	Fri 24-Dec-2010	24-Dec-10	5,257,040	10,807,241				47,773	6,353	50,934	53,607
18	Sat 25-Dec-2010	25-Dec-10	5,324,118	10,807,241				49,693	5,655	52,561	55,132
19	Sun 26-Dec-2010	26-Dec-10	5,387,798	10,807,241				51,508	5,029	54,114	56,587
20	Mon 27-Dec-2010	27-Dec-10	5,448,803	10,807,241				53,237	4,467	55,611	57,988
21	Tue 28-Dec-2010	28-Dec-10	5,507,494	10,807,241				54,893	3,961	57,058	59,343
22	Wed 29-Dec-2010	29-Dec-10	5,565,850	10,807,241				56,463	3,503	58,454	60,652
23	Thu 30-Dec-2010	30-Dec-10	5,620,025	10,807,241				57,987	2,892	59,760	61,891
24	Thu 06-Jan-2011	6-Jan-11	5,964,668	10,807,241				67,525	991	68,404	69,983
25	Thu 13-Jan-2011	13-Jan-11	6,189,597	10,807,241				0	226	76,067	77,176
26	Thu 20-Jan-2011	20-Jan-11	6,454,878	10,807,241				0	18	83,106	83,826
27	Thu 27-Jan-2011	27-Jan-11	6,701,193	10,807,241				0	0	89,610	90,057
28	Thu 03-Feb-2011	3-Feb-11	6,932,625	10,807,241				0	0	95,659	95,945
29	Thu 10-Feb-2011	10-Feb-11	7,152,422	10,807,241				0	0	101,344	101,531
30	Thu 17-Feb-2011	17-Feb-11	7,362,668	10,807,241				0	0	106,709	106,854
31	Thu 24-Feb-2011	24-Feb-11	7,564,498	10,807,241				0	0	111,809	111,939
32	Thu 03-Mar-2011	3-Mar-11	7,759,755	10,807,241				0	0	116,669	116,811
33	Thu 10-Mar-2011	10-Mar-11	7,827,684	10,807,241				0	0	0	121,495
34	Thu 17-Mar-2011	17-Mar-11	8,007,351	10,807,241				0	0	0	126,006
35	Sat 16-Apr-2011	16-Apr-11	8,590,732	10,807,241				0	0	0	0
36	Mon 16-May-2011	16-May-11	9,090,189	10,807,241				0	0	0	0
37	Wed 15-Jun-2011	15-Jun-11	9,524,471	10,807,241				0	0	0	0
38	Fri 15-Jul-2011	15-Jul-11	9,906,155	10,807,241				0	0	0	0
39	Sun 14-Aug-2011	14-Aug-11	10,244,391	10,807,241				0	0	0	0
40	Tue 13-Sep-2011	13-Sep-11	10,542,762	10,807,241				0	0	0	0
41	Thu 13-Oct-2011	13-Oct-11	10,807,241	10,807,241				0	0	0	0
42	Sat 12-Nov-2011	12-Nov-11	10,105,390	10,807,241				0	0	0	0

Table of Contents / Portfolio / Trade Details / Original CLU Profile / Parameters / Deposit Details / Deposit CLU Data

Fig39. Screenshot of the space given to a new trade

For a portfolio that is not full, the tool creates additional fields to enter credit calculation of proposed new legs (trades) so that the portfolio CLU will be more efficiently used within the limit. Users can expand these three columns from Column E to Column G for new trade inputs. Moreover, the tool provides indications on possible space for new trades given original CLU profile that users can refer to when they decide on the length, notional and strike of a new proposed trade. The indications are explained in the following section "Trade Details".

Ex-Portfolio

Fig40. Screenshot of x portfolio

64

Ex-Portfolio is a hidden helper tab to store processed portfolio data which will be used for indicator calculations. This tab is designed to identify the CLU contribution of each leg. It contains same CLU dates that are extracted from "Original CLU Profile" while in each column to the left it subtracts the credit contribution from original credit total on the corresponding date.

Every other cell in the field is populated using such a formula to create this ex-portfolio that indicates behaviours of the original portfolio without each leg. It is so important that Ex-Portfolio becomes an accelerator for this tool in looking up specific CLU indication on each leg. Data stored here are linked by formulas in "Trade Details" when calculating CLU contribution related indicators. A macro is also designed to fill in data in this tab and it is incorporated in the indicator calculation process.

Trade Details

Trade Details gives all analysis specifics of the portfolio restructuring strategy. Not only can users view indicators on each leg, they can also make further assumptions, experiment with them and observe hypothetical results.
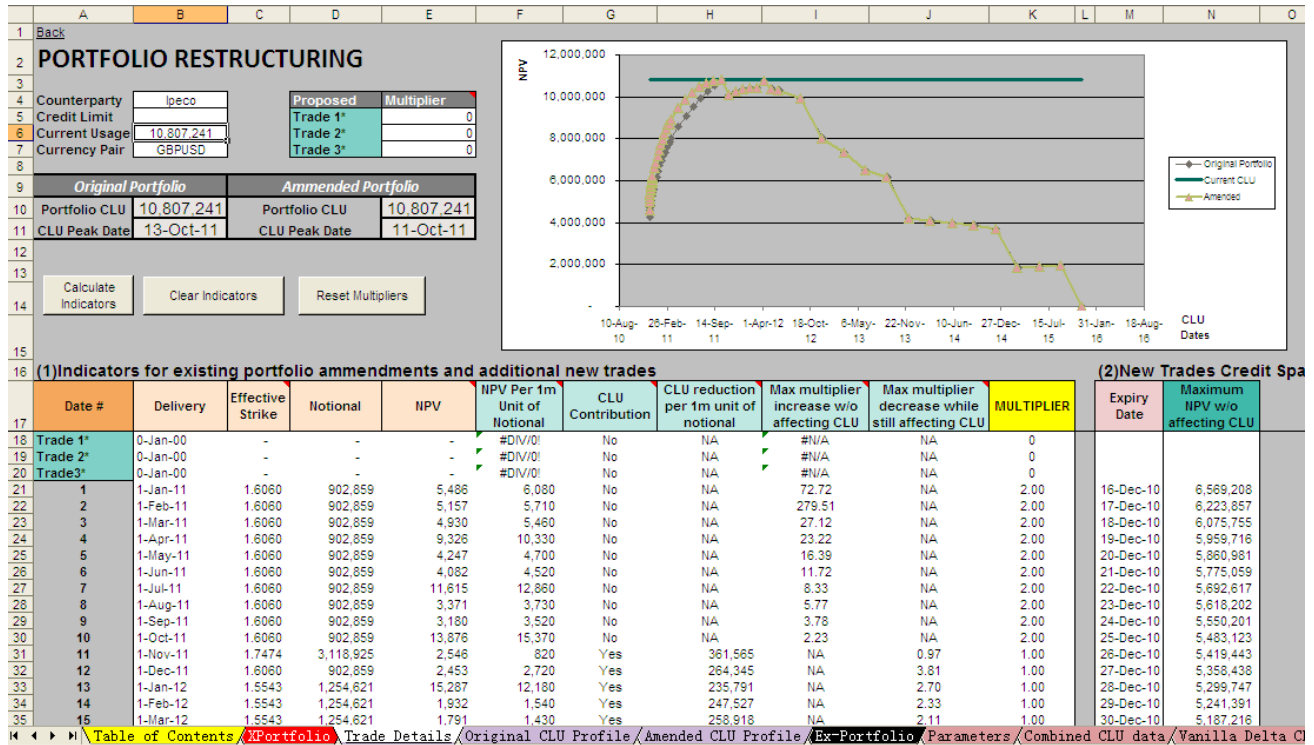
Fig41. Screenshot of the entire Portfolio Restructuring tab

There are two main indicator metrics:

(1)Indicators for existing portfolio amendments and additional new trades.

(1)Indicators for existing portfolio ammendments and additional new trades

Date #	Delivery	Effective Strike	Notional	NPV	NPV Per 1m Unit of Notional	CLU Contribution	CLU reduction per 1m unit of notional	Max multiplier increase w/o affecting CLU	Max multiplier decrease while still affecting CLU	MULTIPLIER
Trade 1*	0-Jan-00	-	-	-	#DIV/0!	No	NA	#N/A	NA	0
Trade 2*	0-Jan-00	-	-	-	#DIV/0!	No	NA	#N/A	NA	0
Trade3*	0-Jan-00	-	-	-	#DIV/0!	No	NA	#N/A	NA	0
1	1-Jan-11	1.6060	902,859	5,486	6,080	No	NA	72.72	NA	2.00
2	1-Feb-11	1.6060	902,859	5,157	5,710	No	NA	279.51	NA	2.00
3	1-Mar-11	1.6060	902,859	4,930	5,460	No	NA	27.12	NA	2.00
4	1-Apr-11	1.6060	902,859	9,326	10,330	No	NA	23.22	NA	2.00
5	1-May-11	1.6060	902,859	4,247	4,700	No	NA	16.39	NA	2.00
6	1-Jun-11	1.6060	902,859	4,082	4,520	No	NA	11.72	NA	2.00
7	1-Jul-11	1.6060	902,859	11,615	12,860	No	NA	8.33	NA	2.00
8	1-Aug-11	1.6060	902,859	3,371	3,730	No	NA	5.77	NA	2.00
9	1-Sep-11	1.6060	902,859	3,180	3,520	No	NA	3.78	NA	2.00
10	1-Oct-11	1.6060	902,859	13,876	15,370	No	NA	2.23	NA	2.00
11	1-Nov-11	1.7474	3,118,925	2,546	820	Yes	361,565	NA	0.97	1.00
12	1-Dec-11	1.6060	902,859	2,453	2,720	Yes	264,345	NA	3.81	1.00
13	1-Jan-12	1.5543	1,254,621	15,287	12,180	Yes	235,791	NA	2.70	1.00
14	1-Feb-12	1.5543	1,254,621	1,932	1,540	Yes	247,527	NA	2.33	1.00
15	1-Mar-12	1.5543	1,254,621	1,791	1,430	Yes	258,918	NA	2.11	1.00

Fig42. Screenshot of the first indicator metric

This metric includes all indicators of CLU for our original portfolio. Columns with heads highlighted in salmon are NMOSS inputs that automatically replicate from "XPortfolio". Columns with heads highlighted in blue are indicators that quantify cost/CLU reduction relationships in several aspects. The indicators are: NPV per 1 million unit of notional, CLU contribution, CLU reduction per 1 million unit of notional, Maximum multiplier increase without affecting CLU, Maximum multiplier decrease while still affecting CLU. The right most column represents multipliers that can be applied to each expiry date of the portfolio to increase or decrease its notional. A VBA macro calculates all these indicators by using pre-set formulas.

Indicators on this tab

1. NPV per 1 million of notional

NPV per 1 million of notional (i.e. leg 1)= Initial Value of leg 1 / Initial Notional of leg 1 * 1,000,000

As transactions usually are for large amounts, 1 million o notional is used as a unit. We used per 1 million of notional instead of per notional. This indicator shows the value of a leg by notional where a higher value is equivalent to a higher credit usage (higher credit exposure) and vice versa. NPVs, extracted from XPortfolio deal level reports, differ from one leg to another depending on the strike, notional and tenor. Users can thus identify which leg is most sensitive subject to notional change and which legs have a lower sensibility to notional.

2. CLU Contribution

CLU Contribution (i.e. leg 1) = "No", if Ex-Portfolio CLU (excluding leg 1) = Original CLU; "Yes", Otherwise

In a portfolio, the normal case for a peak date to appear is in the middle of the entire CLU term as each leg has an increasing credit and the combination of credit strips along time stacks up making a hill-shape curve.

Legs that expire earlier than peak date would not have any contribution to portfolio CLU because its own credit curve ends before the peak occurs. This indicator shows hints for users about these legs with great potential to increase but not affecting the portfolio CLU. If users are able to increase notional of legs that say "NO" (meaning this leg does not affect original CLU), instead of having a steep uphill, more space above will be used therefore making credit line usage more efficient.

3. CLU reduction per 1 million unit of notional

*CLU reduction per 1million of notional (i.e. leg 1) = CLU of leg 1/ Initial Notional of leg 1*1,000,000*

Given other legs stay the same, this indicator shows how much portfolio CLU a leg can reduce by reducing 1million of notional on this leg. A decrease in notional results in less positive value in favour of RBS, thus generating a cost. At the same time of reducing credit usage, users

can compare between legs that which one can reduce CLU the most with least cost by looking at legs with greatest CLU reduction per 1million of notional.

4. Maximum multiplier increase without affecting CLU

Maximum multiplier increase without affecting CLU(i.e. leg1) = if "CLU Contribution" is "NO", Original CLU / CLU of leg1; if "CLU Contribution" is "Yes", "NA"

For legs that expire later than the original peak date, no matter how notionals change CLU always gets affected. On the other hand, there might be plenty of credit space for legs that have no impact to CLU. This indicator shows the multiplier a leg can have without changing the current CLU. Compared to when salespeople used to lack a clear picture of portfolio CLU, now users of this tool can clearly spot opportunities for possible increase in value but no more consumption of credit. At time of completion of this project, we have used this part of the tool to find opportunities in real company portfolio to double notionals of some legs without affecting CLU. This has never been discovered before.

5. Maximum multiplier decrease while still affecting CLU

Maximum multiplier decrease while affecting CLU(i.e. leg1)= if "CLU Contribution" is "NO", "NA"; if "CLU Contribution" is "Yes,{ Ex-Portfolio CLU(excluding leg1)- Ex-Portfolio Credit(excluding leg1 at time of peak of CLU of leg 1)} / CLU of leg 1

When reducing the notional of a leg that affects the CLU, CLU changes as well. There is a chance that CLU reduces to a point where the original peak date is no longer the peak. In this case, it is pointless to keep reducing the notional of a leg because peak date is shifted and new observation shall be made. This indicator aims at providing information regarding the peak shifting point. It points out how much the notional of a leg can be reduced before it stops having effect on CLU so that users are prone to situations where they might generate extra cost but not necessarily making CLU efficient.

Multipliers

In Column K, this is where the actual portfolio restructuring work is done. For each leg, there is a multiplier field in which users can input numbers that are eventually applied as multipliers to each leg to be effective as changing notional.

9	Original Portfolio		Ammended Portfolio	
10	Portfolio CLU	10,807,241	Portfolio CLU	10,807,241
11	CLU Peak Date	13-Oct-11	CLU Peak Date	11-Oct-11
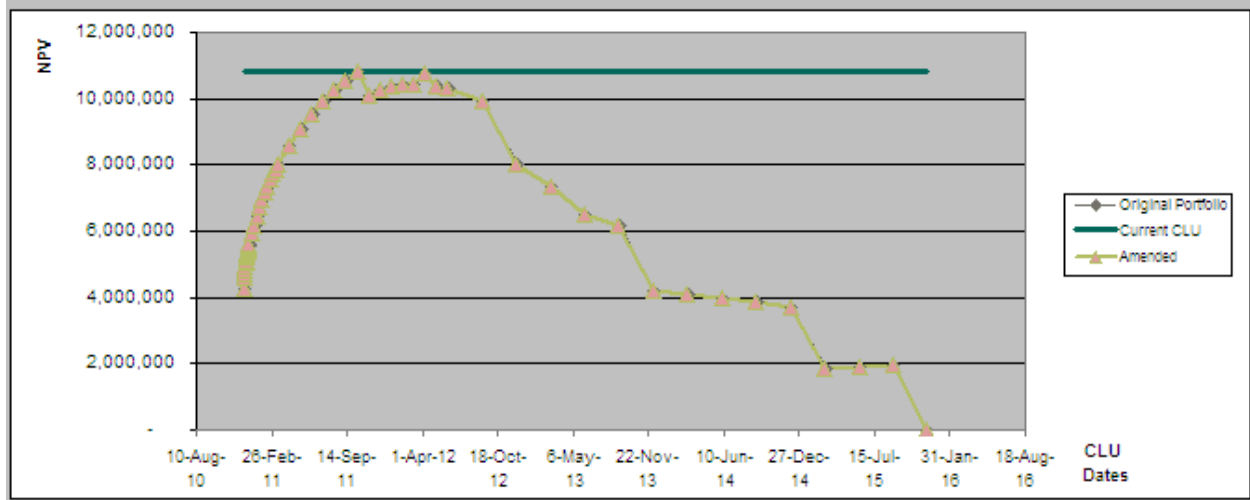
Fig43. Screenshot of the comparison and graph in the Portfolio Restructuring strategy

The amended portfolio CLU is shown in comparison with the original and the amended CLU line is on the same graph with original CLU line to display difference. All the indicators above do nothing but providing as much information as possible before users apply multipliers. In a big-volume portfolio where users are faced with more than 100 legs, simply doing trial and error on multiplier of each leg seems impossible. Nevertheless, with the foundation of indicators, users will have a general direction of all possible paths to CLU efficiency before actually going down the road.

(2)New Trades Credit Space	
Expiry Date	Maximum NPV w/o affecting CLU
16-Dec-10	6,569,208
17-Dec-10	6,223,857
18-Dec-10	6,075,755
19-Dec-10	5,959,716
20-Dec-10	5,860,981
21-Dec-10	5,775,059
22-Dec-10	5,692,617
23-Dec-10	5,618,202
24-Dec-10	5,550,201
25-Dec-10	5,483,123
26-Dec-10	5,419,443
27-Dec-10	5,358,438
28-Dec-10	5,299,747
29-Dec-10	5,241,391
30-Dec-10	5,187,216

Fig44. Screenshot of the New Trades Credit Space

New Trades Credit Space shows possible credit space before original peak. Across the same CLU dates (ends at peak), each field is obtained by subtracting total on the corresponding date from original CLU. This space can be either an indication for increasing notionals on the legs that expire early or proposing additional trades that fills up such credit space. Following up with this indicator, users are able to input proposed new trades in "Original CLU Profile" and apply multipliers to these new trades as well.

Amended CLU Profile

	Expiry	Total	CLU	Trade 1*	Trade 2*	Trade3*	1	2	3	4	5	
Back			Amended Notional				1,805,718	1,805,718	1,805,718	1,805,718	1,805,718	1,8...
			Amended Value				10,972	10,314	9,860	18,652	8,494	8,1...
Portfolio CLU	10807241		Multiplier	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	
Peak Date	11-Oct-11											
Raw CLU dates				Amended CLU specifics on portfolio								
Tue 14-Dec-2010	14-Dec-10	4,598,395	10,807,241	0	0	0	37804	47174	55736	63546	70430	
Wed 15-Dec-2010	15-Dec-10	5,000,919	10,807,241	0	0	0	56564	33106	70674	77850	84346	
Thu 16-Dec-2010	16-Dec-10	5,174,488	10,807,241	0	0	0	64998	27894	77312	84136	90400	
Fri 17-Dec-2010	17-Dec-10	5,311,015	10,807,241	0	0	0	71678	24200	82610	89154	95244	
Sat 18-Dec-2010	18-Dec-10	5,427,427	10,807,241	0	0	0	77416	21266	87196	93482	99414	
Sun 19-Dec-2010	19-Dec-10	5,528,947	10,807,241	0	0	0	82542	18684	91218	97278	103060	
Mon 20-Dec-2010	20-Dec-10	5,626,083	10,807,241	0	0	0	87224	16560	95024	100864	106498	
Tue 21-Dec-2010	21-Dec-10	5,713,598	10,807,241	0	0	0	91512	14286	98502	104120	109584	
Wed 22-Dec-2010	22-Dec-10	5,794,325	10,807,241	0	0	0	95546	12706	101868	107214	112536	
Thu 23-Dec-2010	23-Dec-10	5,873,981	10,807,241	0	0	0	99386	11310	105122	110264	115456	
Fri 24-Dec-2010	24-Dec-10	5,949,670	10,807,241	0	0	0	103016	10058	108228	113174	118240	
Sat 25-Dec-2010	25-Dec-10	6,022,243	10,807,241	0	0	0	106474	8934	111222	115976	120918	
Sun 26-Dec-2010	26-Dec-10	6,092,125	10,807,241	0	0	0	109786	7922	114116	118686	123506	
Mon 27-Dec-2010	27-Dec-10	6,161,421	10,807,241	0	0	0	112926	7006	116908	121304	126018	
Tue 28-Dec-2010	28-Dec-10	6,225,544	10,807,241	0	0	0	115974	5784	119520	123782	128354	
Tue 04-Jan-2011	4-Jan-11	6,637,206	10,807,241	0	0	0	135050	1982	136808	139966	143744	
Tue 11-Jan-2011	11-Jan-11	6,846,246	10,807,241	0	0	0	0	452	152134	154352	157412	
Tue 18-Jan-2011	18-Jan-11	7,159,597	10,807,241	0	0	0	0	36	166212	167652	170056	
Tue 25-Jan-2011	25-Jan-11	7,451,073	10,807,241	0	0	0	0	0	179220	180114	181938	
Tue 01-Feb-2011	1-Feb-11	7,725,210	10,807,241	0	0	0	0	0	191318	191890	193216	
Tue 08-Feb-2011	8-Feb-11	7,985,789	10,807,241	0	0	0	0	0	202688	203062	204008	
Tue 15-Feb-2011	15-Feb-11	8,235,159	10,807,241	0	0	0	0	0	213418	213708	214386	
Tue 22-Feb-2011	22-Feb-11	8,474,686	10,807,241	0	0	0	0	0	223618	223878	224394	
Tue 01-Mar-2011	1-Mar-11	8,706,466	10,807,241	0	0	0	0	0	233338	233622	234026	
Tue 08-Mar-2011	8-Mar-11	8,688,474	10,807,241	0	0	0	0	0	0	242990	243310	
Tue 15-Mar-2011	15-Mar-11	8,898,088	10,807,241	0	0	0	0	0	0	252012	252292	
Thu 14-Apr-2011	14-Apr-11	9,458,565	10,807,241	0	0	0	0	0	0	0	287976	
Sat 14-May-2011	14-May-11	9,892,841	10,807,241	0	0	0	0	0	0	0	0	
Mon 13-Jun-2011	13-Jun-11	10,225,635	10,807,241	0	0	0	0	0	0	0	0	
Wed 13-Jul-2011	13-Jul-11	10,473,652	10,807,241	0	0	0	0	0	0	0	0	
Fri 12-Aug-2011	12-Aug-11	10,649,040	10,807,241	0	0	0	0	0	0	0	0	
Sun 11-Sep-2011	11-Sep-11	10,757,648	10,807,241	0	0	0	0	0	0	0	0	
Tue 11-Oct-2011	11-Oct-11	10,807,241	10,807,241	0	0	0	0	0	0	0	0	
Thu 10-Nov-2011	10-Nov-11	10,105,390	10,807,241	0	0	0	0	0	0	0	0	

Table of Contents / XPortfolio / Trade Details / Original CLU Profile / Amended CLU Profile / Ex-Portfolio / Paramete...

Fig45. Screenshot of the Amended CLU Profile tab

The "Amended CLU Profile" has the same layout as "Original CLU Profile". It processes portfolio restructuring strategy to "Original CLU Profile" and populates a credit profile of the amended portfolio. Row3 are multipliers that are linked directly to users' multiplier inputs in "Trade Details". Amended notional and amended value in Row1 and Row2 are the results of initial notional and initial value timing the multipliers. The white field below that correspond to raw data fields for original CLU in "Original CLU Profile" are simply the data from "Original CLU Profile" each applying multiplier according to each leg. The amended portfolio CLU is

then highlighted in Cell B3. The populating process of this tab is also incorporated in the macro that calculates indicators in "Trade Details".

Strategic Example

In the latest tool test, we've used this tool on the portfolio of a counterparty called Ipeco and discovered opportunities to more efficiently use credit line by doubling some notionals while keeping the CLU unchanged. As a result, the portfolio restructuring strategy could help use credit line in a more efficiently.

Original Portfolio		Ammended Portfolio	
Portfolio CLU	10,807,241	Portfolio CLU	10,807,241
CLU Peak Date	13-Oct-11	CLU Peak Date	13-Oct-11

The original portfolio of IPECO has a CLU of 10,807,241. With the implication provided by various indicators, we tried doubling the notional of all legs that don't effect on CLU by changing all of their multipliers to 2.00. While the CLU is still the same, the value of the portfolio increases.
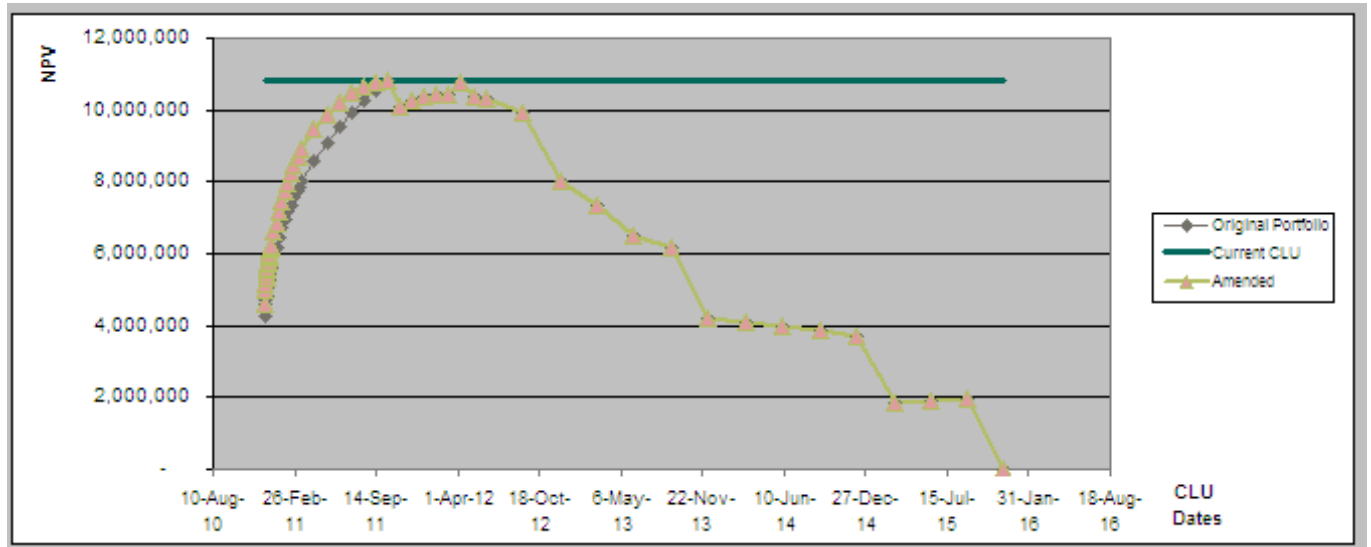
Fig46. Portfolio restructuring graph

As shown in the new graph, with the help of the tool, the amended portfolio(salmon colour) has used more space under the credit limit than original(grey) with no extra cost but more positive value.

Strategy 2: New Vanilla Options

Fig47. Screenshot of 2nd part of "table of contents"

In the CLU analysis, RBS only considers option or forward contracts that have positive NPVs across time because only in such a case there is credit concern as counterparties might default. When a portfolio has a CLU reaching the limit, the "New Vanilla Options" strategy is able to offset the original credit usage if the counterparties enter into an option/forward contract that works in favour of them, in other words adding additional legs to the portfolio that has negative NPVs from RBS' perspective so that certain amount can be subtracted from the original total. This strategy is best for a portfolio that has reached CLU or is over the credit limit and the user is interested in lowering it to a specific amount.

Although this strategy can help free up credit space, the cost is very obvious since the additional leg has a negative NPVs to the bank. It leaves the users to decide if it is worth it to do so considering the balance between the credit reduction and cost. We shall go over the functionality of each excel tab in this strategy.

The credit calculation (CLU calculation) of possible options that offset credit usage are stored here. They are divided into five categories by five different delta values: 5,10,15,20 and 25 deltas. Delta is the first derivative of NPV over spot; It describes the moneyness of an option. For example, a 5 delta option now has 5% chance to be in the money. A contract with higher delta is more expensive when purchased. Within each of the five categories, the tenors of all basic options range from one month to twenty-four months. Users can choose from different combinations of delta and tenor to decide what would be the ideal options to purchase for this strategy.

#	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	5	Rate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2	1	Multiplier	0	0	0	0	0	0	0	5	50	58	0	0	0	0	0	0	0	0
3	5 DELTAS																			
4		EUR Cost							2,250	2,434	2,595	2,756	2,903	3,023	3,145	3,257	3,359	3,462	3,561	3,640
5	11-Oct-10	0.8696							-831	-897	-940	-992	-1,041	-1,090	-1,157	-1,210	-1,269	-1,345	-1,407	-1,470
6	12-Oct-10	0.8608							-1,092	-1,154	-1,193	-1,241	-1,287	-1,338	-1,408	-1,461	-1,521	-1,603	-1,666	-1,732
7	13-Oct-10	0.8571							-1,211	-1,270	-1,306	-1,352	-1,396	-1,448	-1,518	-1,572	-1,633	-1,716	-1,780	-1,847
8	14-Oct-10	0.8544							-1,305	-1,361	-1,395	-1,440	-1,482	-1,534	-1,605	-1,659	-1,720	-1,804	-1,869	-1,936
9	15-Oct-10	0.852							-1,387	-1,441	-1,472	-1,513	-1,553	-1,608	-1,680	-1,733	-1,794	-1,879	-1,945	-2,012
10	16-Oct-10	0.85							-1,456	-1,507	-1,538	-1,578	-1,618	-1,676	-1,748	-1,801	-1,862	-1,948	-2,014	-2,082
11	17-Oct-10	0.8482							-1,527	-1,576	-1,605	-1,643	-1,681	-1,738	-1,810	-1,863	-1,925	-2,011	-2,077	-2,146
12	18-Oct-10	0.8465							-1,593	-1,640	-1,667	-1,703	-1,740	-1,797	-1,869	-1,922	-1,983	-2,071	-2,137	-2,206
13	19-Oct-10	0.8449							-1,653	-1,697	-1,723	-1,758	-1,793	-1,852	-1,924	-1,977	-2,038	-2,126	-2,193	-2,262
14	20-Oct-10	0.8434							-1,710	-1,752	-1,777	-1,810	-1,844	-1,904	-1,976	-2,029	-2,090	-2,179	-2,246	-2,315
15	21-Oct-10	0.842							-1,767	-1,805	-1,828	-1,859	-1,892	-1,953	-2,026	-2,078	-2,139	-2,228	-2,295	-2,364
16	22-Oct-10	0.8407							-1,821	-1,857	-1,877	-1,904	-1,934	-2,000	-2,072	-2,124	-2,185	-2,275	-2,342	-2,411
17	23-Oct-10	0.8394							-1,862	-1,898	-1,919	-1,947	-1,977	-2,046	-2,118	-2,170	-2,231	-2,321	-2,388	-2,458
18	24-Oct-10	0.8382							-1,914	-1,948	-1,967	-1,994	-2,022	-2,091	-2,163	-2,214	-2,276	-2,366	-2,433	-2,503
19	25-Oct-10	0.8371							-1,965	-1,996	-2,014	-2,039	-2,067	-2,135	-2,207	-2,258	-2,320	-2,411	-2,478	-2,548
20	1-Nov-10	0.8299							-2,274	-2,286	-2,289	-2,307	-2,326	-2,396	-2,480	-2,529	-2,590	-2,684	-2,751	-2,822
21	8-Nov-10	0.824							-2,530	-2,531	-2,524	-2,537	-2,549	-2,617	-2,718	-2,765	-2,826	-2,921	-2,989	-3,061
22	15-Nov-10	0.8187							-2,760	-2,748	-2,731	-2,741	-2,746	-2,812	-2,931	-2,978	-3,038	-3,136	-3,203	-3,276
44	5-Mar-12	0.6905							0	0	0	0	0	0	0	0	0	0	-956	-2,411
45	4-Apr-12	0.686							0	0	0	0	0	0	0	0	0	0	0	-879
46	10	Rate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
47	2	Multiplier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	10 DELTAS																			
91	15	Rate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
92	3	Multiplier	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0
93	15 DELTAS																			
136	20	Rate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
137	4	Multiplier	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	10	0
138	20 DELTAS																			
184	25	Rate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
185	5	Multiplier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig48. Screenshot of the Deltas tab

In this tab, five categories, starting from 5 deltas, are placed from top and then down as delta increases. The column head of each category shows the tenor of the option and below the tenors are multipliers users can apply under each tenor with base options. The top row of the

CLU field shows the NPV of the corresponding option and CLU calculation from NMOSS are entered right below NPVs. In the far right Column AB, it sums the product of multipliers and base options chosen from each delta category.

The market is moving all the time and therefore CLU calculations in this tab are constantly changing as well depending on the spot, volatility etc. However, currently we are not able to dynamically update this field. It is possible in the future that a place holder for volatility is developed so that the CLU calculations can be refreshed when a new volatility is entered at different times.

Combined CLU Data (Hidden)

This tab, as its name conveys, combines original CLU data with the new vanilla option strategy.

Fig49. Screenshot of the Combined CLU data tab

In Column C, it extracts the portfolio CLU total from "Original CLU Profile". From Column E to Column I are CLU calculation of total new vanilla options chosen from each of the delta categories. In Column B are the then modified portfolio CLU.

Parameters

In this tab, users select delta categories and tenors of new vanilla options. They can enter multipliers to options chosen to lower and observe modified CLU so as to lower it to an ideal amount.
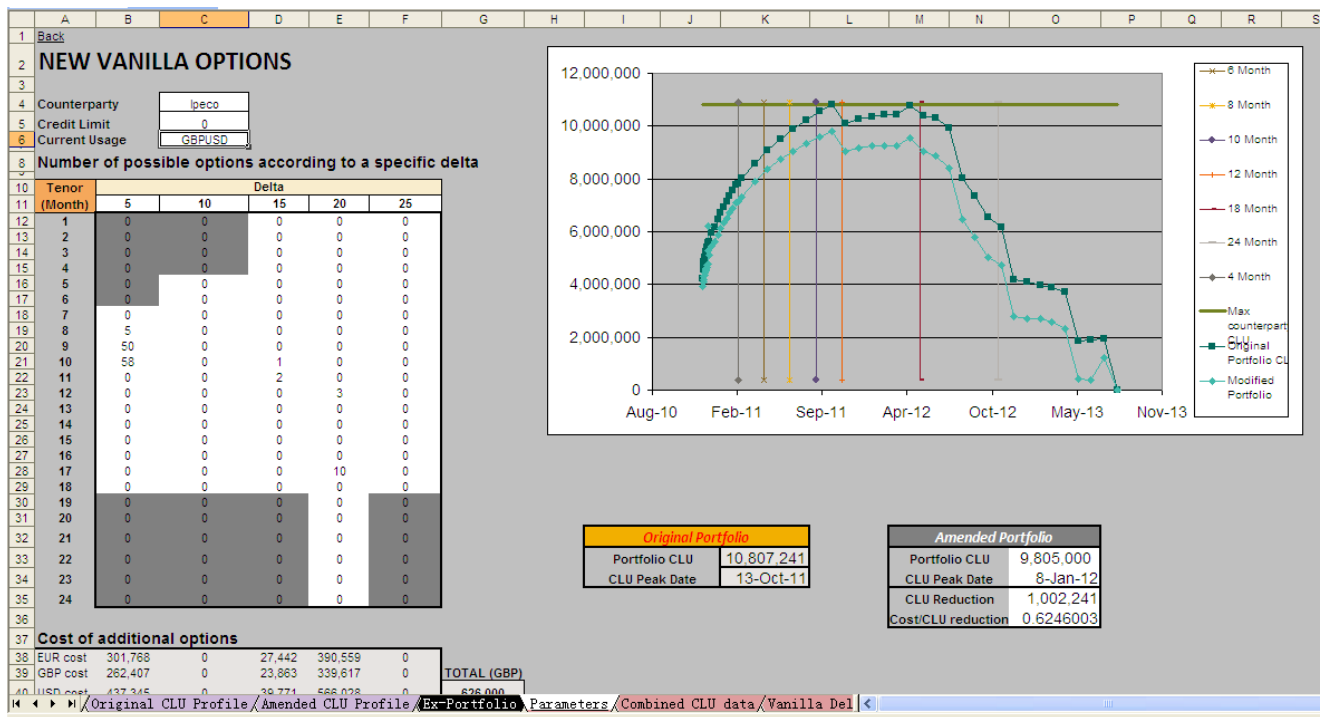
Fig50. Screenshot of the Parameters tab

Multiplier fields that have blank background are available for inputs. Cells highlighted in grey are tenors that are not stored in "Vanilla Delta CLU Values" because they are filtered out for these tenors are not as effective. It seems that all roads lead to Rome since there are five

79

categories and many available inputs for different approaches. Cost then becomes the key at determining the final approach. Below the multiplier input fields is a table that shows cost of additional options purchased. It helps users compare costs and it is shown in three currencies.

This strategy automatically incorporates these options into the portfolio and shows a graph which marks each maturity for each option to help the user decide which maturity to choose. The graph on the left displays both portfolios: original and modified. When applying multipliers, users are able to view CLU reduction visually. In addition, in order to clearly identify CLU reduction made by different tenors, eight vertical lines marked the main expiry dates. Besides graphical comparison, users can view change in CLU value underneath the graph, which accurately calculates the amended portfolio CLU, CLU reduction and cost.

Strategic Example

Now we show an example using "New Vanilla Option" to further explain the functionality of this strategy. We use the same portfolio throughout the three strategies to establish a consistent example.
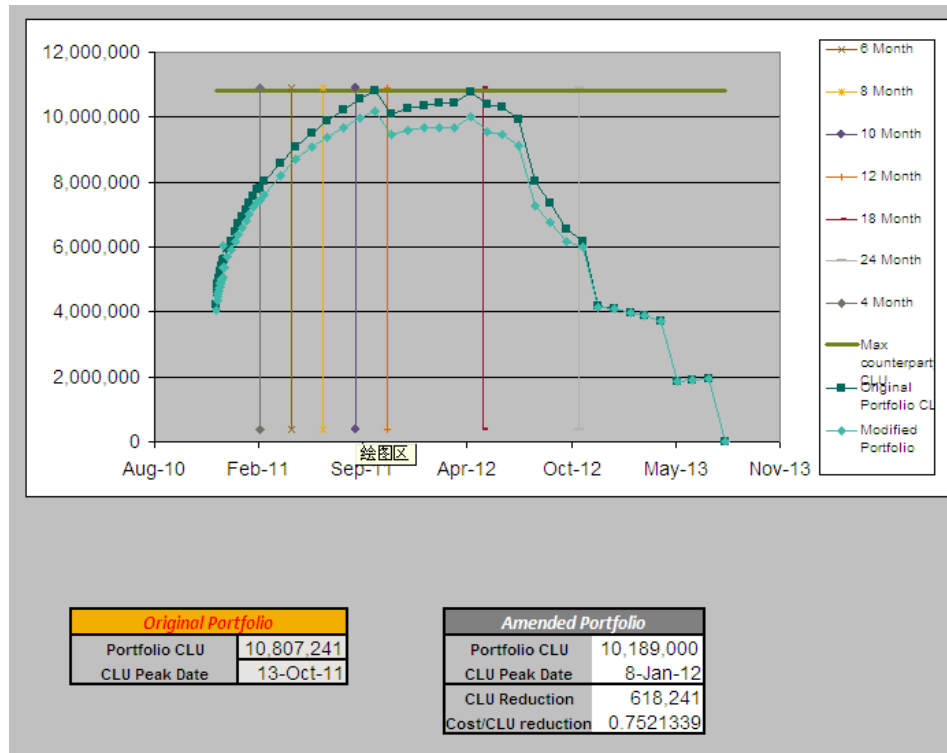
Fig51. Screenshot of 5 delta (graph & comparison)

For the counterparty named "IPECO", the current CLU is 10,807,241. If it has reached the credit limit, no more transaction is possible. If IPECO now buys all 5 delta options, 50 each of 8-month, 9-month, 10-month and 11-month, the amended CLU decreases to 10,189,000 with a total cost of GBP465,000.
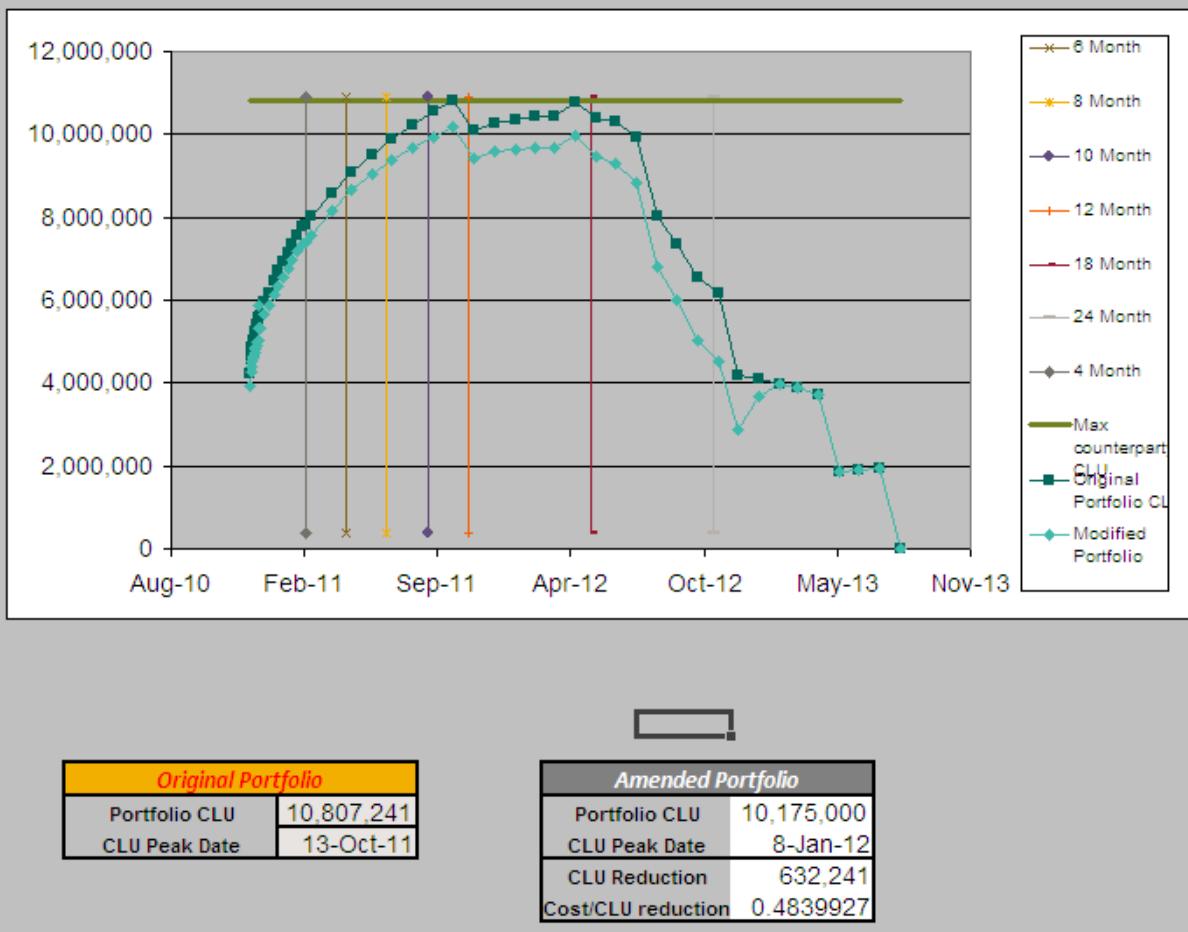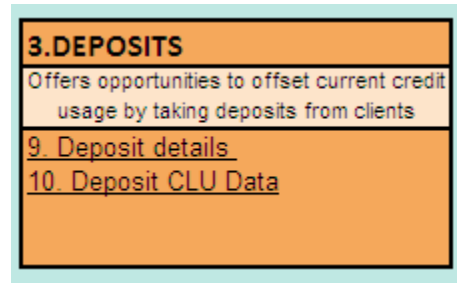
Fig52. Screenshot of 15 delta (graph &comparison)

Instead of buying 5 deltas, IPECO buys all in 15 deltas 10 of 10-month, 20 of 11-month and 8 of 12-month, the portfolio CLU is lowered at the same magnitude at 10,175,000, however, with a cost of GBP306, 000.   All delta categories are independent of each other. It requires a bit of trial and error to find an optimal solution with less cost and more CLU reduction. Nonetheless, higher deltas indicate higher unit cost and it is likely that less quantity of high delta options have the same effect to CLU reduction as larger quantity of low delta options.

Strategy 3: Deposits

Fig53. Screenshot of the 3rd part of "table of contents"

Deposits is the last strategy in our tool. The most essential characteristic that distinguishes Deposits from the previous two strategies is that this is a zero-cost way of analysing credit. The idea for it to work is that RBS would enter into a netting agreement with counterparty when the counterparty wants to do a new trade but the portfolio would exceed the credit limit. The deposit has to be made as part of the new trade in such a way that the counterparty is able to lower the exceeding CLU by the deposit amount. This strategy would take in CLU calculation of original Portfolio and new trade CLU calculation as inputs. It will then indicate during when the deposit should be made and how much the standard deposit is in order to lower the CLU below the credit limit. In the case where the counterparty wishes to make a deposit other than the standard, an additional function is added to this strategy to view CLU reduction with any available amount of deposit. Now we will go over the functionality of this strategy by each tab.

	ORIGINAL PORTFOLIO			NEW PORTFOLIO					Max CLU Excess	Standard Deposit		Available deposit	2000000
	Original Portfolio CLU	10,807,241		New Portfolio CLU	10,807,241				2807241	2850000		Current CLU	8,807,241
	CLU Peak Date	13-Oct-11		CLU Peak Date	13-Oct-11								
	CLU Date	Original Portfolio CLU		CLU Date	New Portfolio CLU		Credit Limit	Deposit Dates	Exceeded CLU	portfolio w/ std deposit			Portfolio w/ava
	16-Dec-10	4,238,033		16-Dec-10	4,238,033		8,000,000		0	4,238,033			4,238,033
	17-Dec-10	4,583,384		17-Dec-10	4,583,384		8,000,000		0	4,583,384			4,583,384
	18-Dec-10	4,731,486		18-Dec-10	4,731,486		8,000,000		0	4,731,486			4,731,486
	19-Dec-10	4,847,525		19-Dec-10	4,847,525		8,000,000		0	4,847,525			4,847,525
	20-Dec-10	4,946,260		20-Dec-10	4,946,260		8,000,000		0	4,946,260			4,946,260
	21-Dec-10	5,032,182		21-Dec-10	5,032,182		8,000,000		0	5,032,182			5,032,182
	22-Dec-10	5,114,624		22-Dec-10	5,114,624		8,000,000		0	5,114,624			5,114,624
	23-Dec-10	5,189,039		23-Dec-10	5,189,039		8,000,000		0	5,189,039			5,189,039
	24-Dec-10	5,257,040		24-Dec-10	5,257,040		8,000,000		0	5,257,040			5,257,040
	25-Dec-10	5,324,118		25-Dec-10	5,324,118		8,000,000		0	5,324,118			5,324,118
	26-Dec-10	5,387,798		26-Dec-10	5,387,798		8,000,000		0	5,387,798			5,387,798
	27-Dec-10	5,448,803		27-Dec-10	5,448,803		8,000,000		0	5,448,803			5,448,803
	28-Dec-10	5,507,494		28-Dec-10	5,507,494		8,000,000		0	5,507,494			5,507,494
	29-Dec-10	5,565,850		29-Dec-10	5,565,850		8,000,000		0	5,565,850			5,565,850
	30-Dec-10	5,620,025		30-Dec-10	5,620,025		8,000,000		0	5,620,025			5,620,025
	6-Jan-11	5,964,668		6-Jan-11	5,964,668		8,000,000		0	5,964,668			5,964,668
	13-Jan-11	6,189,597		13-Jan-11	6,189,597		8,000,000		0	6,189,597			6,189,597
	20-Jan-11	6,454,878		20-Jan-11	6,454,878		8,000,000		0	6,454,878			6,454,878
	27-Jan-11	6,701,193		27-Jan-11	6,701,193		8,000,000		0	6,701,193			6,701,193
	3-Feb-11	6,932,625		3-Feb-11	6,932,625		8,000,000		0	6,932,625			6,932,625
	10-Feb-11	7,152,422		10-Feb-11	7,152,422		8,000,000		0	7,152,422			7,152,422
	17-Feb-11	7,362,668		17-Feb-11	7,362,668		8,000,000		0	7,362,668			7,362,668
	24-Feb-11	7,564,498		24-Feb-11	7,564,498		8,000,000		0	7,564,498			7,564,498
	3-Mar-11	7,759,755		3-Mar-11	7,759,755		8,000,000		0	7,759,755			7,759,755
	10-Mar-11	7,827,684		10-Mar-11	7,827,684		8,000,000		0	7,827,684			7,827,684
	17-Mar-11	8,007,351		17-Mar-11	8,007,351		8,000,000	17-Mar-11	7351	5,157,351			6,007,351
	16-Apr-11	8,590,732		16-Apr-11	8,590,732		8,000,000	16-Apr-11	590732	5,740,732			6,590,732
	16-May-11	9,090,189		16-May-11	9,090,189		8,000,000	16-May-11	1090189	6,240,189			7,090,189
	15-Jun-11	9,524,471		15-Jun-11	9,524,471		8,000,000	15-Jun-11	1524471	6,674,471			7,524,471
	15-Jul-11	9,906,155		15-Jul-11	9,906,155		8,000,000	15-Jul-11	1908155	7,056,155			7,906,155
	14-Aug-11	10,244,391		14-Aug-11	10,244,391		8,000,000	14-Aug-11	2244391	7,394,391			8,244,391
	13-Sep-11	10,542,762		13-Sep-11	10,542,762		8,000,000	13-Sep-11	2542762	7,692,762			8,542,762
	13-Oct-11	10,807,241		13-Oct-11	10,807,241		8,000,000	13-Oct-11	2807241	7,957,241			8,807,241
	12-Nov-11	10,105,390		12-Nov-11	10,105,390		8,000,000	12-Nov-11	2105390	7,255,390			8,105,390
	12-Dec-11	10,274,439		12-Dec-11	10,274,439		8,000,000	12-Dec-11	2274439	7,424,439			8,274,439
	11-Jan-12	10,363,445		11-Jan-12	10,363,445		8,000,000	11-Jan-12	2363445	7,513,445			8,363,445

Fig54. Screenshot of the details behind the Deposits tab

The function of this tab is to process the original portfolio into a modified portfolio by a defined standard deposit. Standard deposit is the deposit amount that lowers the portfolio CLU right below the limit. This tab sources the original portfolio CLU inputs from "Original CLU Profile" in Column B and C. The current CLU has reached credit limit and any additional trade will cause the entire portfolio CLU exceeding the limit. Recall that in "Original CLU Profile, users can test adding proposed trades to the original portfolio; Column E and Column F in this tab source the CLU calculation of portfolio with new trades added. As the new portfolio CLU overflows, Column I identifies the dates that have NPV over the credit limit. Column J shows the exceeding CLU amount corresponding to the dates. The standard deposit (Cell K3) is then given by the maximum CLU (Cell J3) excess rounded to the nearest 50,000. The new portfolio CLU with standard deposit is calculated in Column K by subtracting standard deposit amount from every date that exceeds CLU. Portfolio with available deposit is calculated the same way with

users' entry.

Deposit Details
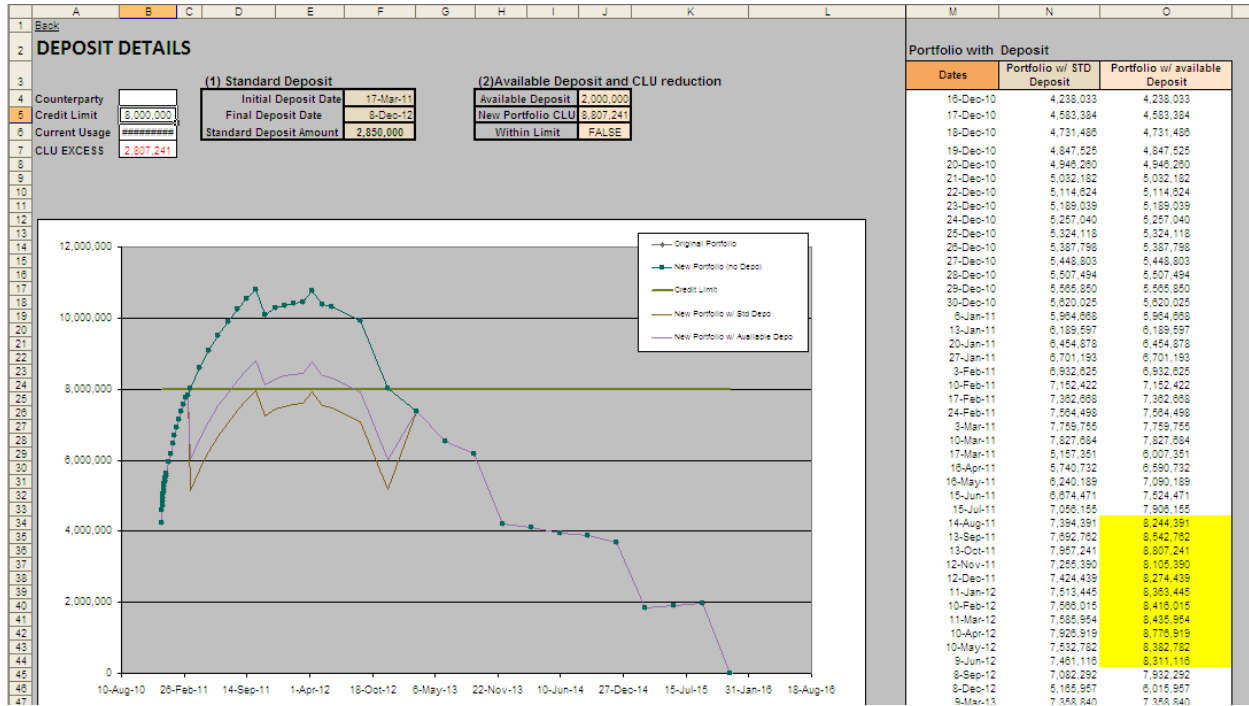
Fig55. Screenshot of entire Deposits tab

This tab displays the deposit strategy results. The two main indicator metrics at the top are (1) standard deposit and (2) available deposit.

The standard deposit field identifies the time period that exceeds credit limit and the standard deposit amount needed to be made. The available deposit metric has a place holder field where users can type any number for available deposit input. As the tool incorporates the available deposit with the original portfolio, the metric also shows the new CLU and suggests if it is still within the limit. From Column M to Column O are CLU calculation of portfolio with standard deposit and portfolio with available deposit extracting from "Deposit CLU Data". A

graph in the middle depicts all CLU behaviours including original portfolio, portfolio with new

trade, portfolio with standard deposit, portfolio with available deposit and credit limit.

Strategic Example

Counterparty	IPECO
Credit Limit	11,000,000
Current Usage	11,909,369
CLU EXCESS	909,369

For the same counterparty IPECO, the original portfolio CLU is 10,807,241. If a credit

limit of 11,000,000 is assumed, any trade with a CLU amount greater than 200,000 cannot be

processed. However IPECO would enter into the deposit agreement with RBS and decide on

making a deposit along with the new trade that gives them additional coverage. Users enters the

new trade CLU in "Original CLU Profile" tab, and "Deposit CLU Data" automatically feed in

the new portfolio. If the new trade were actually added, now the portfolio would have a CLU of

11,909309, which exceeds the CLU limit. Something then has to be done.

ORIGINAL PORTFOLIO			NEW PORTFOLIO	
Original Portfolio	10,807,241		New Portfolio CLU	11,909,369
CLU Peak Date	13-Oct-11		CLU Peak Date	10-Apr-12

The tool identifies the standard deposit to be 950,000.

Max CLU Excess	Standard Deposit		**(1) Standard Deposit**	
909369	950000		Initial Deposit Date	14-Aug-11
			Final Deposit Date	8-Sep-12
			Standard Deposit Amount	950,000

Based on the standard deposit given, users can provide any input for available deposit amount to view difference in CLU and whether the portfolio with available deposit is still within the limit.

(2)Available Deposit and CLU reduction	
Available Deposit	500,000
New Portfolio CLU	11,409,369
Within Limit	FALSE

All portfolio CLU behaviours are assorted together and shown in the graph.
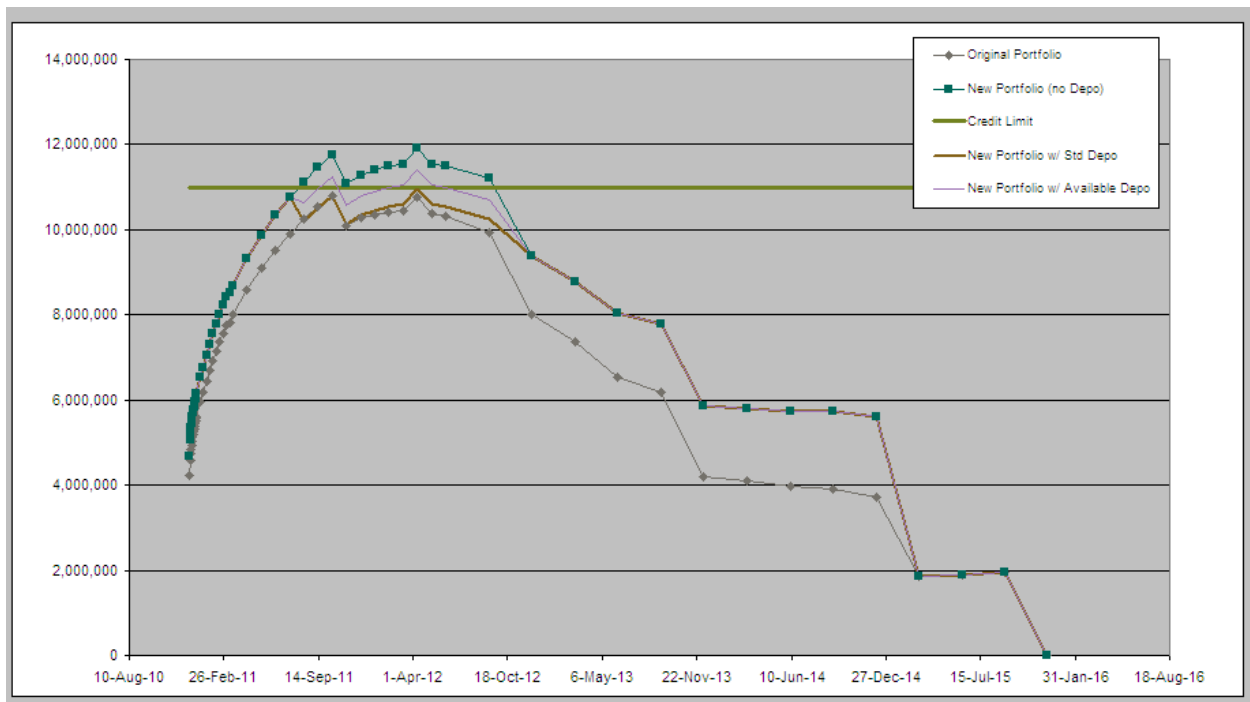
Fig56. Screenshot of the Strategic Example

The graph dynamically depicts the behaviour of original portfolio, portfolio with the new trade but exceeding CLU limit, portfolio with standard deposit and portfolio with available deposit. The green horizontal bar is the credit limit. It helps users clearly see which exceeds the limit and which are under usage.

87

5. Conclusion & Recommendations

Our tool proved to be the first step into a more efficient credit usage within the Currency Structuring Desk at RBS. Over the course of eight weeks, we provided a new perspective on credit and made credit analysis a tangible topic. By understanding the implications of the lack of credit analysis and developing different portfolio optimization strategies we created a tool that will not only provide unmeasurable profit for the firm but will also be a prototype for any system enhancement.

An analysis on the current market conditions led us to see the importance orf optimizing the credit use and taking advantage of credit opportunities that had not been exploited yet. Before our work, portfolios with a full credit line at RBS did not meet the requirements for additional trading activity with the client. Our project showed three solutions for this matter going from a situation with only quantitative credit information to a state where credit information is both: quantitative and qualitative.

For clients with no credit space, the original portfolio showed full credit line utilization and with no possibility of additional transactions, no credit line utilization strategy could be used in amending their portfolios and therefore RBS could neither provide additional coverage for the client nor obtain any profit from them. With the usage of our tool, clients with no credit space show an original portfolio with full credit line utilization that can be amended in three different ways and allow additional trades with the client as well as optimize their coverage.

There is not a final figure of the gain our tool would signify to the currency structuring

desk. However, during our final days at the firm, we were able to provide a solid trade

recommendation by having salespeople use data from a current customer into our tool.
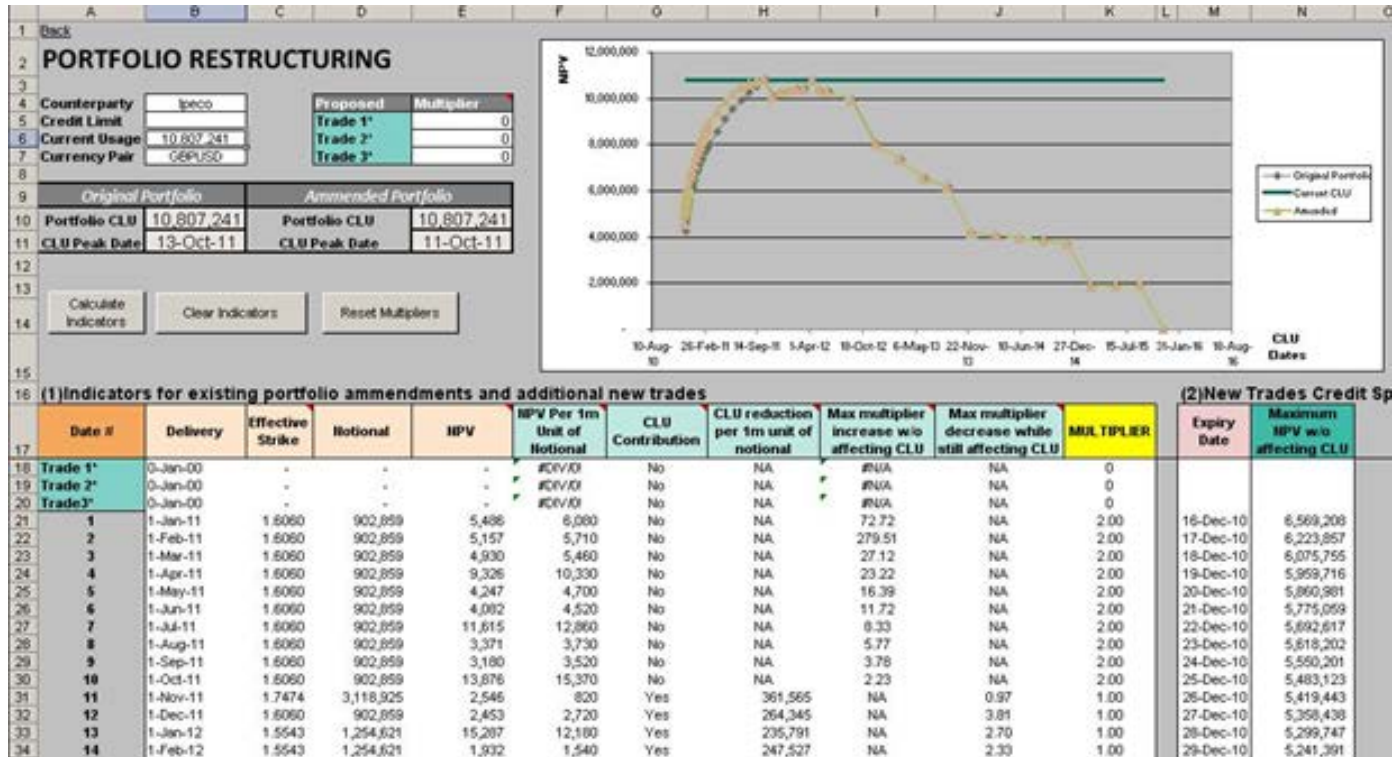
Fig57. Screenshot of the Portfolio Restructuring analysis performed on Ipeco

The following shows a portfolio restructuring analysis where the Ipeco counterparty is

reaching its CLU peak on Oct 13th, 2011. By doubling the notional amounts for an entire year

using a multiplier of two from January 1st, 2011 until September 1st, 2011, we created an

opportunity of an additional ten million pounds on the current portfolio. This trade opportunity

shifts the portfolio CLU graph and it would have not been spotted otherwise.

This is just the beginning to a new credit approach in currency structuring. However,

there are still many aspects we identified while developing our project that could improve the

current platform for our tool and could take our analysis to another level:

Short term

Implementing additional strategies that can predict CLU movements as a function of market moves and as a function of time

In the vanilla pricer, we found information on the current credit usage and current credit limit of each counterparty. This data was updated daily by the credit team based on their analysis. We identified the need to predict how credit would behave across time because this tool gave data in a limited way. We developed the idea of a new CLU Optimization strategy that would be represented as a CLU ladder similar to the across time ladder examples. This ladder would show CLU behaviour by using a given delta and showing portfolio CLU sensibility.

Offering another metric in the "New Vanilla Options" strategy to keep the data source updated according to a given Vol

In our Parameter details tab, we have a data set of all the CLU values for every 5, 10, 15 and 20 delta options. This data was taken at a certain time and serves as the data source for all the calculations related to buying the new credit offset vanilla options. One of the problems with this dataset is that it is not fresh and for this strategy to work, the user would have to retrieve this data from NMOSS. We suggest the usage of a specified vol that can update the current CLU values automatically.

Currently, our analysis can only be applied to portfolios that reach only one peak date but we have no means to experiment on portfolios with multiple peak dates. There might be cases where portfolios have more than one peak date, so we suggest enhancing our current strategies to include this portfolio nature.

Availability to export data from XPortfolio into NMOSS

There are various details such as the PV Value, the delta values and the notional value for specific trades that can not be exported directly from XPortfolio into NMOSS and this lack of connectivity between the two systems generated serious inconvenients in our project. We believe that more consolidation within the two systems would benefit CLU analysis.

Mid Term

An update of the tool with any new indicators based on feedback based on opinions from the first set of users.

Long Term

NMOSS (or successor) System upgrades to include individual date CLU contribution

Current systems only provide CLU information on a portfolio basis. In order to implement any of our proposed strategies, a breakdown of CLU contribution per date is required. We used the strips option on NMOSS to obtain this information but it is not a practical way for our users to obtain the data.

XPortfolio upgrade to include CLU information in order to book hypothetical deals on NMOSS

Hypothetical deals allow us to see how the addition or restructuring of a current portfolio would look without performing the deal. NMOSS does not support booking of hypothetical deals and given that NMOSS holds all CLU data, we believe it would be a great benefit to add this system functionality.

6. Appendix

1. Data for across time ladders

a. Values for the bought call

	26-Oct-10	05-Dec-10	14-Jan-11	23-Feb-11	04-Apr-11	14-May-11	23-Jun-11	02-Aug-11	11-Sep-11	25-Oct-11
2.55	365224	366358	367436	368425	369363	370226	370984	371582	372077	372544
2.4933	351080	352193	353251	354223	355145	355995	356742	357332	357822	358284
2.4367	336282	337370	338408	339360	340266	341102	341838	342420	342904	343360
2.38	320785	321845	322859	323790	324679	325499	326224	326797	327275	327726
2.3233	304545	305569	306554	307462	308331	309136	309848	310413	310884	311330
2.2667	287516	288493	289441	290319	291166	291954	292653	293209	293673	294113
2.21	269656	270568	271466	272304	273123	273891	274577	275123	275580	276014
2.1533	250933	251752	252575	253356	254136	254879	255549	256085	256535	256962
2.0967	231333	232016	232729	233419	234137	234843	235493	236017	236460	236881
2.04	210871	211362	211907	212454	213067	213707	214325	214835	215269	215683
1.9833	189616	189838	190136	190459	190890	191403	191956	192444	192868	193275
1.9267	167708	167570	167521	167504	167632	167903	168308	168738	169150	169548
1.87	145384	144792	144284	143785	143442	143280	143361	143622	143994	144383
1.8133	123004	121880	120807	119684	118676	117822	117271	117076	117272	117645
1.7567	101055	99363	97667	95821	93988	92183	90602	89411	88926	89183
1.7	80138	77914	75620	73060	70371	67498	64601	61801	59507	58823
1.6452	61504	58886	56146	53050	49703	45975	41942	37531	32670	27451
1.5938	45995	43188	40243	36915	33293	29221	24740	19694	13702	939
1.5455	33515	30730	27828	24588	21104	17258	13146	8752	4106	0
1.5	23800	21216	18565	15671	12648	9453	6264	3256	846	0
1.4571	16481	14220	11955	9562	7169	4801	2674	1011	118	0
1.4167	11137	9260	7437	5590	3847	2263	1024	262	11	0

1.3784	7350	5865	4475	3136	1957	993	353	57	1	0
1.3421	4743	3617	2608	1691	947	406	110	11	0	0
1.3077	2996	2175	1474	878	436	156	31	2	0	0
1.275	1854	1276	810	440	192	56	8	0	0	0
1.2439	1125	732	433	213	81	19	2	0	0	0
1.2143	671	411	225	100	33	6	0	0	0	0
1.186	393	226	115	45	13	2	0	0	0	0
1.1591	227	122	57	20	5	1	0	0	0	0
1.1333	129	65	28	9	2	0	0	0	0	0

B. Values for the sold call

	26-Oct-10	05-Dec-10	14-Jan-11	23-Feb-11	04-Apr-11	14-May-2011	23-Jun-11	02-Aug-11	11-Sep-11	25-Oct-11
2.55	-365224	-366348	-367418	-368424	-369376	-370239	-370988	-371590	-372083	-372544
2.4933	-351081	-352183	-353234	-354222	-355159	-356008	-356746	-357340	-357828	-358284
2.4367	-336283	-337360	-338390	-339359	-340280	-341115	-341842	-342428	-342910	-343360
2.38	-320788	-321836	-322841	-323789	-324692	-325513	-326228	-326806	-327281	-327726
2.3233	-304550	-305561	-306537	-307460	-308345	-309150	-309852	-310421	-310891	-311330
2.2667	-287524	-288486	-289424	-290318	-291181	-291968	-292658	-293217	-293680	-294113
2.21	-269670	-270565	-271450	-272304	-273138	-273906	-274581	-275131	-275587	-276014
2.1533	-250957	-251755	-252564	-253358	-254152	-254895	-255554	-256094	-256542	-256962
2.0967	-231371	-232031	-232724	-233426	-234156	-234859	-235498	-236027	-236467	-236881
2.04	-210931	-211394	-211915	-212470	-213091	-213725	-214330	-214845	-215277	-215683
1.9833	-189706	-189895	-190166	-190490	-190924	-191426	-191963	-192454	-192876	-193275
1.9267	-167837	-167664	-167582	-167561	-167685	-167937	-168319	-168749	-169158	-169548
1.87	-145563	-144934	-144389	-143880	-143526	-143336	-143383	-143636	-144002	-144383
1.8133	-123240	-122078	-120968	-119830	-118806	-117916	-117319	-117101	-117281	-117645
1.7567	-101350	-99622	-97889	-96028	-94177	-92332	-90697	-89466	-88939	-89183
1.7	-80485	-78229	-75902	-73328	-70621	-67710	-64761	-61914	-59536	-58823
1.6452	-61886	-59240	-56471	-53363	-49999	-46238	-42159	-37708	-32730	-27451

1.5938	-46389	-43556	-40585	-37243	-33602	-29498	-24976	-19892	-13774	-935
1.5455	-33897	-31087	-28158	-24899	-21391	-17511	-13355	-8915	-4155	0
1.5	-24152	-21540	-18861	-15943	-12889	-9654	-6417	-3357	-865	0
1.4571	-16788	-14498	-12203	-9781	-7353	-4942	-2768	-1058	-123	0
1.4167	-11393	-9486	-7632	-5754	-3975	-2352	-1073	-280	-12	0
1.3784	-7555	-6040	-4620	-3251	-2040	-1043	-375	-62	-1	0
1.3421	-4901	-3747	-2711	-1767	-996	-432	-119	-12	0	0
1.3077	-3113	-2267	-1544	-925	-464	-168	-34	-2	0	0
1.275	-1938	-1340	-854	-468	-206	-61	-9	0	0	0
1.2439	-1184	-774	-460	-229	-88	-21	-2	0	0	0
1.2143	-710	-438	-242	-108	-36	-7	0	0	0	0
1.186	-419	-243	-124	-50	-14	-2	0	0	0	0
1.1591	-244	-132	-62	-22	-5	-1	0	0	0	0
1.1333	-139	-71	-31	-10	-2	0	0	0	0	0

2. Excel macro code

```
Sub AggregateNPV()
'sort PV fields by dates


 Range("I1:L1").Select
    Range(Selection, Selection.End(xlDown)).Select
    Selection.Sort Key1:=Range("I2"), Order1:=xlAscending, Key2:=Range("J2") _
        , Order2:=xlAscending, Header:=xlGuess, OrderCustom:=1, MatchCase:= _
        False, Orientation:=xlTopToBottom, SortMethod:=xlPinYin, DataOption1:= _
        xlSortNormal, DataOption2:=xlSortNormal


'create pivot table of total PVs for unique dates
```

```
 Range("I1:J1").Select

    Range(Selection, Selection.End(xlDown)).Select

    Selection.Copy

    Application.CutCopyMode = False

    ActiveWorkbook.PivotCaches.Add(SourceType:=xlDatabase, SourceData:= _

        "XPortfolio!R1C9:R422C10").CreatePivotTable TableDestination:="XPortfolio!R2C22",
TableName:="PivotTable5", DefaultVersion _

        :=xlPivotTableVersion10

    Sheets("XPortfolio").Select

     ActiveWorkbook.ShowPivotTableFieldList = True

    With ActiveSheet.PivotTables("PivotTable5").PivotFields("Delivery Date")

    .Orientation = xlRowField

        .Position = 1

    End With


     ActiveSheet.PivotTables("PivotTable5").AddDataField ActiveSheet.PivotTables("PivotTable5" _

        ).PivotFields("PV Value"), "Sum of PV Value", xlSum


     'paste pivot table


      Range("V3:W3").Select

    Range(Selection, Selection.End(xlDown)).Select


    Selection.Copy


    Range("N3").Select
```

```vba
    ActiveSheet.Paste


  'clear pivot table


   Range("U1").Select
   Range(Selection, Selection.End(xlToRight)).Select
   Range(Selection, Selection.End(xlDown)).Select
   Application.CutCopyMode = False
   Selection.Clear


   'fill background


 Selection.Interior.ColorIndex = 15


 Range("O3").Select
   ActiveCell.FormulaR1C1 = "PV total"


   With Selection.Font
       .Name = "Arial"
       .Size = 10
       .Strikethrough = False
       .Superscript = False
       .Subscript = False
       .OutlineFont = False
       .Shadow = False
```

```
            .Underline = xlUnderlineStyleNone

            .ColorIndex = xlAutomatic

    End With


End Sub


Sub clearNPV()

Range("n2:o1000").Select

Selection.ClearContents



End Sub


Sub GetPortfolioCLU()

'Button:Get Portfolio Clu


'


'inputting dates and CLU formula


    Range("b9:b1000").Select


    Selection.Formula = "=IF(A9="""","""",DATEVALUE(MID(A9,5,11)))"



        Range("c9:c1000").Select
```

```vba
Selection.Formula = "=IF(A9="""","""",SUM(e9:IV9))"


    Range("d9:d1000").Select


    Selection.Formula = "=IF(A9="""","""",MAX($c$9:$c$1000))"




  Range("b9").Select

    Selection.End(xlDown).Select

    Selection.Offset(1, 0).Select

    Range(Selection, Selection.End(xlToRight)).Select

     Range(Selection, Selection.End(xlDown)).Select


    Application.CutCopyMode = False

    Selection.Clear



  Range("B9").Select

    Range(Selection, Selection.End(xlDown)).Select

    Selection.NumberFormat = "[$-409]d-mmm-yy;@"



    'Copy Dates to Amended
```

99

```vba
Range("A9:d9").Select

Range(Selection, Selection.End(xlDown)).Select

Application.CutCopyMode = False

Selection.Copy

Sheets("Amended CLU Profile").Select

Range("A9").Select

ActiveSheet.Paste


Sheets("Original CLU Profile").Select


Range("c1").Select




End Sub


Sub ClearAllFields()
    'clear orignial



    Sheets("Original CLU Profile").Select


    Range("A9:IV1000").Select
```

```
        Selection.Clear

        'clear amended


        Sheets("Amended CLU Profile").Select

        Range("a9:d1000").Select


        Selection.Clear


        Sheets("Original CLU Profile").Select

Range("f7").Select




End Sub


Sub getheader()

Sheets("Original CLU profile").Select


'name ranges in original clu profile



Range("b9").Select

        Range(Selection, Selection.End(xlDown)).Select
```

```vba
    ActiveWorkbook.Names.Add Name:="Date", RefersToR1C1:= _
        "='Original CLU profile'!R9C2:R1000C2"


Range("c9").Select

Range(Selection, Selection.End(xlDown)).Select

ActiveWorkbook.Names.Add Name:="CLU", RefersToR1C1:="='Original CLU
profile'!R9C3:R1000C3"


Range("e7").Select

    Range(Selection, Selection.End(xlToRight)).Select

  ActiveWorkbook.Names.Add Name:="Header", RefersToR1C1:="='Original CLU
profile'!R7C5:R7C256"


    Selection.Copy


    'copy ranges to EX-portfolio



Sheets("Ex-Portfolio").Select


Range("C1").Select

Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False
```

```
Sheets("Original CLU profile").Select

Range("Date").Select

Selection.Copy

Sheets("Ex-Portfolio").Select

Range("A2").Select

Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _

        :=False, Transpose:=False


Sheets("Original CLU profile").Select

Range("CLU").Select

Selection.Copy

Sheets("Ex-Portfolio").Select

Range("B2").Select

Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _

        :=False, Transpose:=False


Range("C2").Activate


    ActiveCell.FormulaR1C1 = _

        "='Original CLU Profile'!R[7]C3-'Original CLU Profile'!R[7]C[2]"

    Range("C2").Select


    Selection.Copy

    Range("B2").Select

    Selection.End(xlDown).Select
```

```vba
    Selection.Offset(0, 1).Select


    Range(Selection, Selection.End(xlUp)).Select
  Selection.Activate
   ActiveSheet.Paste
  ActiveSheet.Select
   Selection.Activate


   Selection.Copy


  num3 = WorksheetFunction.Count(Range("a1:iv1"))
  Range(Cells(2, 4), Cells(2, num3 + 2)).Select




    ActiveSheet.Paste


Sheets("Ex-Portfolio").Select
Range("c1").Select
Range(Selection, Selection.End(xlToRight)).Select
Selection.Copy
Sheets("Trade Details").Select
Range("a18").Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
```

```
            :=False, Transpose:=True

      Sheets("Ex-Portfolio").Select

        a_ct = WorksheetFunction.Count(Range("a1:a1000"))

        num1 = a_ct + 2



        Range("A" & num1 & ":IV1000").Select

        Selection.Clear

     'inserting "max" row



        Rows("2:2").Select

    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove

    Range("B2").Select



    ActiveCell.FormulaR1C1 = "=MAX(R[1]C:R[498]C)"

        Selection.Copy



    Range("C2").Select

    Range(Selection, Selection.End(xlToRight)).Select

    ActiveSheet.Paste


'inserting peak date contribution row


Rows("2:2").Select

    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
```

```vba
        Range("C2").Select


ActiveCell.FormulaR1C1 = _

        "=INDEX(R[2]C:R[998]C,MATCH('Original CLU Profile'!R[4]C[2],'Original CLU
Profile'!R[7]C[2]:R[998]C[2],0))"

    Range("C2").Select

    Selection.Copy

    Range("D2").Select

    Range(Selection, Selection.End(xlToRight)).Select

    ActiveSheet.Paste


'Getting Ammended Profile




    Sheets("Amended CLU Profile").Select


        Range("e9").Select

    ActiveCell.FormulaR1C1 = _

        "=IF(R7C="""""",0,'Original CLU Profile'!RC*'Amended CLU Profile'!R3C)"

    Range("e9").Select

    Selection.Copy


    num2 = WorksheetFunction.CountA(Range("a8:a1000"))

    i = num2 + 7
```

106

```vba
        Range("e9" & ":iv" & i).Select

        ActiveSheet.Paste


    Sheets("Trade Details").Select


End Sub



Sub Clearrow2()
'
' Clearrow2 Macro
' Macro recorded 11/16/2010 by qinya
'


'
Sheets("Trade Details").Select

        Range("A18").Select
        Range(Selection, Selection.End(xlDown)).Select
        Selection.ClearContents

        Sheets("Ex-Portfolio").Select
        Cells.Clear
```

```vba
    'clear amended

    Sheets("Amended CLU Profile").Select

    Range("e9:iv1000").Select


    Selection.Clear



    Sheets("Trade Details").Select



End Sub

Sub Reset_Multipliers()



    Range("K21:K256").Select

    Selection.Formula = "=IF(A21="""","""",1)"


End Sub
```

3. IPECO raw data input

Xportfolio

Cash flow analysis

		0.99	0.99	Strikes	Abs. Strike
	Total	48,063,532	- 78,200,000		
	Dec-10	0	0		
1	Jan-11	902,859	-1,450,000	-1.6060	1.6060
2	Feb-11	902,859	-1,450,000	-1.6060	1.6060
3	Mar-11	902,859	-1,450,000	-1.6060	1.6060
4	Apr-11	902,859	-1,450,000	-1.6060	1.6060
5	May-11	902,859	-1,450,000	-1.6060	1.6060
6	Jun-11	902,859	-1,450,000	-1.6060	1.6060
7	Jul-11	902,859	-1,450,000	-1.6060	1.6060
8	Aug-11	902,859	-1,450,000	-1.6060	1.6060
9	Sep-11	902,859	-1,450,000	-1.6060	1.6060
10	Oct-11	902,859	-1,450,000	-1.6060	1.6060
11	Nov-11	3,118,925	-5,450,000	-1.7474	1.7474
12	Dec-11	902,859	-1,450,000	-1.6060	1.6060
13	Jan-12	1,254,621	-1,950,000	-1.5543	1.5543
14	Feb-12	1,254,621	-1,950,000	-1.5543	1.5543
15	Mar-12	1,254,621	-1,950,000	-1.5543	1.5543
16	Apr-12	1,254,621	-1,950,000	-1.5543	1.5543
17	May-12	1,254,621	-1,950,000	-1.5543	1.5543
18	Jun-12	1,254,621	-1,950,000	-1.5543	1.5543
19	Jul-12	1,254,621	-1,950,000	-1.5543	1.5543
20	Aug-12	1,254,621	-1,950,000	-1.5543	1.5543
21	Sep-12	1,254,621	-1,950,000	-1.5543	1.5543
22	Oct-12	1,254,621	-1,950,000	-1.5543	1.5543
23	Nov-12	1,254,621	-1,950,000	-1.5543	1.5543
24	Dec-12	3,470,687	-5,950,000	-1.7144	1.7144
25	Jan-13	947,960	-1,500,000	-1.5823	1.5823
26	Feb-13	947,960	-1,500,000	-1.5823	1.5823
27	Mar-13	947,960	-1,500,000	-1.5823	1.5823
28	Apr-13	947,960	-1,500,000	-1.5823	1.5823
29	May-13	947,960	-1,500,000	-1.5823	1.5823
30	Jun-13	947,960	-1,500,000	-1.5823	1.5823
31	Jul-13	513,851	-800,000	-1.5569	1.5569
32	Aug-13	513,851	-800,000	-1.5569	1.5569
33	Sep-13	513,851	-800,000	-1.5569	1.5569
34	Oct-13	513,851	-800,000	-1.5569	1.5569
35	Nov-13	513,851	-800,000	-1.5569	1.5569
36	Dec-13	2,729,917	-4,800,000	-1.7583	1.7583

37	Jan-14	193,548	-300,000	-1.5500	1.5500
38	Feb-14	193,548	-300,000	-1.5500	1.5500
39	Mar-14	193,548	-300,000	-1.5500	1.5500
40	Apr-14	193,548	-300,000	-1.5500	1.5500
41	May-14	193,548	-300,000	-1.5500	1.5500
42	Jun-14	193,548	-300,000	-1.5500	1.5500
43	Jul-14	193,548	-300,000	-1.5500	1.5500
44	Aug-14	193,548	-300,000	-1.5500	1.5500
45	Sep-14	193,548	-300,000	-1.5500	1.5500
46	Oct-14	193,548	-300,000	-1.5500	1.5500
47	Nov-14	193,548	-300,000	-1.5500	1.5500
48	Dec-14	2,409,614	-4,300,000	-1.7845	1.7845
49	Dec-15	2,216,066	-4,000,000	-1.8050	1.8050

Deal level report

Delivery Date	PV Value	PV Ccy	PV Delta
20-Jan-11	-9,382	GBP	47,428
20-Jan-11	-341	GBP	-26,545
20-Jan-11	6	GBP	9
20-Jan-11	15,203	GBP	-380,437
26-Jan-11	-1,631	GBP	-100,185
26-Jan-11	6,788	GBP	-183,948
2-Feb-11	-2,110	GBP	-111,956
2-Feb-11	7,040	GBP	-178,036
17-Feb-11	-6,387	GBP	-25,258
17-Feb-11	-1,040	GBP	-47,411
17-Feb-11	63	GBP	1,200
17-Feb-11	16,690	GBP	-338,508
24-Feb-11	-3,553	GBP	-136,546
24-Feb-11	7,800	GBP	-165,657
2-Mar-11	-3,903	GBP	-141,006
2-Mar-11	7,985	GBP	-163,403
17-Mar-11	-5,040	GBP	-18,200
17-Mar-11	-1,750	GBP	-58,787
17-Mar-11	211	GBP	6,546
17-Mar-11	18,194	GBP	-315,549
28-Mar-11	-5,418	GBP	-156,326
28-Mar-11	8,789	GBP	-155,625
4-Apr-11	-5,830	GBP	-159,680
4-Apr-11	9,010	GBP	-153,910
19-Apr-11	-3,939	GBP	-14,959
19-Apr-11	-2,550	GBP	-67,250
19-Apr-11	444	GBP	15,548
19-Apr-11	19,921	GBP	-298,288
28-Apr-11	-7,202	GBP	-169,084
28-Apr-11	9,748	GBP	-149,067
4-May-11	-7,414	GBP	-170,288

4-May-11	9,867	GBP	-148,427
18-May-11	-3,515	GBP	-9,835
18-May-11	-3,194	GBP	-72,190
18-May-11	667	GBP	22,581
18-May-11	21,329	GBP	-288,066
26-May-11	-8,560	GBP	-176,349
26-May-11	10,492	GBP	-145,249
2-Jun-11	-8,877	GBP	-177,826
2-Jun-11	10,668	GBP	-144,461
17-Jun-11	-3,804	GBP	-75,880
17-Jun-11	-3,078	GBP	-7,800
17-Jun-11	917	GBP	28,162
17-Jun-11	22,685	GBP	-280,285
27-Jun-11	-9,952	GBP	-182,289
27-Jun-11	11,268	GBP	-142,035
5-Jul-11	-10,278	GBP	-183,491
5-Jul-11	11,452	GBP	-141,364
19-Jul-11	-4,444	GBP	-78,959
19-Jul-11	-2,732	GBP	-6,669
19-Jul-11	1,220	GBP	32,621
19-Jul-11	24,113	GBP	-273,611
26-Jul-11	-11,285	GBP	-186,975
26-Jul-11	12,010	GBP	-139,430
2-Aug-11	-11,585	GBP	-187,915
2-Aug-11	12,179	GBP	-138,893
17-Aug-11	-5,005	GBP	-81,228
17-Aug-11	-2,564	GBP	-5,407
17-Aug-11	1,496	GBP	35,576
17-Aug-11	25,379	GBP	-268,550
26-Aug-11	-12,621	GBP	-190,915
26-Aug-11	12,764	GBP	-137,150
2-Sep-11	-12,895	GBP	-191,636
2-Sep-11	12,921	GBP	-136,715
19-Sep-11	-5,571	GBP	-83,154
19-Sep-11	-2,321	GBP	-4,799
19-Sep-11	1,793	GBP	37,777
19-Sep-11	26,691	GBP	-264,036
27-Sep-11	-13,789	GBP	-193,778
27-Sep-11	13,443	GBP	-135,375
4-Oct-11	-14,045	GBP	-194,373
4-Oct-11	13,591	GBP	-135,006
19-Oct-11	-6,082	GBP	-84,701
19-Oct-11	-2,207	GBP	-4,099
19-Oct-11	2,060	GBP	39,214
19-Oct-11	27,865	GBP	-260,370
26-Oct-11	-14,842	GBP	-196,109
26-Oct-11	14,052	GBP	-133,905
2-Nov-11	-15,082	GBP	-196,598
2-Nov-11	14,192	GBP	-133,584
17-Nov-11	-6,539	GBP	-85,919

111

17-Nov-11	-2,120	GBP	-3,595
17-Nov-11	2,302	GBP	40,133
17-Nov-11	28,933	GBP	-257,341
25-Nov-11	-15,876	GBP	-198,129
25-Nov-11	14,657	GBP	-132,558
2-Dec-11	-16,101	GBP	-198,531
2-Dec-11	14,791	GBP	-132,276
15-Dec-11	-7,719	GBP	-135,860
15-Dec-11	368,310	GBP	-1,915,857
19-Dec-11	-6,984	GBP	-86,936
19-Dec-11	-1,998	GBP	-3,320
19-Dec-11	2,537	GBP	40,727
19-Dec-11	30,017	GBP	-254,609
29-Dec-11	-16,831	GBP	-199,657
29-Dec-11	15,247	GBP	-131,423
4-Jan-12	-17,051	GBP	-200,051
4-Jan-12	15,375	GBP	-131,174
19-Jan-12	-7,441	GBP	-87,953
19-Jan-12	-1,892	GBP	-3,078
19-Jan-12	2,774	GBP	41,142
19-Jan-12	31,099	GBP	-252,075
26-Jan-12	-11,942	GBP	-103,999
26-Jan-12	4,814	GBP	35,749
26-Jan-12	9,818	GBP	-96,351
31-Jan-12	-9,845	GBP	-118,164
31-Jan-12	11,915	GBP	-92,522
2-Feb-12	-12,008	GBP	-103,807
2-Feb-12	4,822	GBP	35,467
2-Feb-12	9,982	GBP	-97,244
17-Feb-12	-7,836	GBP	-88,748
17-Feb-12	-1,863	GBP	-2,770
17-Feb-12	2,976	GBP	41,343
17-Feb-12	32,052	GBP	-250,007
24-Feb-12	-12,214	GBP	-103,226
24-Feb-12	4,846	GBP	34,610
24-Feb-12	10,477	GBP	-99,660
29-Feb-12	-10,390	GBP	-119,481
29-Feb-12	12,244	GBP	-91,692
2-Mar-12	-12,276	GBP	-103,051
2-Mar-12	4,853	GBP	34,356
2-Mar-12	10,637	GBP	-100,441
19-Mar-12	-8,211	GBP	-89,420
19-Mar-12	-1,800	GBP	-2,595
19-Mar-12	3,165	GBP	41,407
19-Mar-12	32,980	GBP	-248,143
27-Mar-12	-12,481	GBP	-102,469
27-Mar-12	4,874	GBP	33,535
27-Mar-12	11,199	GBP	-103,148
29-Mar-12	-10,911	GBP	-120,645
29-Mar-12	12,564	GBP	-90,937

3-Apr-12	-12,540	GBP	-102,309
3-Apr-12	4,880	GBP	33,306
3-Apr-12	11,354	GBP	-103,823
18-Apr-12	-8,591	GBP	-90,066
18-Apr-12	-1,721	GBP	-2,470
18-Apr-12	3,352	GBP	41,389
18-Apr-12	33,917	GBP	-246,340
25-Apr-12	-12,727	GBP	-101,820
25-Apr-12	4,898	GBP	32,610
25-Apr-12	11,811	GBP	-105,635
1-May-12	-11,455	GBP	-121,749
1-May-12	12,904	GBP	-90,185
2-May-12	-12,784	GBP	-101,671
2-May-12	4,903	GBP	32,401
2-May-12	11,961	GBP	-106,230
17-May-12	-8,937	GBP	-90,606
17-May-12	-1,687	GBP	-2,306
17-May-12	3,519	GBP	41,296
17-May-12	34,785	GBP	-244,759
29-May-12	-12,980	GBP	-101,136
29-May-12	4,918	GBP	31,683
29-May-12	12,552	GBP	-108,642
30-May-12	-11,935	GBP	-122,661
30-May-12	13,206	GBP	-89,550
6-Jun-12	-13,032	GBP	-100,987
6-Jun-12	4,922	GBP	31,491
6-Jun-12	12,699	GBP	-109,165
19-Jun-12	-9,299	GBP	-91,112
19-Jun-12	-1,597	GBP	-2,227
19-Jun-12	3,690	GBP	41,127
19-Jun-12	35,714	GBP	-243,167
26-Jun-12	-13,207	GBP	-100,585
26-Jun-12	4,936	GBP	30,915
26-Jun-12	13,111	GBP	-110,323
29-Jun-12	-12,419	GBP	-123,519
29-Jun-12	13,514	GBP	-88,933
3-Jul-12	-13,259	GBP	-100,455
3-Jul-12	4,940	GBP	30,741
3-Jul-12	13,254	GBP	-110,788
18-Jul-12	-9,619	GBP	-91,532
18-Jul-12	-1,594	GBP	-2,085
18-Jul-12	3,837	GBP	40,938
18-Jul-12	36,538	GBP	-241,808
26-Jul-12	-13,433	GBP	-100,036
26-Jul-12	4,952	GBP	30,173
26-Jul-12	13,750	GBP	-112,446
31-Jul-12	-12,880	GBP	-124,250
31-Jul-12	13,816	GBP	-88,364
2-Aug-12	-13,483	GBP	-99,913
2-Aug-12	4,955	GBP	30,012

2-Aug-12	13,889	GBP	-112,854
17-Aug-12	-9,942	GBP	-91,928
17-Aug-12	-1,530	GBP	-2,006
17-Aug-12	3,982	GBP	40,708
17-Aug-12	37,380	GBP	-240,474
29-Aug-12	-13,654	GBP	-99,465
29-Aug-12	-13,309	GBP	-124,899
29-Aug-12	4,964	GBP	29,451
29-Aug-12	14,097	GBP	-87,852
29-Aug-12	14,418	GBP	-114,406
4-Sep-12	-13,704	GBP	-99,360
4-Sep-12	4,967	GBP	29,304
4-Sep-12	14,554	GBP	-114,758
19-Sep-12	-10,264	GBP	-92,272
19-Sep-12	-1,474	GBP	-1,933
19-Sep-12	4,124	GBP	40,433
19-Sep-12	38,243	GBP	-239,177
25-Sep-12	-13,844	GBP	-99,019
25-Sep-12	4,974	GBP	28,873
25-Sep-12	14,877	GBP	-115,305
1-Oct-12	-13,758	GBP	-125,513
1-Oct-12	14,399	GBP	-87,328
2-Oct-12	-13,890	GBP	-98,908
2-Oct-12	4,976	GBP	28,733
2-Oct-12	15,010	GBP	-115,634
17-Oct-12	-10,536	GBP	-92,545
17-Oct-12	-1,493	GBP	-1,820
17-Oct-12	4,240	GBP	40,181
17-Oct-12	38,977	GBP	-238,109
25-Oct-12	-14,045	GBP	-98,548
25-Oct-12	4,983	GBP	28,277
25-Oct-12	15,504	GBP	-117,013
31-Oct-12	-14,177	GBP	-126,062
31-Oct-12	14,680	GBP	-86,854
2-Nov-12	-14,099	GBP	-98,424
2-Nov-12	4,986	GBP	28,122
2-Nov-12	15,682	GBP	-117,510
19-Nov-12	-10,835	GBP	-92,810
19-Nov-12	-1,406	GBP	-1,787
19-Nov-12	4,364	GBP	39,872
19-Nov-12	39,805	GBP	-236,952
27-Nov-12	-14,242	GBP	-98,057
27-Nov-12	4,990	GBP	27,692
27-Nov-12	16,131	GBP	-118,443
29-Nov-12	-14,562	GBP	-126,526
29-Nov-12	14,944	GBP	-86,426
4-Dec-12	-14,285	GBP	-97,955
4-Dec-12	4,991	GBP	27,571
4-Dec-12	16,234	GBP	-118,566
19-Dec-12	-11,118	GBP	-93,056

19-Dec-12	-1,395	GBP	-1,720
19-Dec-12	4,480	GBP	39,577
19-Dec-12	40,579	GBP	-235,868
20-Dec-12	-21,370	GBP	-236,073
20-Dec-12	404,950	GBP	-1,681,652
28-Dec-12	-14,422	GBP	-97,615
28-Dec-12	4,996	GBP	27,178
28-Dec-12	16,615	GBP	-119,275
31-Dec-12	-14,966	GBP	-126,973
31-Dec-12	15,214	GBP	-85,947
3-Jan-13	-14,471	GBP	-97,527
3-Jan-13	4,999	GBP	27,058
3-Jan-13	16,755	GBP	-119,527
17-Jan-13	-11,404	GBP	-93,307
17-Jan-13	-1,342	GBP	-1,641
17-Jan-13	4,598	GBP	39,284
17-Jan-13	41,287	GBP	-234,581
30-Jan-13	-11,140	GBP	-81,526
30-Jan-13	-10,857	GBP	-80,172
30-Jan-13	-3,607	GBP	5,517
30-Jan-13	-2,449	GBP	4,021
30-Jan-13	3,051	GBP	17,232
30-Jan-13	3,506	GBP	21,082
30-Jan-13	14,899	GBP	-90,227
30-Jan-13	24,399	GBP	-148,669
19-Feb-13	-11,703	GBP	-93,532
19-Feb-13	-1,275	GBP	-1,589
19-Feb-13	4,719	GBP	38,950
19-Feb-13	42,041	GBP	-233,208
28-Feb-13	-11,053	GBP	-80,080
28-Feb-13	-2,293	GBP	3,189
28-Feb-13	3,528	GBP	20,741
28-Feb-13	15,204	GBP	-89,973
1-Mar-13	-11,345	GBP	-81,408
1-Mar-13	-3,558	GBP	5,034
1-Mar-13	3,063	GBP	16,925
1-Mar-13	24,932	GBP	-148,276
19-Mar-13	-11,957	GBP	-93,709
19-Mar-13	-1,294	GBP	-1,514
19-Mar-13	4,819	GBP	38,660
19-Mar-13	42,678	GBP	-232,046
28-Mar-13	-11,233	GBP	-79,984
28-Mar-13	-2,287	GBP	3,006
28-Mar-13	3,548	GBP	20,431
28-Mar-13	15,488	GBP	-89,728
2-Apr-13	-11,517	GBP	-81,248
2-Apr-13	-3,588	GBP	4,851
2-Apr-13	3,072	GBP	16,653
2-Apr-13	25,405	GBP	-147,904
17-Apr-13	-12,217	GBP	-93,876

115

17-Apr-13	-1,251	GBP	-1,471
17-Apr-13	4,921	GBP	38,356
17-Apr-13	43,330	GBP	-230,853
30-Apr-13	-11,432	GBP	-79,857
30-Apr-13	-2,194	GBP	2,549
30-Apr-13	3,567	GBP	20,089
30-Apr-13	15,804	GBP	-89,443
1-May-13	-11,723	GBP	-81,138
1-May-13	-3,441	GBP	4,115
1-May-13	3,083	GBP	16,368
1-May-13	25,933	GBP	-147,481
17-May-13	-12,482	GBP	-94,030
17-May-13	-1,205	GBP	-1,423
17-May-13	5,021	GBP	38,037
17-May-13	43,994	GBP	-229,633
29-May-13	-11,891	GBP	-81,009
29-May-13	-3,498	GBP	4,086
29-May-13	3,091	GBP	16,127
29-May-13	26,381	GBP	-147,101
30-May-13	-11,618	GBP	-79,746
30-May-13	-2,185	GBP	2,386
30-May-13	3,586	GBP	19,780
30-May-13	16,099	GBP	-89,168
19-Jun-13	-12,746	GBP	-94,145
19-Jun-13	-1,163	GBP	-1,378
19-Jun-13	5,120	GBP	37,696
19-Jun-13	44,670	GBP	-228,372
28-Jun-13	-11,790	GBP	-79,629
28-Jun-13	-2,179	GBP	2,249
28-Jun-13	3,601	GBP	19,497
28-Jun-13	16,373	GBP	-88,902
1-Jul-13	-12,075	GBP	-80,847
1-Jul-13	-3,353	GBP	3,466
1-Jul-13	3,098	GBP	15,860
1-Jul-13	26,882	GBP	-146,653
31-Jul-13	-12,249	GBP	-80,703
31-Jul-13	-11,969	GBP	-79,482
31-Jul-13	-3,345	GBP	3,255
31-Jul-13	-2,112	GBP	1,949
31-Jul-13	3,105	GBP	15,620
31-Jul-13	3,616	GBP	19,197
31-Jul-13	16,665	GBP	-88,605
31-Jul-13	27,348	GBP	-146,221
29-Aug-13	-12,409	GBP	-80,556
29-Aug-13	-3,337	GBP	3,079
29-Aug-13	3,110	GBP	15,399
29-Aug-13	27,782	GBP	-145,801
30-Aug-13	-12,138	GBP	-79,351
30-Aug-13	-2,105	GBP	1,832
30-Aug-13	3,629	GBP	18,925

30-Aug-13	16,937	GBP	-88,321
30-Sep-13	-12,289	GBP	-79,196
30-Sep-13	-2,100	GBP	1,732
30-Sep-13	3,640	GBP	18,670
30-Sep-13	17,190	GBP	-88,040
1-Oct-13	-12,576	GBP	-80,376
1-Oct-13	-3,232	GBP	2,669
1-Oct-13	3,115	GBP	15,164
1-Oct-13	28,245	GBP	-145,329
30-Oct-13	-12,725	GBP	-80,220
30-Oct-13	-12,447	GBP	-79,053
30-Oct-13	-3,256	GBP	2,597
30-Oct-13	-2,054	GBP	1,545
30-Oct-13	3,119	GBP	14,961
30-Oct-13	3,651	GBP	18,418
30-Oct-13	17,448	GBP	-87,748
30-Oct-13	28,657	GBP	-144,894
29-Nov-13	-12,877	GBP	-80,054
29-Nov-13	-12,600	GBP	-78,904
29-Nov-13	-3,186	GBP	2,319
29-Nov-13	-2,030	GBP	1,416
29-Nov-13	3,122	GBP	14,755
29-Nov-13	3,660	GBP	18,174
29-Nov-13	17,700	GBP	-87,454
29-Nov-13	29,077	GBP	-144,434
19-Dec-13	-30,608	GBP	-126,438
19-Dec-13	-26,909	GBP	-253,525
19-Dec-13	327,433	GBP	-1,822,962
31-Dec-13	-13,046	GBP	-79,910
31-Dec-13	-12,769	GBP	-78,777
31-Dec-13	-3,101	GBP	2,005
31-Dec-13	-1,975	GBP	1,222
31-Dec-13	3,127	GBP	14,546
31-Dec-13	3,672	GBP	17,927
31-Dec-13	17,955	GBP	-87,104
31-Dec-13	29,505	GBP	-143,883
30-Jan-14	-13,526	GBP	-80,963
30-Jan-14	-3,178	GBP	5,110
30-Jan-14	4,126	GBP	19,775
30-Jan-14	17,718	GBP	-85,189
4-Mar-14	-13,725	GBP	-80,851
4-Mar-14	-3,007	GBP	4,213
4-Mar-14	4,144	GBP	19,498
4-Mar-14	17,983	GBP	-84,800
1-Apr-14	-13,895	GBP	-80,757
1-Apr-14	-3,042	GBP	4,181
1-Apr-14	4,158	GBP	19,267
1-Apr-14	18,207	GBP	-84,462
30-Apr-14	-14,070	GBP	-80,658
30-Apr-14	-2,989	GBP	3,870

Date			
30-Apr-14	4,173	GBP	19,034
30-Apr-14	18,435	GBP	-84,105
30-May-14	-14,249	GBP	-80,554
30-May-14	-2,928	GBP	3,582
30-May-14	4,187	GBP	18,798
30-May-14	18,667	GBP	-83,730
2-Jul-14	-14,429	GBP	-80,428
2-Jul-14	-2,875	GBP	3,300
2-Jul-14	4,200	GBP	18,558
2-Jul-14	18,899	GBP	-83,322
30-Jul-14	-14,583	GBP	-80,320
30-Jul-14	-2,906	GBP	3,300
30-Jul-14	4,211	GBP	18,356
30-Jul-14	19,095	GBP	-82,969
2-Sep-14	-14,753	GBP	-80,177
2-Sep-14	-2,806	GBP	2,941
2-Sep-14	4,221	GBP	18,128
2-Sep-14	19,309	GBP	-82,544
1-Oct-14	-14,917	GBP	-80,067
1-Oct-14	-2,798	GBP	2,822
1-Oct-14	4,232	GBP	17,923
1-Oct-14	19,513	GBP	-82,160
30-Oct-14	-15,068	GBP	-79,947
30-Oct-14	-2,786	GBP	2,725
30-Oct-14	4,241	GBP	17,731
30-Oct-14	19,699	GBP	-81,781
2-Dec-14	-15,226	GBP	-79,801
2-Dec-14	-2,711	GBP	2,475
2-Dec-14	4,249	GBP	17,523
2-Dec-14	19,892	GBP	-81,351
18-Dec-14	-38,738	GBP	-291,958
18-Dec-14	-29,525	GBP	-102,488
18-Dec-14	376,354	GBP	-1,609,937
31-Dec-14	-15,387	GBP	-79,696
31-Dec-14	-2,691	GBP	2,368
31-Dec-14	4,259	GBP	17,336
31-Dec-14	20,078	GBP	-80,949
17-Dec-15	-53,114	GBP	-327,480
17-Dec-15	-23,730	GBP	-66,530
17-Dec-15	406,992	GBP	-1,400,879

NMOSS CLU calculation of portfolio(49 legs)

Leg1~5

		1	2	3	4	5
Input Raw CLU Dates	Input					

	ORIGINAL CLU of each expiry date				
Thu 16-Dec-2010	18,902	23,587	27,868	31,773	35,215
Fri 17-Dec-2010	28,282	16,553	35,337	38,925	42,173
Sat 18-Dec-2010	32,499	13,947	38,656	42,068	45,200
Sun 19-Dec-2010	35,839	12,100	41,305	44,577	47,622
Mon 20-Dec-2010	38,708	10,633	43,598	46,741	49,707
Tue 21-Dec-2010	41,271	9,342	45,609	48,639	51,530
Wed 22-Dec-2010	43,612	8,280	47,512	50,432	53,249
Thu 23-Dec-2010	45,756	7,143	49,251	52,060	54,792
Fri 24-Dec-2010	47,773	6,353	50,934	53,607	56,268
Sat 25-Dec-2010	49,693	5,655	52,561	55,132	57,728
Sun 26-Dec-2010	51,508	5,029	54,114	56,587	59,120
Mon 27-Dec-2010	53,237	4,467	55,611	57,988	60,459
Tue 28-Dec-2010	54,893	3,961	57,058	59,343	61,753
Wed 29-Dec-2010	56,463	3,503	58,454	60,652	63,009
Thu 30-Dec-2010	57,987	2,892	59,760	61,891	64,177
Thu 06-Jan-2011	67,525	991	68,404	69,983	71,872
Thu 13-Jan-2011	0	226	76,067	77,176	78,706
Thu 20-Jan-2011	0	18	83,106	83,826	85,028
Thu 27-Jan-2011	0	0	89,610	90,057	90,969
Thu 03-Feb-2011	0	0	95,659	95,945	96,608
Thu 10-Feb-2011	0	0	101,344	101,531	102,004
Thu 17-Feb-2011	0	0	106,709	106,854	107,193
Thu 24-Feb-2011	0	0	111,809	111,939	112,197
Thu 03-Mar-2011	0	0	116,669	116,811	117,013
Thu 10-Mar-2011	0	0	0	121,495	121,655
Thu 17-Mar-2011	0	0	0	126,006	126,146
Sat 16-Apr-2011	0	0	0	0	143,988
Mon 16-May-2011	0	0	0	0	0
Wed 15-Jun-2011	0	0	0	0	0
Fri 15-Jul-2011	0	0	0	0	0
Sun 14-Aug-2011	0	0	0	0	0
Tue 13-Sep-2011	0	0	0	0	0
Thu 13-Oct-2011	0	0	0	0	0
Sat 12-Nov-2011	0	0	0	0	0
Mon 12-Dec-2011	0	0	0	0	0
Wed 11-Jan-2012	0	0	0	0	0
Fri 10-Feb-2012	0	0	0	0	0
Sun 11-Mar-2012	0	0	0	0	0
Tue 10-Apr-2012	0	0	0	0	0
Thu 10-May-2012	0	0	0	0	0
Sat 09-Jun-2012	0	0	0	0	0
Sat 08-Sep-2012	0	0	0	0	0
Sat 08-Dec-2012	0	0	0	0	0
Sat 09-Mar-2013	0	0	0	0	0
Sat 08-Jun-2013	0	0	0	0	0
Sat 07-Sep-2013	0	0	0	0	0
Sat 07-Dec-2013	0	0	0	0	0
Sat 08-Mar-2014	0	0	0	0	0

Sat 07-Jun-2014	0	0	0	0	0
Sat 06-Sep-2014	0	0	0	0	0
Sat 06-Dec-2014	0	0	0	0	0
Sat 07-Mar-2015	0	0	0	0	0
Sat 06-Jun-2015	0	0	0	0	0
Sat 05-Sep-2015	0	0	0	0	0
Thu 03-Dec-2015					

Leg6~14

6	7	8	9	10	11	12	13	14
38,856	41,703	44,676	47,646	50,136	383,264	55,056	57,268	60,285
45,659	48,417	51,308	54,205	56,676	417,115	61,532	64,548	67,606
48,587	51,316	54,174	57,048	59,507	431,500	64,327	67,700	70,770
50,940	53,627	56,451	59,295	61,734	442,690	66,522	70,177	73,254
52,963	55,607	58,391	61,200	63,619	452,066	68,361	72,282	75,365
54,730	57,340	60,100	62,892	65,312	460,542	70,044	74,177	77,261
56,389	58,971	61,696	64,457	66,861	468,199	71,558	75,906	78,994
57,857	60,436	63,129	65,861	68,274	475,289	72,943	77,483	80,571
59,278	61,816	64,477	67,182	69,597	481,765	74,226	78,985	82,072
60,684	63,188	65,820	68,502	70,900	488,104	75,502	80,437	83,524
62,024	64,494	67,099	69,758	72,139	494,108	76,715	81,818	84,905
63,312	65,749	68,327	70,963	73,327	499,847	77,878	83,144	86,230
64,556	66,959	69,511	72,125	74,472	505,357	78,998	84,422	87,506
65,774	68,167	70,688	73,272	75,589	510,741	80,099	85,657	88,739
66,877	69,244	71,744	74,314	76,633	515,789	81,099	86,808	89,888
74,228	76,385	78,709	81,112	83,329	547,759	87,659	94,321	97,410
80,732	82,659	84,833	87,078	89,172	575,271	93,355	100,816	103,968
86,743	88,445	90,463	92,556	94,534	600,074	98,585	106,838	109,992
92,398	93,891	95,743	97,679	99,533	622,888	103,437	112,425	115,596
97,770	99,056	100,749	102,531	104,267	644,192	108,023	117,721	120,888
102,936	104,031	105,531	107,187	108,803	664,299	112,402	122,793	125,921
107,915	108,834	110,150	111,673	113,163	683,374	116,592	127,648	130,703
112,741	113,492	114,620	116,007	117,383	701,724	120,662	132,386	135,375
117,424	118,031	118,998	120,254	121,511	719,349	124,611	137,004	139,918
121,977	122,460	123,278	124,382	125,543	736,371	128,442	141,522	144,357
126,407	126,785	127,470	128,430	129,493	752,860	132,192	145,954	148,708
144,144	144,316	144,602	145,073	145,710	818,782	147,614	164,198	166,655
160,175	160,303	160,481	160,685	161,008	878,745	162,287	181,830	183,891
0	175,062	175,208	175,366	175,528	934,156	176,304	199,086	200,643
0	0	189,030	189,160	189,307	986,177	189,752	216,034	217,124
0	0	0	202,262	202,387	1,035,540	202,720	232,815	233,526
0	0	0	0	214,886	1,082,594	215,158	249,268	249,677
0	0	0	0	0	1,127,693	227,109	265,285	265,530
0	0	0	0	0	0	238,666	280,784	281,002
0	0	0	0	0	0	0	295,828	296,031
0	0	0	0	0	0	0	0	310,552

Leg15~22

15	16	17	18	19	20	21	22
62,777	65,451	67,994	70,546	72,954	75,528	77,848	80,186
70,130	72,842	75,415	77,996	80,429	83,028	85,377	87,741
73,303	76,027	78,610	81,199	83,640	86,246	88,604	90,976
75,793	78,525	81,113	83,708	86,154	88,765	91,128	93,505
77,909	80,647	83,240	85,839	88,289	90,905	93,274	95,657
79,805	82,545	85,138	87,737	90,186	92,800	95,169	97,549
81,541	84,284	86,881	89,484	91,935	94,553	96,927	99,312
83,118	85,863	88,460	91,063	93,514	96,132	98,507	100,893
84,619	87,365	89,962	92,566	95,018	97,636	100,012	102,400
86,072	88,819	91,417	94,021	96,473	99,091	101,469	103,857
87,452	90,200	92,798	95,403	97,854	100,473	102,851	105,241
88,777	91,525	94,123	96,727	99,179	101,796	104,176	106,566
90,052	92,801	95,398	98,002	100,453	103,070	105,450	107,841
91,284	94,031	96,627	99,230	101,679	104,294	106,674	109,063
92,431	95,178	97,773	100,375	102,822	105,437	107,817	110,207
99,936	102,671	105,252	107,841	110,275	112,876	115,251	117,633
106,473	109,191	111,754	114,328	116,747	119,334	121,702	124,077
112,469	115,163	117,703	120,255	122,651	125,214	127,572	129,932
118,042	120,709	123,224	125,752	128,126	130,658	133,010	135,355
123,312	125,949	128,435	130,938	133,286	135,782	138,130	140,458
128,346	130,950	133,404	135,878	138,199	140,652	142,998	145,307
133,172	135,741	138,164	140,610	142,903	145,313	147,661	149,953
137,859	140,390	142,777	145,190	147,453	149,827	152,159	154,429
142,394	144,898	147,248	149,628	151,858	154,200	156,511	158,759
146,774	149,292	151,603	153,948	156,145	158,455	160,743	162,967
151,064	153,589	155,860	158,168	160,331	162,608	164,870	167,070
168,722	171,083	173,307	175,443	177,445	179,541	181,699	183,784
185,693	187,732	189,782	191,804	193,624	195,515	197,541	199,493
202,135	203,856	205,599	207,477	209,177	210,842	212,711	214,515
218,213	219,580	221,056	222,633	224,192	225,757	227,463	229,106
234,271	235,286	236,440	237,744	239,047	240,392	241,999	243,470
250,185	250,872	251,679	252,677	253,759	254,868	256,285	257,630
265,829	266,336	266,876	267,559	268,353	269,204	270,403	271,563
281,198	281,565	281,942	282,400	282,904	283,470	284,469	285,396
296,207	296,525	296,768	297,091	297,375	297,670	298,509	299,265
310,718	311,038	311,229	311,458	311,655	311,740	312,374	312,945
324,844	325,158	325,327	325,498	325,616	325,610	326,103	326,497

0	338,959	339,140	339,290	339,365	339,301	339,721	339,974
0	352,503	352,632	352,782	352,849	352,773	353,170	353,384
0	0	0	366,003	366,076	366,014	366,383	366,561
0	0	0	0	379,081	379,037	379,385	379,548
0	0	0	0	0	0	0	417,702
0	0	0	0	0	0	0	0

Leg 23~30

23	24	25	26	27	28	29	30
82,601	452,863	74,706	76,217	77,548	78,993	80,421	81,711
90,180	484,809	81,002	82,512	83,842	85,284	86,708	87,995
93,422	498,350	83,682	85,191	86,518	87,959	89,380	90,665
95,957	508,878	85,773	87,279	88,604	90,042	91,461	92,743
98,114	517,817	87,552	89,055	90,378	91,812	93,226	94,506
100,004	525,607	89,043	90,544	91,864	93,296	94,708	95,985
101,772	532,889	90,537	92,037	93,358	94,790	96,201	97,477
103,353	539,478	91,910	93,408	94,728	96,158	97,566	98,841
104,861	545,663	93,115	94,609	95,924	97,349	98,752	100,022
106,319	551,620	94,311	95,803	97,116	98,538	99,939	101,207
107,703	557,263	95,446	96,936	98,247	99,667	101,065	102,331
109,029	562,657	96,532	98,020	99,328	100,747	102,142	103,407
110,304	567,836	97,576	99,061	100,368	101,784	103,178	104,440
111,525	572,789	98,588	100,075	101,384	102,803	104,198	105,463
112,669	577,513	99,599	101,085	102,394	103,812	105,206	106,470
120,086	607,466	105,667	107,140	108,440	109,848	111,231	112,487
126,522	633,301	110,918	112,481	113,767	115,160	116,524	117,765
132,363	656,525	115,664	117,216	118,493	119,876	121,230	122,463
137,771	677,925	120,054	121,646	122,912	124,281	125,621	126,843
142,857	697,936	124,175	125,823	127,061	128,418	129,743	130,954
147,686	716,835	128,080	129,712	130,984	132,329	133,642	134,842
152,316	734,895	131,825	133,444	134,822	136,149	137,441	138,626
156,769	752,138	135,414	137,015	138,387	139,704	140,985	142,162
161,077	768,760	138,883	140,467	141,900	143,187	144,454	145,619
165,262	784,835	142,249	143,814	145,233	146,565	147,817	148,971
169,340	800,434	145,524	147,072	148,475	149,853	151,090	152,232
185,942	863,238	158,817	160,285	161,621	163,111	164,406	165,490
201,520	921,116	171,219	172,598	173,858	175,268	176,641	177,777
216,398	975,487	183,008	184,292	185,471	186,797	188,094	189,325
230,831	1,027,399	194,392	195,576	196,670	197,908	199,125	200,282
245,027	1,077,497	205,532	206,612	207,617	208,762	209,893	210,973
259,009	1,126,008	216,454	217,424	218,335	219,381	220,421	221,419
272,802	1,173,082	227,182	228,042	228,857	229,802	230,750	231,663
286,444	1,219,008	237,799	238,549	239,270	240,115	240,972	241,802
300,115	1,264,069	248,339	248,980	249,606	250,348	251,110	251,853
313,604	1,307,986	258,709	259,242	259,775	260,417	261,081	261,739
326,984	1,350,872	268,934	269,348	269,831	270,375	270,943	271,515
340,300	1,392,946	279,160	279,498	279,857	280,322	280,795	281,282
353,605	1,434,511	289,295	289,549	289,818	290,170	290,565	290,974
366,734	1,475,198	299,327	299,476	299,686	299,963	300,261	300,609
379,698	1,515,204	309,302	309,422	309,556	309,755	309,951	310,196
417,868	1,632,477	338,681	338,768	338,847	338,929	338,957	339,041
0	0	366,907	367,016	367,106	367,194	367,189	367,255

0	0	0	0	0	393,906	393,938	394,023
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Leg 31~39

31	32	33	34	35	36	37	38	39
40,539	41,276	41,951	42,611	43,281	450,979	16,347	16,574	16,788
43,710	44,448	45,125	45,785	46,454	476,801	17,520	17,745	17,958
45,058	45,797	46,473	47,133	47,802	487,679	18,018	18,243	18,455
46,109	46,847	47,523	48,182	48,851	496,112	18,405	18,629	18,841
46,999	47,736	48,410	49,069	49,736	503,211	18,732	18,956	19,167
47,746	48,484	49,158	49,816	50,483	509,232	19,011	19,235	19,446
48,502	49,239	49,914	50,573	51,240	515,291	19,291	19,514	19,726
49,191	49,927	50,602	51,259	51,925	520,812	19,539	19,763	19,974
49,786	50,521	51,193	51,848	52,513	525,505	19,758	19,981	20,191
50,386	51,120	51,792	52,446	53,110	530,248	19,978	20,201	20,411
50,955	51,688	52,359	53,013	53,676	534,738	20,187	20,409	20,619
51,499	52,232	52,902	53,555	54,218	539,027	20,387	20,608	20,818
52,022	52,754	53,424	54,076	54,738	543,141	20,579	20,800	21,009
52,543	53,277	53,949	54,604	55,268	547,362	20,776	20,998	21,208
53,053	53,787	54,459	55,114	55,777	551,433	20,959	21,181	21,389
56,103	56,836	57,507	58,160	58,823	575,479	22,084	22,305	22,512
58,776	59,504	60,168	60,815	61,471	596,254	23,059	23,277	23,481
61,162	61,887	62,550	63,196	63,851	614,833	23,940	24,156	24,359
63,385	64,106	64,765	65,407	66,058	631,984	24,754	24,969	25,170
65,472	66,189	66,844	67,482	68,128	648,014	25,518	25,729	25,931
67,448	68,161	68,813	69,448	70,091	663,165	26,244	26,454	26,655
69,368	70,073	70,717	71,344	71,979	677,649	26,937	27,144	27,341
71,168	71,871	72,513	73,138	73,772	691,394	27,601	27,808	28,005
72,926	73,624	74,262	74,883	75,512	704,683	28,243	28,448	28,642
74,632	75,325	75,958	76,574	77,200	717,529	28,865	29,069	29,262
76,292	76,980	77,608	78,220	78,841	729,988	29,471	29,673	29,864
83,043	83,705	84,310	84,897	85,494	780,076	31,921	32,116	32,299
89,311	89,948	90,531	91,097	91,673	826,094	34,199	34,387	34,565
95,266	95,876	96,434	96,978	97,531	869,306	36,358	36,540	36,710
100,959	101,613	102,150	102,673	103,205	910,767	38,452	38,628	38,793
106,423	107,125	107,695	108,194	108,702	950,434	40,477	40,646	40,805
111,767	112,427	113,058	113,561	114,043	988,637	42,445	42,606	42,757
117,014	117,631	118,223	118,827	119,320	1,026,064	44,392	44,547	44,693
122,220	122,793	123,347	123,915	124,496	1,062,722	46,321	46,467	46,604
127,388	127,915	128,426	128,954	129,495	1,098,004	48,216	48,353	48,483
132,481	132,960	133,429	133,916	134,417	1,131,734	50,070	50,217	50,340
137,527	137,957	138,383	138,828	139,289	1,164,825	51,854	52,035	52,175
142,582	142,963	143,343	143,744	144,161	1,197,447	53,637	53,804	53,969
147,611	147,944	148,280	148,639	149,014	1,229,635	55,414	55,568	55,721
152,624	152,909	153,202	153,518	153,851	1,261,399	57,186	57,327	57,467
157,632	157,870	158,120	158,394	158,685	1,292,760	58,957	59,084	59,211
172,754	172,861	172,983	173,145	173,319	1,385,847	64,330	64,416	64,505
187,699	187,737	187,778	187,838	187,905	1,476,199	69,702	69,753	69,807
201,961	201,998	202,029	202,049	202,068	1,562,938	74,943	74,962	74,982

215,709	215,767	215,813	215,852	215,884	1,647,092	80,103	80,107	80,110
0	0	0	229,210	229,264	1,728,097	85,121	85,131	85,139
0	0	0	0	0	0	89,994	90,013	90,027
0	0	0	0	0	0	0	0	0

Leg 40~49

40	41	42	43	44	45	46	47	48	49
17,017	17,244	17,455	17,666	17,880	18,076	18,287	18,485	448,799	442,199
18,186	18,411	18,620	18,829	19,041	19,234	19,442	19,639	470,969	461,841
18,682	18,906	19,114	19,322	19,534	19,725	19,932	20,128	480,330	470,084
19,067	19,291	19,498	19,706	19,916	20,107	20,313	20,509	487,580	476,478
19,393	19,617	19,825	20,032	20,242	20,432	20,638	20,834	493,787	481,983
19,671	19,894	20,101	20,308	20,517	20,707	20,912	21,107	499,018	486,567
19,951	20,175	20,382	20,589	20,798	20,988	21,194	21,388	504,419	491,356
20,199	20,423	20,629	20,835	21,045	21,234	21,439	21,633	509,107	495,666
20,416	20,638	20,844	21,049	21,258	21,446	21,650	21,844	513,147	499,246
20,635	20,857	21,062	21,267	21,475	21,662	21,866	22,059	517,214	502,827
20,842	21,064	21,269	21,473	21,681	21,867	22,071	22,263	521,062	506,214
21,041	21,262	21,466	21,670	21,877	22,063	22,266	22,459	524,736	509,447
21,231	21,452	21,656	21,859	22,066	22,252	22,454	22,646	528,260	512,547
21,431	21,652	21,857	22,061	22,268	22,454	22,657	22,850	532,160	515,961
21,611	21,831	22,034	22,237	22,443	22,627	22,828	23,019	535,391	518,961
22,731	22,950	23,151	23,351	23,554	23,736	23,935	24,124	556,223	537,317
23,699	23,916	24,115	24,313	24,514	24,694	24,890	25,077	574,176	553,295
24,575	24,789	24,986	25,181	25,381	25,557	25,752	25,936	590,241	567,549
25,384	25,596	25,792	25,985	26,182	26,357	26,549	26,731	605,093	580,771
26,142	26,353	26,546	26,737	26,933	27,105	27,295	27,475	618,957	593,109
26,864	27,073	27,264	27,453	27,646	27,816	28,004	28,182	632,116	604,899
27,548	27,755	27,945	28,131	28,323	28,490	28,676	28,852	644,539	616,014
28,210	28,416	28,604	28,789	28,979	29,145	29,329	29,503	656,571	626,689
28,848	29,052	29,238	29,421	29,609	29,772	29,955	30,126	668,094	636,981
29,466	29,668	29,853	30,034	30,220	30,382	30,562	30,732	679,251	646,947
30,068	30,268	30,452	30,630	30,815	30,974	31,153	31,320	690,078	656,625
32,495	32,691	32,867	33,036	33,213	33,364	33,535	33,694	733,484	695,476
34,754	34,941	35,115	35,276	35,446	35,589	35,753	35,904	773,577	731,443
36,892	37,071	37,240	37,403	37,567	37,704	37,862	38,005	811,506	765,685
38,969	39,142	39,306	39,462	39,621	39,749	39,898	40,031	847,754	798,216
40,973	41,138	41,295	41,445	41,601	41,726	41,868	41,992	882,521	829,519
42,918	43,074	43,224	43,368	43,517	43,644	43,783	43,898	916,131	859,915
44,849	44,998	45,144	45,282	45,427	45,551	45,690	45,805	949,553	890,311
46,751	46,890	47,027	47,157	47,294	47,410	47,541	47,652	981,679	919,349
48,621	48,750	48,880	49,003	49,132	49,242	49,365	49,470	1,013,070	947,983
50,472	50,592	50,716	50,834	50,957	51,063	51,181	51,282	1,043,973	976,549
52,298	52,409	52,525	52,635	52,751	52,850	52,961	53,056	1,073,988	1,004,214
54,094	54,195	54,304	54,408	54,518	54,613	54,718	54,808	1,103,385	1,031,351
55,897	55,994	56,094	56,189	56,289	56,376	56,472	56,554	1,132,450	1,058,198
57,629	57,772	57,880	57,967	58,060	58,142	58,231	58,306	1,161,481	1,085,540
59,359	59,489	59,637	59,727	59,814	59,892	59,977	60,048	1,190,097	1,112,228
64,611	64,701	64,812	64,929	65,051	65,181	65,246	65,299	1,275,003	1,192,029
69,874	69,924	69,998	70,079	70,165	70,260	70,360	70,456	1,357,584	1,270,172
75,019	75,042	75,086	75,135	75,189	75,248	75,314	75,380	1,433,330	1,344,300
80,118	80,115	80,125	80,150	80,179	80,206	80,244	80,284	1,507,196	1,416,647

85,141	85,135	85,132	85,133	85,135	85,124	85,144	85,163	1,579,466	1,487,376
90,038	90,045	90,051	90,050	90,045	90,019	90,016	90,011	1,650,288	1,556,228
94,633	94,648	94,658	94,673	94,678	94,660	94,653	94,654	1,718,225	1,618,059
0	0	0	99,121	99,138	99,132	99,138	99,165	1,784,223	1,678,270
0	0	0	0	0	103,455	103,465	103,520	1,847,409	1,737,177
0	0	0	0	0	0	0	0	1,908,297	1,794,930
0	0	0	0	0	0	0	0	0	1,851,455
0	0	0	0	0	0	0	0	0	1,906,028
0	0	0	0	0	0	0	0	0	1,957,870

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