**Questions related to risk measures**

**1. How would you calculate Value at Risk (VaR)?**

*Three methods:*

* *Parametric*
* *Historical*
* *Simulation*

*Percentile based on the assumed disiribution; Percentile of distribution; Percentile of Simulations*

**2. What's wrong with VaR as a measurement of risk?**

* *Not sub-additive (not coherent)*
* *Does not account for what happens in the tail (fat tails)*
* *A fixed holding period to account for liquidity*
* *Does not account for intra-day risks*
* *May not capture illiquid risk factors (basis risk, cross risk)*
* *Does not capture default risk*
* *Static measure*

**3. What is non-Linear VaR? How would you calculate it?**

**KEY TAKEAWAYS**

* *Traders and investors aim to minimize the risk and potential losses of their trading portfolios.*
* *VaR measures the potential loss of a portfolio within a specified time frame with a degree of confidence.*
* *There are two types of risk exposure: linear and nonlinear.*
* *Nonlinear derivatives are those whose payoffs change with time and the location of the strike price to the spot price.*
* *Nonlinear derivatives come with nonlinear risk exposure where the distribution of returns is skewed.*
* *Because the returns of a nonlinear derivative are not normally distributed, a standard VaR model would not work and instead, another model, such as a Monte Carlo VaR, would need to be used.*

**Nonlinear Considerations**

*Nonlinear risk exposure arises in the VaR calculation of a portfolio of nonlinear derivatives. Nonlinear derivatives, such as options, depend on a variety of characteristics, including implied volatility, time to maturity, underlying asset price, and the current interest rate.*

*It is difficult to collect the historical data on the returns because the option returns would need to be conditioned on all of the characteristics to use the standard VaR approach. Inputting all of the characteristics associated with options into the Black-Scholes model or another option pricing model causes the models to be nonlinear due to the nature of the derivative. Therefore, the payoff curves are nonlinear because the corresponding value is not proportional to the input due to the time and volatility portion of the model, in particular since options are wasting assets.*

*The nonlinearity of certain derivatives leads to nonlinear risk exposures in the VaR of a portfolio. Nonlinearity can be witnessed in the payoff diagram of a plain vanilla call option. The payoff diagram has a strong positive convex payoff profile before the option's expiration date, with respect to the stock price.*

*When the call option reaches a point where the option is in the money, it reaches a point where the payoff becomes linear. Conversely, as a call option becomes increasingly out of the money, the rate at which the option loses money decreases until the option premium is zero.*

**Kurtosis**

*If a portfolio includes nonlinear derivatives, such as options, the distribution of the portfolio returns will have a positive or negative skew or high or low kurtosis. The skewness measures the asymmetry of a probability distribution around its mean. Kurtosis measures the distribution around the mean; a high kurtosis has fatter tail ends of the distribution, and a low kurtosis has skinny tail ends of the distribution.*

*Therefore, it is difficult to use the VaR method that assumes the returns are normally distributed. Instead, the VaR calculation of a portfolio containing nonlinear exposures is usually calculated using Monte Carlo VaR simulations of options pricing models to estimate the VaR of the portfolio.*

**4. What is the parametric method of calculating VaR? What are its advantages?**

*- Estimate parameters of the assumed distribution (often Gaussian) based on historical returns*

*- Calculate VaR from the formula for the percentile of the distribution*

|  |  |
| --- | --- |
| **Confidence** | **# of Standard Deviations (σ)** |
| 95% (high) | - 1.65 x σ |
| 99% (really high) | - 2.33 x σ |

*Plus mu (average return)*

*Advantage:*

*- Relatively straightforward method*

*- Not expensive computationally*

*- Easily interpretable*

*Also known as the Variance/Co-variance VAR. Most commonly used in practice with hedge fund managers. Only variables you need is the mean and the standard deviation of the portfolio. Assume that the portfolio is normally distributed.  
  
Formula is: Mean - Sx(z-Score)  
  
Advantages –*

* *simple,*
* *data is easy to obtain*

*Disadvantages –*

* *assumption of normality,*
* *exposing the portfolio to massive risk if the standard deviation moves away from historical mean.*
* *Also need to rely on the stability of the standard deviation through time and the variance/co-variance matrix.*
* *Without adjusting VAR for extreme events you expose your portfolio to additional risk.*

**5. What is the historical method of calculating VaR? What are its advantages?**

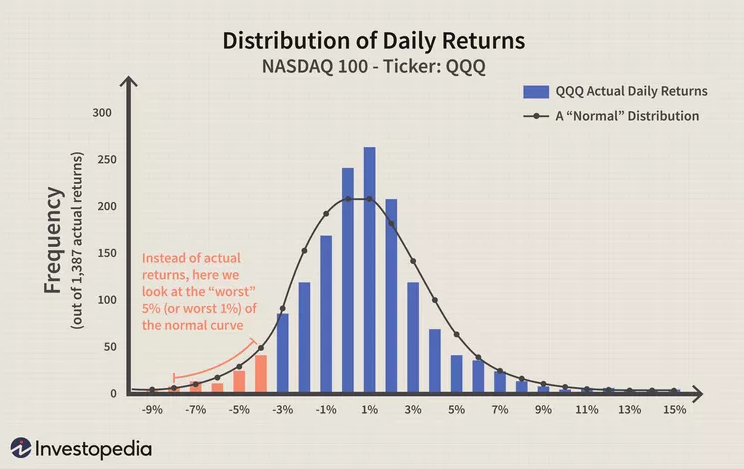
*Assuming the history will repeat itself, sort the historical returns in ascending order and pick the one equal to a pre-assumed percentile.*

*Value at Risk = vm (vi / v(i - 1))*

*M = the number of days from which historical data is taken*

*vi = the number of variables on the day i.*

*In calculating each daily return, we produce a rich data set of more than 1,400 points. Let's put them in a histogram that compares the frequency of return "buckets."*

**

*At the highest bar, there were more than 250 days when the daily return was between 0% and 1%. At the far right, a tiny bar at 13% represents the one single day within five-plus years when the daily return for the QQQ was 12.4%.*

**6. Why would you calculate VaR using Monte Carlo simulations?**

* *In case of complex portfolio, including derivatives, there are a lot of non-linear payoff. Hence, it might be challenging to analytically calculate VaR.*
* *On top of it, history does not always repeat itself,*
* *the sample may not cover the truly severe shocks etc.*

**7. What are the challenges in calculating VaR for a mixed portfolio?**

*Need to measure not only return and volatility of individual assets, but also the correlations between them. When the number and diversity of positions grow, the difficulty and cost of measuring risk grows exponentially.*

*The VAR of A&B, is NOT the sum of VAR A and VAR B. Need to factor in correlation, sometimes a higher individual VAR can result in a lower portfolio VAR.*

**8. What's GVAR? How can you calculate it?**

*It stands for generalized value at risk (generalized VaR); a type or method of value at risk (VaR) that subjects the standard value at risk (for optimization of a portfolio/ a fund, etc.) to two constraints: a conditional value at risk or censored mean lower bound. The censored mean, for normal distributions (but not fat-tailed distributions), is equivalent to the* ***statistical hazard function****. The censored mean for normal distributions would yield wider bounds for a given set of admissible portfolios, with a more complicated portfolio choice rule.*

*In other contexts, GVaR may also denote other types of VaR including* ***global value at risk (global VaR****),* ***Gaussian value at risk*** *(Gaussian VaR****), glue value at risk*** *(glue VaR), etc.*

* ***statistical hazard function***
* ***global value at risk (global VaR****),*
* ***Gaussian value at risk*** *(Gaussian VaR****),***
* ***glue value at risk*** *(glue VaR),*

**9. What is the one-day VaR of a $50m portfolio with a daily standard deviation of 2% at a 95% confidence level? What is the annualized VaR?**

*Daily VaR = - 50m \* 2% \* 1.65 = -1.65m*

*Annualized VaR = -1.65m \* sqrt(252)*

**10. What do you know about extreme value theory?**

*Extreme value theory or extreme value analysis (EVA) is a branch of statistics dealing with the extreme deviations from the median of probability distributions. It seeks to assess, from a given ordered sample of a given random variable, the probability of events that are more extreme than any previously observed. Extreme value analysis is widely used in many disciplines, such as structural engineering, finance, earth sciences, traffic prediction, and geological engineering. For example, EVA might be used in the field of hydrology to estimate the probability of an unusually large flooding event, such as the 100-year flood. Similarly, for the design of a breakwater, a coastal engineer would seek to estimate the 50-year wave and design the structure accordingly.*

[**https://en.wikipedia.org/wiki/Extreme\_value\_theory**](https://en.wikipedia.org/wiki/Extreme_value_theory)

**11. What is Expected Shortfall? How is it calculated? Why is it considered better than VaR? What are the disadvantages?**

*Calculated as weighted average in the distribution tail (or integral over prob density in the tail)*

*Measures the wavg loss outside of the VaR (higher than assumed VaR)*

*It is a consistent risk measure, better accounting for extreme events*

*It is more cumbersome to compute; backtesting and stability concerns.*

*Expected shortfall has disadvantages as well as advantages, of course. First, it is difficult to back-test. When a one-day 99% VAR model based on the most recent historical data is being back-tested, we can observe the number of exceptions that would have been encountered if the model had been used in the past, and test whether this is significantly different from what is expected. Back-testing a one-day ES model is much more challenging, because we are interested in the average size of the losses when exceptions are observed. A back-testing period of 250 days is usually used by regulators. This can be expected to give about 6 exceptions when a 97.5% confidence limit is used, which is a small sample. However, Acerbi and Szekely (2014) seem to get reasonable results when experimenting with three different tests of ES and standard distributions. A key point is that back-testing a stressed model, whether VAR or ES, is not possible because we are interested in whether the model performs well for another stressed period, but we do not have another such period to use for testing. The use of varying time horizons in FRTB is an added complication in back-testing. The Basel Committee has presumably recognised this because the review requires the back-testing of a one-day VAR model calculated in the usual way from recent historical data. We are therefore in the strange position where the risk measure being back-tested is quite different from that used to calculate capital. Another disadvantage of ES is that estimates of the measure may not be as accurate as estimates of VAR. Yamai and Yoshiba (2002) looked at this. They found that for a certain number of observations and a certain confidence level, the accuracy of VAR and ES is about the same when the loss is normally distributed, but that VAR estimates are more accurate than ES estimates when the losses have fat tails.6 This means capital calculated from ES may be less stable than capital calculated from VAR.*

[*https://www.risk.net/risk-management/market-risk/2375185/hull-and-white-on-the-pros-and-cons-of-expected-shortfall*](https://www.risk.net/risk-management/market-risk/2375185/hull-and-white-on-the-pros-and-cons-of-expected-shortfall)

**12. What are the strengths and weaknesses of historical simulation, Monte-Carlo simulation, and Variance-Covariance method in VaR calculation?**

*If We look at past crises we can see how a particular portfolio would have fared in these crises. Major drawback. History seldom repeats itself (but it does rhyme)*

*With Monte Carlo we do a large number of simulated tress tests but you have to have a decent knowledge of the distributions of the stressors and their linkages.*

*VCOV allows for inter-relationships in the returns however these covariances are usually not stable and Long term covariances are typically smaller than short term covariances.*

**13. What is expected shortfall?**

*Point 11*

**14. What is incremental default risk?**

[**https://www.eba.europa.eu/sites/default/documents/files/documents/10180/104828/938f9f0d-ec75-4874-9835-870e7cfda648/EBA-BS-2012-79--GL-on-IRC-.pdf?retry=1**](https://www.eba.europa.eu/sites/default/documents/files/documents/10180/104828/938f9f0d-ec75-4874-9835-870e7cfda648/EBA-BS-2012-79--GL-on-IRC-.pdf?retry=1)

*Among these revisions was a new requirement for banks that model interest rate risk, to measure and hold capital against default risk that is incremental to any default risk captured in the bank‟s value-at-risk (VaR) model. The incremental default risk charge was incorporated into the trading book capital regime in response to the increasing amount of exposure in banks‟ trading books to credit risk, often related to illiquid products, whose risk is not reflected in the VaR.*

*In October 2007, the BCBS released guidelines for computing capital for incremental default risk for public comment. At its meeting in March 2008, the Basel Committee reviewed comments received and decided to expand the scope of the capital charge.*

*The decision was taken in light of the recent credit market turmoil where a number of major banking institutions had experienced large losses, most of which were sustained in the banks‟ trading books. Most of those losses were not captured in the 99%/10-day VaR. Since observed losses had not arisen from actual defaults, but rather from credit migrations combined with a widening of credit spreads and the loss of liquidity, applying an incremental risk charge covering default risk only, did not appear to be sufficient.*

*In January 2009, the BCBS proposed supplementing the current VaR-based trading book framework with, among other measures, an incremental risk capital charge (IRC), which covers default risk as well as migration risk for unsecuritised credit products and a stressed value-at-risk (Stressed VaR)***.**

**Questions on the yield curve:**

**15. What are the uses of the yield curve?**

*Investors can use the yield curve to make predictions on where the economy might be headed and use this information to make their investment decisions. If the bond yield curve indicates an economic slowdown might be on the horizon, investors might move their money into defensive assets that traditionally do well during recessionary times, such as consumer staples. If the yield curve becomes steep, this might be a sign of future inflation. In this scenario, investors might avoid long-term bonds with a yield that will erode against increased prices.*

*In addition to using the shape of the Treasury yield curve to help determine the current and future strength of the economy, the Treasury yield curve occupies a special place compared to all other yield curves as it is generally regarded as the "benchmark curve." Yields on Treasury bonds and other securities are generally among the lowest because they’re backed by the full faith and credit of the US government. This allows bond investors to compare the Treasury yield curve with that of riskier assets such as the yield curve of Agency bonds or A-rated corporate bonds for example. The yield difference between the two is referred to as the "spread." The closer the yields are together the more confident investors are in taking the risk in a bond that is not government-backed. The spread generally widens during recessions and contracts during recoveries.*

*The slope of the yield curve is critical for financial intermediaries, especially commercial banks, savings and loan associations, and savings banks. A rising yield curve is generally favorable for the these institutions because they borrow most of their funds by selling short- term deposits and lend a major portion of those funds long term.*

*The more steeply the yield curve slopes upward, the wider the spread between borrowing and lending rates and the greater the potential profit for a financial intermediary. However, if the yield curve begins to flatten out or slope downward, this should serve as a warning signal to portfolio managers of these institutions.*

*A flattening or downward-sloping yield curve squeezes the earnings of financial intermediaries and calls for an entirely different portfolio-management strategy than an upward-sloping curve.*

*For example, if an upward-sloping yield curve starts to flatten out, portfolio managers of financial institutions might try to “lock in” relatively cheap sources of funds by getting long-term commitments from depositors and other funds-supplying customers.*

*Borrowers, on the other hand, might be encouraged to take out long-term loans at fixed rates of interest. Of course, the financial institution’s customers also may be aware of impending changes in the yield curve and resist taking on long-term loans or deposit contracts at potentially unfavorable interest rates.*

**16. What's the riskiest part of the yield curve?**

*In a normal distribution, the end of the yield curve tends to be the most risky because a small movement in short term years will compound into a larger movement in the long term yields. Long term bonds are very sensitive to rate changes.*

*However, if the yield is inverted, shorter term maturities are considered riskier. WHY?*

**17. What does it mean for risk when the yield curve is inverted?**

*Generally speaking, the yield curve is a line chart that plots interest rates for bonds that have equal credit quality, but different maturity dates.*

*In normal economic conditions, investors are rewarded with higher interest rates for holding bonds over longer time periods, resulting in an upward sloping yield curve. This is because these longer returns factor in the risk of inflation or default over time.*

*So when interest rates on long-term bonds fall lower than those of short-term bonds, it results in an inverted yield curve.*

*The worrying trend is that an inverted yield curve in key government securities such as U.S. Treasuries can often foreshadow a recession. For every recession since 1960, an inverted yield curve took place roughly a year before, with just one exception in the mid-1960s.*

*This is because the yield curve has steep implications for financial markets. If the market predicts economic turbulence, and that interest rates will fall in the long term, investors flock to buy longer-dated bonds.*

**18. What is the discount factor? How would you calculate it?**

*The present value of a cash flow (i.e. the value of future cash in today’s dollars) is calculated by multiplying the cash flow for each projected year by the discount factor, which is driven by the discount rate and the matching time period.*

*Generally speaking, there are two approaches to calculating the discount factor, but in either case, the discount factor is a function of the:*

*Discount Rate*

*Time Period*

*The discount rate can be thought of as representing the percentage of return that you could have received by investing that dollar, if you had received it today.*

*The reason you would prefer to have $1 today than $1 three years from now is that if you received the $1 three years from now, you would have missed out on a full three years when you could have invested that $1 and ended up with more than $1 by the end of that time.*

*Discount Factor Formula*

*The first formula for the discount factor has been shown below.*

*Discount Factor = (1 + Discount Rate) ^ (– Period Number)*

*And the formula can be re-arranged as:*

*Discount Factor = 1 ÷ (1 + Discount Rate) ^ Period Number*

*Either formula could be used in Excel; however, we will be using the first formula in our example as it is a bit more convenient (i.e., Excel re-arranges the formula itself in the first formula).*

*To arrive at the present value using the first approach, the factor would then be multiplied by the cash flow to get the present value (“PV”).*

*Present Value (PV) = Cash Flow x Discount Factor*

*While the discount rate remains constant throughout the projection, the period number rising is what causes the factor to decrease over time.*

*Note that the period can be whatever length you want (years, months, days, even hours) – but it is critical to ensure that the period is aligned with the implied period of the discount rate.*

*Intuitively, the discount factor, which is always calculated by one divided by a figure, decreases the cash flow values. This also ties back to what we discussed at the beginning, where receiving $1 today is more valuable than receiving $1 in the future.*

*To tie this back to the example using $1, assuming a 10% discount rate and a one-year time horizon – the discount factor would be calculated as:*

*0.91 = 1 / (1 + 10%) ^ 1*

*Next, the present value can be calculated using:*

*0.91 = $1 × 0.91*

*The example implies that $1 dollar received one year from the current period would be worth $0.91 in the present day.*

*The formula for the second approach is virtually identical, except for the absence of the negative sign in front of the period number exponent.*

*Discount Factor = (1 + Discount Rate) ^ Period Number*

*Unlike the first approach, the present value formula this time around divides the cash flow by the discount factor.*

*Present Value (PV) = Cash Flow ÷ Discount Factor*

*By entering the discount factor formula into the PV formula, the formula can be re-expressed as:*

*Present Value (PV) = Cash Flow ÷ (1 + Discount Rate) ^ Period Number*

*As opposed to decreasing over time, the factor increases in this case – thereby, the downward adjustment on the present value becomes more apparent in later years.*

*Returning to the $1 dollar example with the same 10% discount rate and one-year time frame, the calculation is:*

*1.1 = (1 + 10%) ^ 1*

*And upon applying this to the $1 in cash flow:*

*0.91 = 1 / 1.1*

*So, as we can see, both methods calculate the same present value for the $1 one year from today ($0.91).*

**19. What is convexity? How would you calculate it? Why is it important?**

*As the yield on a bond changes so too does its duration. A bond’s convexity measures the sensitivity of a bond’s duration to changes in yield. Duration is an imperfect way of measuring a bond’s price change, as it indicates that this change is linear in nature when in fact it exhibits a sloped or “convex” shape. A bond is said to have positive convexity if duration rises as the yield declines. A bond with positive convexity will have larger price increases due to a decline in yields than price declines due to an increase in yields. Positive convexity can be thought of as working in the investor’s favor, since the price becomes less sensitive when yields rise (prices down) than when yields decline (prices up). Bonds can also have negative convexity, which would indicate that duration rises as yields increase and can work against an investor’s interest. The table below highlights the types of bonds that exhibit each type of convexity.*

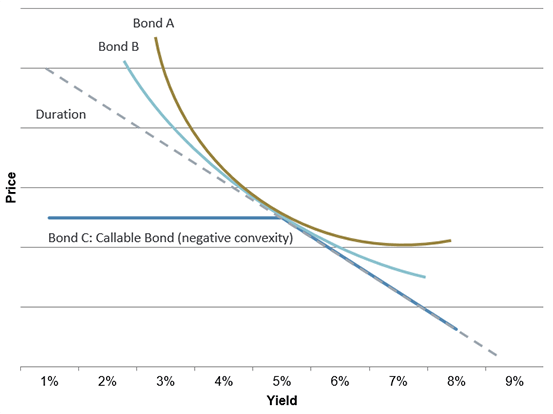
**Examples of Bonds with Positive and Negative Convexity**

|  |  |
| --- | --- |
| **Type of Convexity** | **Typical Types of Bonds** |
| Positive Convexity | Non-callable bonds, bonds with make-whole calls |
| Negative Convexity | MBS (most), bonds with a traditional call, preferreds |

*(Source: Raymond James)*

*A useful way to visualize a bond’s convexity is to plot the potential price change against various yields. If two bonds have the same duration and yield but differing convexities, a change in interest rates will affect each bond differently. For example, the chart below shows three bonds: a bond with higher positive convexity (Bond A) will be less affected by interest rates than a bond with lower positive convexity (Bond B). On the other hand, a bond with negative convexity (Bond C) will exhibit larger price fluctuations should rates rise than if they were to fall.*

**Bonds Can Have Very Different Convexities: Positive vs. Negative**



**20. What's the relationship between coupon rate and convexity?**

*A few assumptions needed here first before the relationship holds at all: given yield and given maturity.*

*There are several steps to this logic*

***1-bond pricing***

*Because bond pricing involves discounted value of all cash payments, the further the payments from today, the worse it will be impacted by changing interest rates. Think about discount factor: (1+interest rate)^(-x), the bigger the x is, the smaller factor it will be and the smaller the present value of that future cash flow will be.*

***2-duration***

*Because bond price reacts to change of interest rate, naturally, we will try to come up with a measure to see how sensitive of a particular bond to a changing interest at a particular yield level. This is what duration measures. However, this sensitivity isn’t always the same, because even with the same bond, if it’s price is already very high, then small change of interest will make a big difference in its pricing. Therefore, to even better understand bond’s pricing, we need to introduce a new measure to see how duration moves as interest changes, entering the concept “convexity”. In other words, convexity is the second derivative or “change of change” of interest rates to bond price, if you are familiar that part of the math.*

***3-coupon and duration***

*If interest rate curve flats out throughout the entire maturity, in other words, if the interest rate stays the same, lower coupon increases duration, or the bond with lower coupons is more sensitive to interest rate changes. To see why, think of 2 bonds: one is zero coupon bond of $100 face value, i.e no cash flows before maturity and pays $100 back at the end of 2 years and another one pays $99 at the end of 1st year and $1 at the end of second year. Connecting 1 and 2 explained above, it shouldn’t surprise you that if interest rate changes at the beginning of the second year, the zero coupon bond will adjust more than the second bond, simply because there is more cash up in the air at stake.*

***4-coupon and convexity***

*If you understand everything above, the answer should come naturally to you now. If duration reacts to coupon level and convexity is measuring changes of duration. Then convexity also reacts to coupon. As explained above, lower coupon, the higher the convexity.*

*This is just one of the ways to look at. If you know the calculation of effective convexity, the explanation will be even simpler.*

**21. What's the meaning of duration? Is it constant for all yields?**

*Duration will be higher the lower its yield.*

*Duration will also be higher the longer its maturity.*

*The following scenarios of comparing two bonds should help clarify how these three traits affect a bond's duration: If the coupon and yield are the same, duration increases with time left to maturity.*

**22. What's the meaning of partial duration?**

*First, you need to clarify what you mean by, simply, “duration”. There are three basic types of duration (and several other specialized versions):*

* ***Macaulay duration****: the weighted-average time to receipt of cash flows, using the present value of each cash flow as the weight on the time until it’s received.*
* ***Modified duration****: (roughly) the (negative of the) percentage change in a bond’s price for a 1% change in its yield to maturity, assuming that its cash flows don’t change.*
* ***Effective duration****: (roughly) the (negative of the) percentage change in a bond’s price for a 1% change in its yield to maturity, allowing that its cash flows might change.*

*All of these measures can be applied to bonds of any sort (though if the bond’s cash flows can change when its YTM changes, Macaulay duration and modified duration aren’t appropriate).*

*These three are the only ones that appear in the Level I curriculum. I wrote an article on them that may be of some use:*

[*http://financialexamhelp123.com/macaulay-duration-modified-duration-and-effective-duration/*](http://financialexamhelp123.com/macaulay-duration-modified-duration-and-effective-duration/)*.*

*Next we have spread duration and key-rate (what you’re calling “partial”) duration; these don’t appear until the Level II curriculum:*

* ***Spread duration****: (roughly) the (negative of the) percentage change in a bond’s price for a 1% change in its spread over a Treasury of the same maturity; although nobody ever says so, you can have*modified*spread duration (assuming that its cash flows don’t change) and*effective*spread duration (allowing that its cash flows might change).*
* ***Key-rate duration****: (roughly) the (negative of the) percentage change in a bond’s price for a 1% change in the YTM of a Treasury of a given maturity; again, you can have*modified*key-rate duration (assuming that its cash flows don’t change) and*effective*key-rate duration (allowing that its cash flows might change).*

*Spread duration is of interest only for risky bonds, and key-rate duration is generally of interest only for portfolios of bonds.*

**23. What are the limits of duration as a risk measure?**

*The main limitation of duration is that it assumes a linear relationship between interest rates and bond price. In reality, the relationship is likely to be curvilinear. The extent of the deviation from a linear relationship is known as convexity. The more convex the relationship between interest rates and bond price, the more inaccurate duration is for measuring interest rate sensitivity.*

*The sensitivity of bond prices to changes in interest rates is dependent on their redemption dates. Bonds which are due to be redeemed at a later date are more price-sensitive to interest rate changes, and therefore are riskier.*

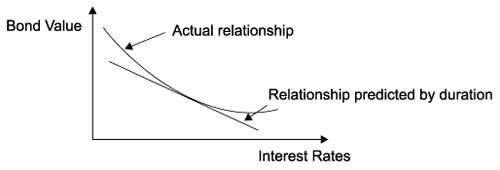
*Duration measures the average time it takes for a bond to pay its coupons and principal and therefore measures the redemption period of a bond. It recognises that bonds which pay higher coupons effectively mature sooner compared to bonds which pay lower coupons, even if the redemption dates of the bonds are the same. This is because a higher proportion of the higher coupon bond's income is received sooner. Therefore these bonds are less sensitive to interest rate changes and will have a lower duration.*

*Duration can be used to assess the change in the value of a bond when interest rates change using the following formula:*

*ΔP = [-D × Δi × P]/[1 + i],*

*where P is the price of the bond, D is the duration and i is the redemption yield.*

*However, duration is only useful in assessing small changes in interest rates because of****convexity****. As interest rates increase, the price of a bond decreases and vice versa, but this decrease is not proportional for coupon paying bonds, the relationship is non-linear. In fact, the relationship between the changes in bond value to changes in interest rates is in the shape of a convex curve to origin, see below.*



*Duration, on the other hand, assumes that the relationship between changes in interest rates and the resultant bond is linear.*

*Therefore duration will predict a lower price than the actual price and for large changes in interest rates this difference can be significant. Duration can only be applied to measure the approximate change in a bond price due to interest changes, only if changes in interest rates do not lead to a change in the shape of the yield curve. This is because it is an average measure based on the gross redemption yield (yield to maturity). However, if the shape of the yield curve changes, duration can no longer be used to assess the change in bond value due to interest rate changes.*

**24. How would you decide which discount curve to use to value future cash flows from interest rate swaps?**

*What is typically done use to use Eurodollar Future strips.*

*The June Future gives you a lock on a three month deposit starting in June. Sep Future gives you a 3 month rate starting in Sep.*

*If Jun is trading at 95 and Sep Is trading at 94.9 then we have June 3 month yield is 5% and Sep is 5.1 % if it is 45 day until the June and the cash rate to Jun is 4.9%*

*We have an effective locked rate of*

*((1 +.4.9%/45/360)((1+5%/90/360)(1+5.1%\*90/360))^(360/225)-1 = 5.118%*

*as an annualized compound yield. The 225 day discount factor is therefore*

*d = ( 1 + 5.118%) ^ (225/360)*

*We can do this for any maturity and create a zero coupon yield curve.*

*That is how it is done in practice.*

**Questions on quantitative concepts:**

**25. Can you explain the assumptions behind Black Scholes?**

*- No Arbitrage (markets are random, unpredictable)*

*- Complete / Frictionless / Liquid Markets*

*- No transaction fees*

*- No dividends*

*- Gaussian distribution, constant volatility*

*- Constant risk-free rate*

*- The option is European and can only be exercised at maturity*

**26. What's a volatility smile? Why does it occur? What are the implications for Black Scholes?**

*- The stylized fact stating that the volatility implied from option prices is not constant (as assumed in BS) but instead it varies dependent on the option strike. Frequently, it is higher in case of option with high strike (deep out-of-the-money) or very low strikes (deep in the money), whereas lower for strikes closer to stock price (at-the-money).*

*- A more general explanation for the volatility smile is that it incorporates* ***the kurtosis seen in stock returns.*** *Stock returns are not normal, stock prices are not lognormal. Both have* ***fatter tails*** *than you would expect from normally distributed returns. We know that, theoretically, the value of an option is the present value of the expected payoff under a risk-neutral random walk. If that risk-neutral probability density function has fat tails then you would expect option prices to be higher than Black–Scholes for very low and high strikes. Hence higher implied volatilities, and the smile.*

*- Another school of thought is that the volatility smile and skew exist because of* ***supply and demand****. Option prices come less from an analysis of probability of tail events than from simple agreement between a buyer and a seller****. Out-of-the-money puts are a cheap way of buying protection against a crash****.* ***But any form of insurance is expensive, after all those selling the insurance also want to make a profit****. Thus out-of-the-money puts are relatively overpriced. This explains high implied volatility for low strikes. At the other end,* ***many people owning stock will write out-of-the-money call options (so-called covered call writing) to take in some premium, perhaps when markets are moving sideways. There will therefore be an oversupply of out-of-the-money calls, pushing the prices down.*** *Net result, a negative skew. Although the simple supply/demand explanation is popular among traders it does not sit comfortably with quants because it does suggest that options are not correctly priced and that there may be arbitrage opportunities. While on the topic of arbitrage, it is worth mentioning that there are constraints on the skew and the smile that come from examining simple option portfolios.* ***For example, rather obviously, the higher the strike of a call option, the lower its price. Otherwise you could make money rather easily by buying the low strike call and selling the higher strike call. This imposes a constraint on the skew.*** *Similarly, a butterfly spread has to have a positive value since the payoff can never be negative.*

*This imposes a constraint on the curvature of the smile. Both of these constraints are model independent. There are many ways to build the volatility-smile effect into an option-pricing model, and still have no arbitrage. The most popular are, in order of complexity, as follows*

*• Deterministic volatility surface*

*• Stochastic volatility*

*• Jump diffusion*

**27. What are the Greeks?**

* ***Delta****, which can help you gauge the likelihood an option will expire in-the-money (ITM), meaning its strike price is below (for calls) or above (for puts) the underlying security’s market price.*
* ***Gamma****, which can help you estimate how much the Delta might change if the stock price changes.*
* ***Theta****, which can help you measure how much value an option might lose each day as it approaches expiration.*
* ***Vega****, which can help you understand how sensitive an option might be to large price swings in the underlying stock.*
* ***Rho****, which can help you simulate the effect of interest rate changes on an option.*

*Now that you’ve been introduced, we can explore these calculations in more detail.*

***Delta***

*Delta measures*how much an option’s price can be expected to move*for every $1 change in the price of the underlying security or index. For example, a Delta of 0.40 means the option’s price will theoretically move $0.40 for every $1 change in the price of the underlying stock or index. As you might guess, this means the higher the Delta, the bigger the price change.*

*Traders often use Delta to predict whether a given option will expire ITM. So, a Delta of 0.40 is taken to mean that at that moment in time, the option has about a 40% chance of being ITM at expiration. This doesn’t mean higher-Delta options are always profitable. After all, if you paid a large premium for an option that expires ITM, you might not make any money.*

*You can also think of Delta as the number of shares of the underlying stock the option behaves like. So, a Delta of 0.40 suggests that given a $1 move in the underlying stock, the option will likely gain or lose about the same amount of money as 40 shares of the stock.*

***Call options***

*Call options have a positive Delta that can range from 0.00 to 1.00.*

*At-the-money options usually have a Delta near 0.50.*

*The Delta will increase (and approach 1.00) as the option gets deeper ITM.*

*The Delta of ITM call options will get closer to 1.00 as expiration approaches.*

*The Delta of out-of-the-money call options will get closer to 0.00 as expiration approaches.*

***Put options***

*Put options have a negative Delta that can range from 0.00 to –1.00.*

*At-the-money options usually have a Delta near –0.50.*

*The Delta will decrease (and approach –1.00) as the option gets deeper ITM.*

*The Delta of ITM put options will get closer to –1.00 as expiration approaches.*

*The Delta of out-of-the-money put options will get closer to 0.00 as expiration approaches.*

***Gamma***

*Where Delta is a snapshot*in time*, Gamma measures the rate of change in an option’s Delta*over time*. If you remember high school physics class, you can think of Delta as speed and Gamma as acceleration. In practice, Gamma is the rate of change in an option’s Delta per $1 change in the price of the underlying stock.*

*In the example above, we imagined an option with a Delta of .40. If the underlying stock moves $1 and the option moves $.40 along with it, the option’s Delta is no longer 0.40. Why? This $1 move would mean the call option is now even deeper ITM, and so its Delta should move even closer to 1.00. So, let’s assume that as a result the Delta is now 0.55. The change in Delta from 0.40 to 0.55 is 0.15—this is the option’s Gamma.*

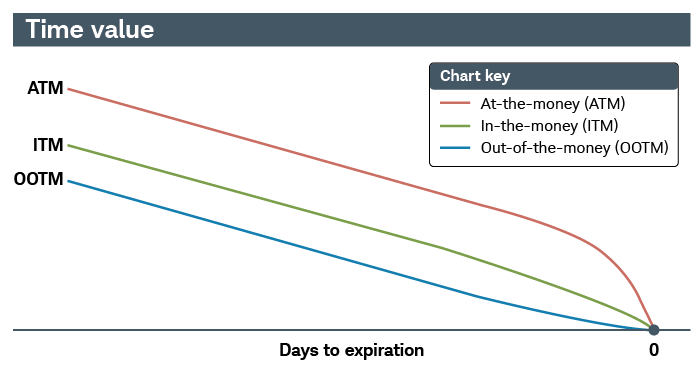
*Because Delta can’t exceed 1.00, Gamma*decreases*as an option gets further ITM and Delta approaches 1.00. After all, there’s less room for acceleration as you approach top speed.*

***Theta***

*Theta tells you how much the price of an option should decrease each day as the option nears expiration, if all other factors remain the same. This kind of price erosion over time is known as time decay.*

*Time-value erosion is not linear, meaning the price erosion of at-the-money (ATM), just slightly out-of-the-money, and ITM options generally increases as expiration approaches, while that of far out-of-the-money (OOTM) options generally decreases as expiration approaches.*

### Time-value erosion



Source: Schwab Center for Financial Research

## ***Vega***

*Vega measures the rate of change in an option’s price per one-percentage-point change in the implied volatility of the underlying stock. (There’s more on implied volatility below.) While Vega is not a real Greek letter, it is intended to tell you how much an option’s price should move when the volatility of the underlying security or index increases or decreases.*

***More about Vega:***

* *Volatility is one of the most important factors affecting the value of options.*
* *A drop in Vega will typically cause both calls and puts to lose value.*
* *An increase in Vega will typically cause both calls and puts to gain value.*

*Neglecting Vega can cause you to potentially overpay when buying options. All other factors being equal, when determining strategy, consider buying options when Vega is below “normal” levels and selling options when Vega is above “normal” levels. One way to determine this is to compare the historical volatility to the implied volatility. Chart studies for both values are available on StreetSmart Edge®.*

***Rho***

*Rho measures the expected change in an option’s price per one-percentage-point change in interest rates. It tells you how much the price of an option should rise or fall if the risk-free interest rate (U.S. Treasury-bills)\* increases or decreases.*

***More about Rho:***

* *As interest rates increase, the value of call options will generally increase.*
* *As interest rates increase, the value of put options will usually decrease.*
* *For these reasons, call options have positive Rho and put options have negative Rho.*

*Consider a hypothetical stock that’s trading exactly at its strike price. If the stock is trading at $25, the 25 calls and the 25 puts would both be exactly at the money. You might see the calls trading at, say, $0.60, while the puts could be trading at $0.50. When interest rates are low, the price difference between puts and calls will be relatively small. If interest rates increase, the gap will get wider—calls will become more expensive and puts will become less so.*

*Rho is generally not a huge factor in the price of an option, but should be considered if prevailing interest rates are expected to change, such as just before a Federal Open Market Committee (FOMC) meeting.*

*Long-Term Equity AnticiPation Securities® (LEAPS®) options are far more sensitive to changes in interest rates than are shorter-term options.*

***Implied volatility: like a Greek***

*Though not actually a Greek, implied volatility is closely related. Implied volatility is a forecast of how volatile an underlying stock is expected to be in the future—but it’s strictly theoretical. While it’s possible to forecast a stock’s future moves by looking at its historical volatility, among other factors, the implied volatility reflected in the price of an option is an inference based on other factors, too, such as upcoming earnings reports, merger and acquisition rumors, pending product launches, etc.*

***Key points to remember:***

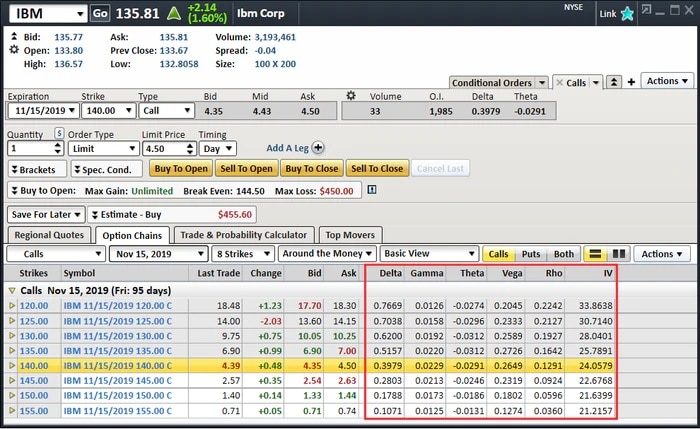
* *Figuring out exactly how volatile a stock will be at any given time is difficult, but looking at implied volatility can give you a sense of what assumptions market makers are using to determine their quoted bid and ask prices. As such, implied volatility can be a helpful proxy in gauging the market.*
* *Higher-than-normal implied volatilities are usually more favorable for options sellers, while lower-than-normal implied volatilities are more favorable for option buyers, because volatility often reverts back to its mean over time.*
* *Implied volatility is often provided on options trading platforms because it is typically more useful for traders to know how volatile a market maker thinks a stock will be than to try to estimate it themselves.*
* *Implied volatility is usually not consistent for all options of a particular security or index and will generally be lowest for at-the-money and near-the-money options.*

*StreetSmart Edge® has charting studies for historical volatility and implied volatility. By comparing the underlying stock’s implied volatility to the historical volatility, you can sometimes get a good sense of whether an option is priced higher or lower than normal.*

*Putting Greeks to work*

*StreetSmart Edge allows you to view streaming Greeks in the options chain of the trading window and in your watch lists. Here is what it looks like.*

***Streaming Greeks in the trading window***

**

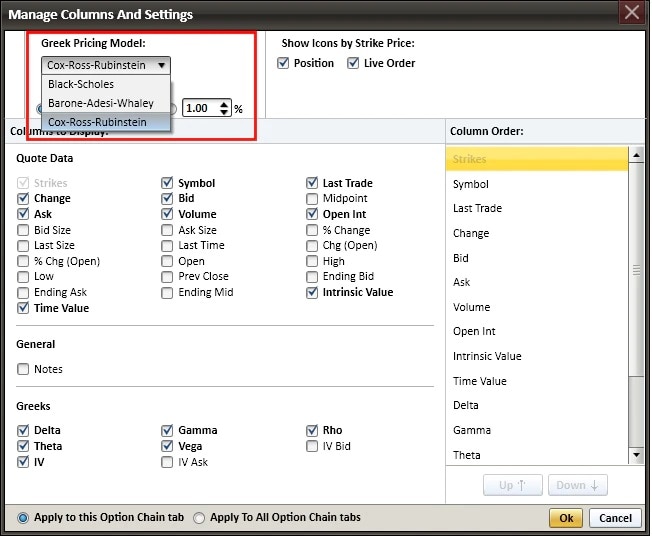
*Source: StreetSmart Edge*

### *Streaming Greeks in a watch list*

**

*Source: StreetSmart Edge*

*You can arrange the columns to display in any order you like. And, as shown below, you can choose between three of the most widely used pricing models. In addition, the dividend yield and 90-day T-bill interest rate are already filled in. You can use these values or specify your own.*



**28. How are the main Greeks derived?**

[**https://www.youtube.com/watch?v=lWWW3xlBHpY**](https://www.youtube.com/watch?v=lWWW3xlBHpY)

**29. What do you know about jump processes?**

***Short Answer***

*Jump-diffusion models combine the continuous Brownian motion seen in Black–Scholes models (the diffusion) with prices that are allowed to jump discontinuously.*

*The timing of the jump is usually random, and this is represented by a Poisson process. The size of the jump can also be random. As you increase the frequency of the jumps (all other parameters remaining the same), the values of calls and puts increase. The prices of binaries, and other options, can go either up or down.*

***Example***

*A stock follows a lognormal random walk. Every month you roll a dice. If you roll a one then the stock price jumps discontinuously. The size of this jump is decided by a random number you draw from a hat. (This is not a great example because the Poisson process is a continuous process, not a monthly event.)*

***Long Answer***

*A Poisson process can be written as dq where dq is the jump in a random variable q during time t to t + dt. Dq is 0 with probability 1 − λ dt and 1 with probability λ dt.*

*Note how the probability of a jump scales with the time period over which the jump may happen, dt. The scale factor λ is known as the intensity of the process, the larger λ the more frequent the jumps. This process can be used to model a discontinuous financial random variable, such as an equity price, volatility or an interest rate. Although there have been research papers on pure jump processes as financial models it is more usual to combine jumps with classical Brownian motion. The model for equities, for example, is often taken to be*

*dS = μS dt + σS dX + (J − 1)S dq.*

*dq is as defined above, with intensity λ, J − 1 is the jump size, usually taken to be random as well. Jump-diffusion models can do a good job of representing the real-life phenomenon of discontinuity in variables, and capturing the fat tails seen in returns data. The model for the underlying asset results in a model for option prices. This model will be an integrodifferential equation, typically, with the integral term representing the probability of the stock jumping a finite distance discontinuously. Unfortunately, markets with jumps of this nature are incomplete, meaning that options cannot be hedged to eliminate risk. In order to derive option-pricing equations one must therefore make some assumptions about risk preferences or introduce more securities with which to hedge. Robert Merton was the first to propose jump-diffusion models. He derived the following equation for equity option values*

*∂V*

*∂t*

*+*

*σ2S2 ∂2V*

*∂S2*

*+ rS*

*∂V*

*∂S*

*− rV*

*+ λE [V(JS, t) − V(S, t)] − λ*

*∂V*

*∂S*

*SE [J − 1] = 0.*

*E[·] is the expectation taken over the jump size. In probability terms this equation represents the expected value of the discounted payoff. The expectation being over the risk-neutral measure for the diffusion but the real measure for the jumps. There is a simple solution of this equation in the special case that the logarithm of J is Normally distributed.*

*If the logarithm of J is Normally distributed with standard deviation σ and if we write k = E[J − 1] then the price of a European non-path-dependent option can be written as*

*∞\_*

*n=0*

*1*

*n!*

*e−λ*

*(T−t)(λ*

*(T − t))nVBS(S, t; σn, rn).*

*In the above*

*λ*

*= λ(1 + k), σ2*

*n*

*= σ2 + nσ*

*2*

*T − t*

*and*

*rn = r − λk + n ln(1 + k)*

*T − t*

*,*

*and VBS is the Black–Scholes formula for the option value in the absence of jumps. This formula can be interpreted as the sum of individual Black–Scholes values each of which assumes that there have been n jumps,*

*and they are weighted according to the probability that there will have been n jumps before expiry. Jump-diffusion models can do a good job of capturing steepness in volatility skews and smiles for short-dated*

*option, something that other models, such as stochastic volatility, have difficulties in doing.*

**30. Should you use implied standard deviation or historical deviation to forecast volatility? Explain your choice.**

*Implied volatility is a better gauge but it will contain a timer varying risk premium. Note that the implied volatility of options on the British pound were very hi prior to the Brexit vote even though the currency wasn't moving much. If you do use historical volatility it is most likely not constant. You may want to use Garch modelling.. Implied volatility is Forward looking. Historical is backward looking*

**Questions on hedging:**

**31. What is delta hedging?**

***Short Answer***

*Dynamic hedging, or delta hedging, means the continuous buying or selling of the underlying asset according to some formula or algorithm so that risk is eliminated from an option position. The key point in this is what formula do you use, and, given that in practice you can’t hedge continuously, how should you hedge discretely?*

*First get your delta correct, and this means use the correct formula and estimates for parameters, such as volatility. Second decide when to hedge based on the conflicting desires of wanting to hedge as often as possible to reduce risk, but as little as possible to reduce any costs associated with hedging.*

***Example***

*The implied volatility of a call option is 20% but you think that is cheap, volatility is nearer 40%. Do you put 20% or 40% into the delta calculation? The stock then moves, should you rebalance, incurring some inevitable*

*transactions costs, or wait a bit longer while taking the risks of being unhedged?*

**Long Answer**

There are three issues, at least, here. First, what is the

correct delta? Second, if I don’t hedge very often how

big is my risk? Third, when I do rehedge how big are

my transaction costs?

*What is the correct delta?* Let’s continue with the above

example, implied volatility 20% but you believe volatility

will be 40%. Does 0.2 or 0.4 go into the Black–Scholes

delta calculation, or perhaps something else? First

let me reassure you that you won’t theoretically lose money in either case (or even if you hedge using a

volatility somewhere in the 20 to 40 range) as long as

you are right about the 40% and you hedge continuously.

There will however be a big impact on your P&L

depending on which volatility you input.

If you use the actual volatility of 40% then you are guaranteed

to make a profit that is the difference between

the Black–Scholes formula using 40% and the Black–

Scholes formula using 20%.

*V*(*S*, *t*; *σ*) − *V*(*S*, *t*; ˜*σ*),

where *V*(*S*, *t*; *σ*) is the Black–Scholes formula for the call

option and *σ* denotes actual volatility and ˜*σ* is implied

volatility.

That profit is realized in a stochastic manner, so that

on a marked-to-market basis your profit will be random

each day. This is not immediately obvious, nevertheless

it is the case that each day you make a random

profit or loss, both equally likely, but by expiration your

total profit is a guaranteed number that was known at

the outset. Most traders dislike the potentially large

P&L swings that you get by hedging using the forecast

volatility that they hedge using implied volatility.

When you hedge with implied volatility, even though

it is wrong compared with your forecast, you will still

make money. But in this case the profit each day is

non negative and smooth, so much nicer than when

you hedge using forecast volatility. The downside is

that the final profit depends on the path taken by the

underlying. If the stock stays close to the strike then

you will make a lot of money. If the stock goes quickly

far into or out of the money then your profit will be

small. Hedging using implied volatility gives you a nice, smooth, monotonically increasing P&L but at the cost of

not knowing how much money you will make.

The profit each time step is

12

\_

*σ*2 − ˜*σ*2

\_

*S*2*\_i dt*,

where *\_i* is the Black–Scholes gamma using implied

volatility. You can see from this expression that as long

as actual volatility is greater than implied you will make

money from this hedging strategy. This means that you

do not have to be all that accurate in your forecast of

future actual volatility to make a profit. *How big is my hedging error?* In practice you cannot hedge

continuously. The Black–Scholes model, and the above

analysis, requires continuous rebalancing or your position

in the underlying. The impact of hedging discretely

is quite easy to quantify.

When you hedge you eliminate a linear exposure to the

movement in the underlying. Your exposure becomes

quadratic and depends on the gamma of your position.

If we use *φ* to denote a normally distributed random

variable with mean of zero and variance one, then the

profit you make over a time step *δt* due to the gamma

is simply

12

*σ*2*S*2*\_ δt φ*2*.*

This is in an otherwise perfect Black–Scholes world.

The only reason why this is not exactly a Black–Scholes

world is because we are hedging at discrete time intervals.

The Black–Scholes models prices in the *expected* value

of this expression. You will recognize the 12

*σ*2*S*2*\_* from

the Black–Scholes equation. So the **hedging error** is simply

12

*σ*2*S*2*\_ δt* (*φ*2 − 1)*.*

This is how much you make or lose between each rebalancing.

We can make several important observations about

hedging error.

• It is large: it is *O*(*δt*) which is the same order of

magnitude as all other terms in the Black–Scholes

model. It is usually much bigger than interest

received on the hedged option portfolio

• On average it is zero: hedging errors balance out

• It is path dependent: the larger gamma, the larger the

hedging errors

• T√he total hedging error has standard deviation of

*δt*: total hedging error is your final error when you

get to expiration. If you want to halve the error you

will have to hedge four times as often.

• Hedging error is drawn from a chi-square distribution:

that’s what *φ*2 is

• If you are long gamma you will lose money approximately 68% of the time: this is chi-square

distribution in action. But when you make money it

will be from the tails, and big enough to give a mean

of zero. Short gamma you lose only 32% of the time,

but they will be large losses.

• In practice *φ* is not normally distributed: the fat tails,

high peaks we see in practice will make the above

observation even more extreme, perhaps a long

gamma position will lose 80% of the time and win

only 20%. Still the mean will be zero.

*How much will transaction costs reduce my profit?* To reduce

hedging error we must hedge more frequently, but

the downside of this is that any costs associated with trading the underlying will increase. Can we quantify

transaction costs? Of course we can.

If we hold a short position in delta of the underlying and

then rebalance to the new delta at a time *δt* later then

we will have had to have bought or sold whatever the

change in delta was. As the stock price changes by *δS*

then the delta changes by *δS \_*. If we assume that costs

are proportional to the absolute value of the amount of

the underlying bought or sold, such that we pay in costs

an amount *κ* times the value traded then the expected

cost each *δt* will be

*κσS*2

√

*δt*

\_

2

*π*

|*\_*|,

where the

2

*π* appears because we have to take the

expected value of the absolute value of a normal variable.

Since this happens every time step, we can adjust

the Black–Scholes equation by subtracting from it the

above divided by *δt* to arrive at *∂V*

*∂t*

+ 12

*σ*2*S*2 *∂V*

*∂S*2

+ *rS*

*∂V*

*∂S*

− *rV* − *κσS*2

\_

2

*πδt*

|*\_*| = 0*.*

This equation is interesting for being non linear, so that

the value of a long call and a short call will be different.

The long call will be less than the Black–Scholes value

and a short call higher. The long position is worth less

because we have to allow for the cost of hedging. The

short position is even more of a liability because of costs.

Crucially we also see that the effect of costs grows

like the inverse of the square root of the time between

rehedges. As explained above if we want to halve hedging

error we must hedge four times as often. But this

would double the effects of transaction costs.

In practice, people do not rehedge at fixed intervals,

except perhaps just before market close. There are many other possible strategies involving hedging when

the underlying or delta moves a specified amount, or

even strategies involving **utility theory**.

**32. How would you hedge against a particular equity/bond under current market conditions?**

* *You can hedge by buying put options at lower levels to protect your stock price.*
* *You can also hedge by selling futures against your cash market holding.*
* *If you are holding bonds, you can hedge by keeping duration the same as your time frame. This saves you from any interest risk.*
* *Also, avoid risky bonds.*

**33. When can hedging an options position mean that you take on more risk?**

* *Hedging an options position can become riskier if one side of the option position is left open.*
* *Also if you hedge through covered calls, it can be risky in the event of a fall in the stock price.*
* *Normally, volatility is positive for options.*

*1. Hedging an options position can become riskier if one side of the option position is left open. Also if you hedge through covered calls, it can be risky in the event of a fall in the stock price. Normally, volatility is positive for options.*

*2. Hedging can increase your risk if you are forced to both buy short-dated options and hedge them.*

*3. E.g. on Monday you get forced to buy some Friday expiry OTM puts, say 95% strike S&P weeklies. Of course, you go and buy some delta against them to "hedge" yourself. Next thing you know, the the market tanks. Unfortunately, by Friday it's only down 3.5%, so it's does not fall far enough to reach the strike. So, on Friday expiration, you are out your premium and down money on your delta.*

*Overall, it's a pretty typical "painful moment" for a market maker. Usually, in this case you are better off selling some ATMish gamma and leaving the tinys to decay in peace. Should the market really take a dive, you got some lottery tickets.*

*4. Hedging does not increase your risk in this particular example: You take on delta exposure by buying the short dated option outright. Thus buying/selling underlying (put/call) in any case will reduce your delta exposure, hence risk of changes in the underlying, given you hedge the right amount and at the right timing (this is venture is impossible to generalize as it applies differently to each case). Now, you are long gamma but being long gamma does not guarantee at all that you end up better off not hedging initially. If your boss instructs you to be at all times almost perfectly delta hedged (most French bosses are anal about this, probably because they are horrible delta traders) then you hedge, period. It reduces your delta exposure, hence risk in moves in the underlying. It is complete nonsense to start arguing in retrospect that no hedge may have resulted in a better payoff because the underlying followed a price path not anticipated earlier.*

*I concur with Strange that there are often better ways to hedge than always going through the underlying but I disagree with him that it poses a "painful moment" to market markers. Market makers who are dependent on the market moving in specific ways are probably very bad volatility traders. Your job as market maker is to earn money from the bid/offer spread and to reduce your risk exposure to lower moment greeks, given it is feasible and cost-efficient. The other times you, as market maker, attempt to benefit from what you perceive as mispricings in the option valuation. Thus, hedging the long options position with the underlying reduces your risk, period. There are obviously exceptions to this, for example, when the underlying is so extremely illiquid that it would be prohibitive to hedge/re-hedge frequently. But it has to really be analyzed in context. But if the interview book looked for a straight forward answer which applies to most cases then hedging reduces your risk, simple as that.*

**34. An option is at the money. How many shares of stock should you hold to hedge it?**

*For example, suppose you buy 15 call option contracts with a delta of 0.2. You are long delta, so you must sell deltas to create a delta-neutral position. Next, you need to find the quantity of the underlying asset you need to hedge. To find the delta hedge quantity, you multiply the absolute value of the delta by the number of option contracts and multiply that by 100 (each option contract controls 100 shares of stock). In this case, the quantity is 300, or equal to (0.20 x 15 x 100). Therefore, you must sell this amount of the underlying asset to be delta neutral.*

*OR: -Delta number of shares*

**Questions on particular products:**

**35. What is interest rate risk?**

*Interest rate risk in the banking book (IRRBB) refers to the current or prospective risk to the bank’s capital and earnings arising from adverse movements in interest rates that affect the bank’s banking book positions. When interest rates change, the present value and timing of future cash flows change. This in turn changes the underlying value of a bank’s assets, liabilities and off-balance sheet items and hence its economic value. Changes in interest rates also affect a bank’s earnings by altering interest rate-sensitive income and expenses, affecting its net interest income (NII). Excessive IRRBB can pose a significant threat to a bank’s current capital base and/or future earnings if not managed appropriately. A more detailed description of IRRBB and its management techniques can be found in SRP98.*

*31.2*

*Three main sub-types of IRRBB are defined for the purposes of this chapter. All three sub-types of IRRBB potentially change the price/value or earnings/costs of interest rate-sensitive assets, liabilities and/or off-balance sheet items in a way, or at a time, that can adversely affect a bank’s financial condition.*

*(1)*

***Gap risk*** *arises from the term structure of banking book instruments, and describes the risk arising from the timing of instruments’ rate changes. The extent of gap risk depends on whether changes to the term structure of interest rates occur consistently across the yield curve (parallel risk) or differentially by period (non-parallel risk).*

*(2)*

***Basis risk*** *describes the impact of relative changes in interest rates for financial instruments that have similar tenors but are priced using different interest rate indices.*

*(3)*

***Option risk*** *arises from option derivative positions or from optional elements embedded in a bank’s assets, liabilities and/or off-balance sheet items, where the bank or its customer can alter the level and timing of their cash flows. Option risk can be further characterized into automatic option risk and behavioral option risk.*

*While the three sub-types listed above are directly linked to IRRBB, credit spread risk in the banking book (CSRBB) is a related risk that banks need to monitor and assess in their interest rate risk management framework. CSRBB refers to any kind of asset/liability spread risk of credit-risky instruments that is not explained by IRRBB and by the expected credit/jump to default risk*

***36. What is reinvestment risk?***

*Reinvestment risk refers to the* ***possibility that an investor will be unable to reinvest cash flows received from an investment, such as coupon payments or interest, at a rate comparable to their current rate of return****. This new rate is called the reinvestment rate.*

***Zero-coupon bonds*** *(Z-bonds) are the only type of fixed-income security to have* ***no inherent investment risk*** *since they issue no coupon payments throughout their lives.*

***KEY TAKEAWAYS***

*• Reinvestment risk is the chance that cash flows received from an investment will earn less when put to use in a new investment.*

*•* ***Callable bonds are especially vulnerable to reinvestment risk because these bonds are typically redeemed when interest rates decline.***

*• Methods to* ***mitigate*** *reinvestment risk include the* ***use of non-callable bonds, zero-coupon instruments, long-term securities, bond ladders, and actively managed bond funds.***

***37. How do interest rate risk and reinvestment risk interact?***

*Fixed income securities such as bonds are instruments that typically pay interest, called the coupon, throughout their lifetimes and then return the face value at maturity. There's generally less risk than with other investments that investors will lose all their money when investing in bonds. There are still risks associated with bonds, though, including factors called* ***interest rate risk and reinvestment risk*** *that focus on whether investors could ultimately be worse off due to changing market conditions.*

***Tip***

***Interest rate risk*** *refers to the danger of a bond* ***losing value because it pays interest rates below what would-be buyers can otherwise find in the market****.* ***Reinvestment risk*** *refers to* ***investors not being able to find a similarly paying investment for their proceeds from a bond****.*

***Exploring Yield vs Price***

*A fixed-rate bond has a stated, unchanging coupon payment it disburses every period - for instance, T-Bonds pay interest semi-annually. The total coupon payments for the year divided by the bond price is the annual yield. Coupons don’t change on fixed-rate bonds, but prices do, and thus so do yields.*

*For an already issued bond to be sellable, its yield must compete with current interest rates. Thus, as rates and yields go up, prices must come down, and vice versa.*

***Interest Rate Risk***

*The scenario in which interest rates rise after a bond is issued leads to interest rate risk. Since prices will decline if interest rates rise, the holder of a fixed-rate bond may experience a capital loss if the bond is sold before its maturity date. The longer the period until maturity, the more the bond is subject to interest rate risk.*

*At maturity, the bond will refund the face amount, so* ***bonds near maturity have little interest rate risk.*** *Bond duration is a mathematical equation that signifies how sensitive a bond is to interest rate risk -- bonds with relatively low durations are more resistant to interest rate risk.*

***Understanding Reinvestment Risk***

*What if interest rates go down instead?* ***The price of a fixed-rate bond will rise and entice some holders to sell the bond for a profit****. But others will hold onto the bond and will find* ***that they cannot make as much interest income from reinvesting the periodic coupon payments they receive****.*

*This is* ***reinvestment risk*** *-- if interest rates go down, your interest on interest will decline. This lowers a bond’s yield to maturity, which is a function of the total income, including reinvested interest income, which will be provided by the bond.*

***Understanding Call Risk***

*Some bonds are considered* ***callable bonds****, which means that the organization that issued them* ***can pay them back early through a process known as calling*** *them. Exactly when the bonds can be called depends on their original terms.*

*Typically,* ***bonds will be called early if the issuer can replace them with lower interest bonds*** *or simply* ***wants to save money on long-term interest payments.*** *This presents a particular type of reinvestment risk, known as call risk, to the investors in the bonds, since the bonds will likely be called when comparable interest rates are no longer available.*

***Floating-Rate Bonds***

*Some bonds have variable coupons that float with current interest rates. These instruments tend to have stable prices because their coupons remain competitive within the changing interest rate environment. However, if interest rates go down, so will the bond’s coupon, cutting interest income.*

*This is* ***income risk****. In addition, lower interest rates create reinvestment risk, whether the bond is fixed rate or floating rate.* ***Floating rate bonds are suitable for investors who are more sensitive to interest rate risk than to income risk, such as investors who do not plan to hold a bond until maturity.***

***38. Which bond has the greatest associated interest rate risk? A five year zero coupon bond? Or a five year bond that pays coupons?***

*Answer and Explanation: A five-year* ***zero-coupon bond*** *has* ***more interest rate risk****. Interest rate risk is higher for bonds that pay lower coupon payments.*

*Therefore,* ***bonds with longer maturities generally have higher interest rate risk than similar bonds with shorter maturities****. to compensate investors for this* ***interest rate risk, long-term bonds*** *generally* ***offer higher coupon rates*** *than short-term bonds of the same credit quality****.***

***39. Which is more volatile, a 20-year zero coupon bond or a 20-year 4.5% coupon bond?***

***Zero-coupon bonds*** *tend to be* ***more volatile*** *because they do* ***not pay any interest*** *during the life of the bond. These bondholders receive the face value on maturity, thus the* ***only value in these bonds happens closer to maturity****.*

***40. A stock is selling at $90. A 3-month call with a strike price of $100 is selling for $3.105 with a delta of 0.329. How many call contracts are required to perform a hedge on 1,000 shares of this stock? Would they be bought or sold? What happens if the price of the stock falls to $50?***

*I think what you are asking is how many 33 delta call would 1000 shares of the underlying stock delta hedge. If One option is on 100 shares then 33 options or one option on 3300 shares will have a delta of 1000 share. This will give you a "static hedge". That is small moves in the share price will be exactly offset by changes in the value of your short option position. A long stock position will hedge a shot call or a long put position. you would collects 3.105 per share on the 3300 shares or $10,246.5.*

*If the shares dropped to 50 you would lose $40,000 on the share but would still have the premium of 10,246.5 so your net loss if this all happens at expiration is 29,753.5*

***41. You have two options with the same underlying strike price. One has an exercise date in three months, one has an exercise date in six months. Which comes with the greatest risk?***

*The longer the time to expiry or exercise the greater the risk, and correspondingly the higher the premium.*

***42. What’s the maximum potential loss you could incur by selling a put on a stock?***

*What is the Maximum Loss Possible When Selling a Put? The maximum loss possible when selling or writing a put is equal to the* ***strike price less the premium received.***

***43. What are the risks inherent in an interest rate swap?***

*Like most non-government fixed income investments, interest-rate swaps involve two primary risks:* ***interest rate risk and credit risk****, which is known in the swaps market as* ***counterparty risk****. Because actual interest rate movements do not always match expectations, swaps entail interest-rate risk.*

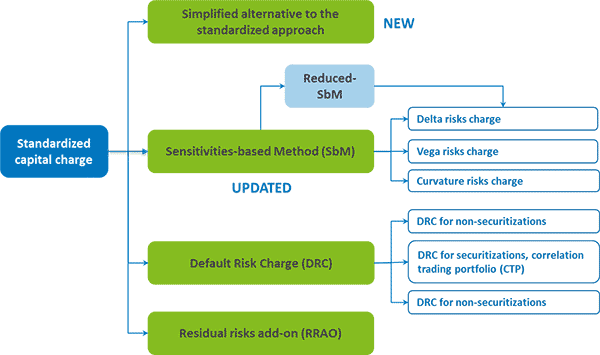
***Questions related to regulation:***

***44. How has Basel III changed the treatment of market risk?***

* *Trading positions often face significant financial loss due to their exposure to volatilities present in underlying market risk factors. As it stands today, the* ***trading book fails to capture the severity of such losses adequately****, which has spurred the BCBS to propose a framework for the estimation of the* ***minimum capital requirements for market******risk****, also known as the* ***Fundamental Review of the Trading Book****, more commonly known as FRTB (BCBS, 2013[1], 2016[2], 2017[3]). Moreover, the Basel Committee is currently monitoring and revising the implementation of the market risk standard, and proposing updated methods (BCBS, 2018[4]).*
* ***Market liquidity risk*** *plays a key role in both the* ***standardized approach (SA)*** *and the* ***internal model approach (IMA).*** *In the IMA the framework introduces the* ***expected shortfall (ES),*** *substituting* ***the value at risk (VaR)*** *as a measure for the measurement of market risk. The new framework also introduces a* ***profit and loss attribution (PLA)*** *test that the trading desk must pass if they want to implement IMA.*
* *Banks do not only have to estimate capital against the exposure to* ***modellable risk factors****. The framework now* ***recognizes an additional capital requirement dedicated to non-modellable risk factors*** *(NMRFs).*
* *To ensure banks do* ***not create regulatory arbitrage****, the new framework aims to* ***close the gaps between the treatment of trading and banking book exposures****. To this end updated revisions to the boundary between the two books have been proposed by the committee (BCBS, 20184).*

***The Standardized Approach to Market Risk***

*Banks must devote a series of methods for implementing the standardized approach (SA) (Figure 1): a)* ***the sensitivities-based method (SbM),*** *b)* ***the default risk charge (DRC),*** *and c)* ***the residual risks add-on (RRAO) methods.*** *The committee also proposes a simplified alternative standardized approach to market risk.*



*Figure 1: Methods for implementing the standardized approach*

***Sensitivities-based Method***

*The SbM framework suggests that banks use* ***sensitivity analysis for the estimation of capital charges against delta, vega, and curvature risks****.*

*Banks should follow several steps for* ***estimating the capital charges based on SbM.*** *These steps include:*

*1. The assignment of the portfolio to risk classes;*

*2. The identification of buckets;*

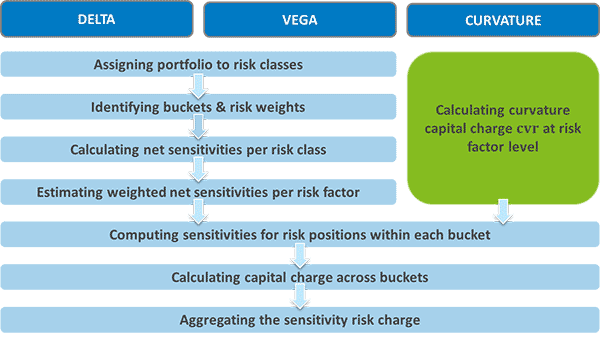
*3. The estimation of net sensitivities for each risk class;*

*4. The calculation of weighted net sensitivities for each risk factor;*

*5. The computation of sensitivities for risk positions within each bucket,*

*6. the estimation of capital charge across buckets;*

*7. The aggregation of the sensitivity risk charge based on correlation scenarios (see Figure 2).*



*Figure 2: Main steps for estimating capital charge based on the sensitivities-based method*

***Delta and vega risk charges*** *are computed individually for* ***seven risk classes, the capital charges within each bucket are aggregated and finally the capital requirements across those buckets is calculated.*** *The weighted delta and vega sensitivities drive the* ***capital on risk factors (RFs)*** *and the correlation factors with and across buckets.*

*Banks also need to capture* ***risks assigned to non-linear instruments*** *which means they must estimate* ***curvature risk dealing with the second-order sensitivity measurements****. Thus, any changes in the price of an option* ***not identified by delta and vega risk is addressed by curvature risk****. The final Basel III framework approximates the curvature as an* ***incremental capital charge above delta capital charge****.*

*After estimating the curvature risk charge, banks have to apply the* ***sensitivity risk charge aggregation based on three scenarios on the correlations between risk factors within a bucket and cross-bucket correlations within a risk class.*** *In fact, the bank has to stress the correlation factors based on three scenarios:*

*1. A shock of increasing the level of correlations by 25%;*

*2. No shock, i.e. unchanged correlation;*

*3. A shock of reducing the level of correlations based on a formula proposed by the framework as proposed in the latest amendments (BCBS, 20184, Annex A: 15 paras 54c).*

*Banks have to implement the above three scenarios individually for each risk class to calculate the risk charges accordingly. A portfolio exposed to risk classes must aggregate the associated risk charges and the three scenario-based risk charges resulting in three values of the aggregated portfolio. The highest of the three aggregated values is the recognized capital charge at portfolio level (Figure 3).*



*Figure 3: The three steps for estimating of the sensitivity risk charge at the portfolio level*

*Grounded by evidential eligibility criteria, a simplified reduced SbA may be an alternative option for banks. The absence of vega estimation and curvature risks, and the reduction of RFs and correlation scenarios under consideration are both benefits of the less demanding framework, however, the upsurge of risk weights under this method means the capital charge rises significantly.*

*In the latest proposed amendments, further to alternative reduced SbA, the committee recommends a second alternative option whereby a recalibrated version of the Basel II standardized approach can be used (BCBS, 2018). It includes four multiplication scaling factors applied respectively to the capital requirements, estimated by the SA, in the four risk classes:* ***FX risk, commodity risk, general and specific interest rate risk, general and specific equity risk.*** *The over capital requirement results in summing up the recalibrated capital estimations (BCBS, 20184, Annex F: 39 paras 3).*

***Example of the Estimation of Delta Capital Charge***

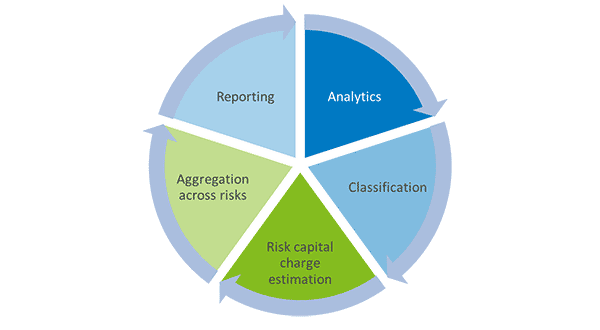
*Let us examine a case of a banking institution based in the Euro-zone area that holds a portfolio consisting of three assets:*

*• A five-year maturity corporate bond with a modified duration of 4.5, denominated in GBP;*

*• A two-year maturity government bond with a modified duration of 2.8, denominated in GBP; and,*

*• A seven-year maturity corporate bond with a modified duration of 6.7, denominated in EUR.*

*By employing SbM the bank estimates delta general interest rate risk (GIRR) capital charges following the steps presented below and as illustrated in Table I:*

*Table I. Steps of estimating the delta (GIRP) capital charge*

*1. All assets are interest rate sensitive. As a result, they fall under the GIRR risk class;*

*2. In the view of the bucket definition of GIRR delta the two currencies, that is, GBP and EUR, define two buckets, b1 and b2, accordingly;*

*3. The sensitivities Sk, Sl and Sm denominated to GBP and EUR are approximated to the modified duration of the instruments, defined at the degrees of 4.5, 2.8 and 6.7 respectively;*

*4. By knowing the instruments’ maturity, the bank identifies the vertexes, as of 5, 2 and 7, set by the framework;*

*5. Corresponding to the above vertexes risk weights (RWs), distinct by the framework, are within a range of [0.90% - 1.20%], [1.10% - 1.50%] and [0.90% - 1.20%];*

*6. The weighted sensitivities are estimated (BCBS, 2016[5] 25 paras 67), within a range of [0.041 - 0.054], [0.031 - 0.042] and [0.060 - 0.080], respectively;*

*7. At the level of each bucket:*

*- For assets one and two, the correlations between the two weighted sensitivities set to the range of [0.941 - 0.941] as derived from the rules defined by the framework (note that as b2 contains only one asset, a correlation factor is out of consideration);*

*- For all assets, the risk positions are calculated resulting of a range within [0.070 - 0.095] for b1, and [0.004 - 0.006] for b2;*

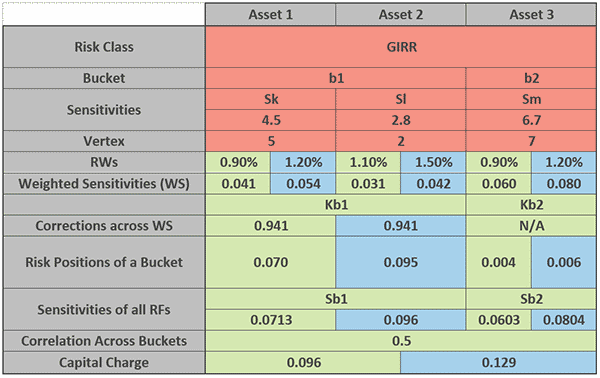
*8. The sensitivities for all risk factors for b1 are estimated within a range of [0.0713 - 0.096] for assets one and two, whereas asset three belongs to bucket b2 calculated within a range of [0.0603 - 0.0804].*

*9. The level of correlation across those buckets is defined by the framework and set to a degree of 0.5;*

*10. The delta capital charge estimated to the range of values between 0.096 and 0.129.*

*Layout of a process for implementing Basel III minimum capital requirements for market risk*

*In conclusion, initially banks must apply the necessary analytics for estimating the market risk sensitivities, classify the risk exposures and the assets under study to identify the associated risk weights, calculate the risk capital charge based on the formulas provided by the framework, apply aggregation rules within and across buckets, report associated capital against risk and losses. The cycle process of implementing Basel III minimum capital requirements for market risk based on the standardized approach is illustrated in Figure 4.*



*Figure 4: Process steps of implementing Basel III minimum capital requirements for Market Risk*

***45. What the implications of Basel IIIs new trading book rules for market risk professionals?***

*In the wake of the Lehman Brothers collapse of 2008 and the ensuing financial crisis, the BCBS decided to update and strengthen the Accords. The BCBS considered poor governance and risk management, inappropriate incentive structures, and an overleveraged banking industry as reasons for the collapse. In November 2010, an agreement was reached regarding the overall design of the capital and liquidity reform package. This agreement is now known as Basel III.*

*Basel III is a continuation of the three pillars along with additional requirements and safeguards. For example, Basel III requires banks to have* ***a minimum amount of common equity and a minimum liquidity ratio****. Basel III also includes additional requirements for what the Accord calls "systemically important banks," or those financial institutions that are considered "too big to fail." In doing so, it got rid of tier 3 capital considerations.*

*The Basel III reforms have now been integrated into the consolidated Basel Framework, which comprises all of the current and forthcoming standards of the Basel Committee on Banking Supervision. Basel III tier 1 has now been implemented and all but one of the 27 Committee member countries participated in the Basel III monitoring exercise held in June 2021. The final Basel III framework includes phase-in provisions for the output floor, which will start at 50% on Jan. 1, 2023, rising in annual steps of 5% and be fully phased-in at the 72.5% level from January 2028. These 2023 onward measures have been referred to as Basel 3.1 or Basel IV.*

*Basel III is an extension of the existing Basel II Framework, and introduces new capital and liquidity standards to strengthen the regulation, supervision, and risk management of the whole of the banking and finance sector.*

*It was agreed upon by the members of the Basel Committee on Banking Supervision in 2010–2011, and was scheduled to be introduced from 2013 until 2015. However, changes made from April 2013 extended implementation until March 31, 2018. The Basel III requirements were in response to the deficiencies in financial regulation that is revealed by the 2000’s financial crisis. Basel III was intended to strengthen bank capital requirements by increasing bank liquidity and decreasing bank leverage.*

*The global capital framework and new capital buffers require financial institutions to hold more capital and higher quality of capital than under current Basel II rules. The new leverage ratio introduces a nonrisk-based measure to supplement the risk-based minimum capital requirements. The new liquidity ratios ensure that adequate funding is maintained in case there are other severe banking crises.*

*The figure below shows how Basel III strengthens the three Basel II pillars, especially Pillar 1 with enhanced minimum capital and liquidity requirements. Figure 1. Basel II and Basel III pillars*

***Capital requirements***

*The Basel III rule introduced the following measures to strengthen the capital requirement and introduced more capital buffers:*

***Capital Conservation Buffer*** *is designed to absorb losses during periods of financial and economic stress. Financial institutions will be required to hold a capital conservation buffer of 2.5% to withstand future periods of stress, bringing the total common equity requirement to 7% (4.5% common equity requirement and the 2.5% capital conservation buffer). The capital conservation buffer must be met exclusively with common equity. Financial institutions that do not maintain the capital conservation buffer faces restrictions on payouts of dividends, share buybacks, and bonuses.*

***Countercyclical Capital Buffer*** *is a countercyclical buffer within a range of 0% and 2.5% of common equity or other fully loss absorbing capital is implemented according to national circumstances. This buffer serves as an extension to the capital conservation buffer.*

***Higher Common Equity Tier 1 (CET1)*** *constitutes an increase from 2% to 4.5%. The ratio is set at:*

*• 3.5% from 1 January 2013*

*• 4% from 1 January 2014*

*• 4.5% from 1 January 2015*

***Minimum Total Capital Ratio remains at 8%.*** *The addition of the capital conservation buffer increases the total amount of capital a financial institution must hold to* ***10.5% of risk-weighted assets****, of which 8.5% must be tier 1 capital. Tier 2 capital instruments are harmonized and tier 3 capital is abolished.*

***Leverage ratio***

*Basel III introduced a minimum "leverage ratio". The leverage ratio was calculated by dividing Tier 1 capital by the bank's average total consolidated assets; the banks were expected to maintain a leverage ratio in excess of 3% under Basel III. In July 2013, the US Federal Reserve Bank announced that the minimum Basel III leverage ratio would be 6% for 8 SIFI banks and 5% for their bank holding companies.*

***Liquidity requirements***

*Basel III introduced two required liquidity ratios:*

*•* ***Liquidity Coverage Ratio (LCR)*** *ensures that sufficient levels of high-quality liquid assets are available for one-month survival in a severe stress scenario.*

*•* ***Net Stable Funding Ratio (NSFR)*** *promotes resilience over long-term time horizons by creating more incentives for financial institutions to fund their activities with more stable sources of funding on an ongoing structural basis.*

***Changes to Counterparty Credit Risk (CCR)***

*Basel III introduced capital requirements to cover* ***Credit Value Adjustment (CVA) risk and higher capital requirements for securitization products.***

*II*

***The Fundamental Review of the Trading Book (“FRTB”)*** *was initiated by the Basel Committee on Banking Supervision (“BCBS”) in the years following the Great Financial Crisis (“GFC”) of 2007-2009, with the aim of completely revising the approach to calculating risk-based capital requirements for trading activities (i.e., “market risk capital”).*

*As we will discuss in forthcoming blogs, this complex series of reforms will likely have far-reaching impacts not only on the trading business models of large banks, but also on liquidity provision in key funding markets and therefore the ability of certain non-financial end-users to raise funds. These impacts are inevitable given that 73 percent of the funding for U.S. non-financial corporations is generated by the U.S. capital markets[1], and because banking organizations remain crucial providers of capital markets services to non-financial end-users. Given these potentially far-reaching impacts, it is important for us to first understand what the FRTB was designed to do, why we are hearing more about it now, and what is contained in the package of reforms.*

***What were regulators’ goals in undertaking the FRTB?***

*In the immediate wake of the GFC, the BCBS introduced the so-called “Basel II.5” package of reforms, which included a significant increase in the market-risk capital standards for banks. While increasing the overall quantum of capital required for market risk and making other modifications to the calculation of market risk capital (****particularly the introduction of the Incremental Risk Charge and the Stressed Value-at-Risk “VaR”****) , the reforms were seen mostly as a stop gap measure until the underlying structural problems with market risk capital standards could be properly addressed by the Committee, which would come later in the form of the more comprehensive FRTB.*

*Those structural problems included the lack of a clearly defined boundary between the trading book and the banking book, which provided opportunities for arbitrage between books to obtain more favorable capital treatment for specific instruments or portfolios. Another important concern involved the weaknesses associated with the existing VaR approach to modelling risk. While this approach did a good job of modeling risk under normal market conditions, it performed poorly during periods of market volatility, such as those that occurred during the GFC (i.e., put differently, it did a poor job of capturing so-called “tail risks”). The addition of a “stressed VaR” measure in the Basel II.5 framework was seen as insufficient to compensate for these weaknesses.*

*A further structural deficiency of the existing market risk capital framework was its failure to consider the relative liquidity of trading book positions and the risks of market illiquidity. The existing framework was based on liquidity horizon assumption of ten days, ignoring the fact that many positions may take far longer to liquidate in practice (and particularly during periods of market stress). Other identified problems with the existing framework included a lack of transparency and comparability between the internal models and standardized approaches, particularly in areas such as hedging and diversification, as well as the more favorable treatment of credit risk in the trading book, which had led banks putting an excessive number of their credit positions in the trading rather than the banking book.*

*To address these deficiencies, the BCBS issued a consultation on the FRTB in 2012. This was followed by further consultation exercises in 2013 and 2014, an initial set of standards in 2016 and subsequent modifications to those standards that were ultimately finalized in early 2019 (see timeline in Figure 1 below).*

*Throughout, the core goals of the FRTB initiative were to:*

*a) create a clear regulatory boundary between the trading and banking books;*

*b) replace the VaR approach to risk measurement with a more comprehensive alternative known as* ***Expected Shortfall (“ES”);***

*c) revise the* ***Standardized Approach (“SA”) to make it more risk-sensitive and allowing it to act as a credible fallback Internal Models Approach (“IMA”);***

*d) replace the* ***static 10-day liquidity horizon assumed under the VaR framework with varying liquidity horizons in the IMA;***

*e) introduce a* ***new capital add-on for risk factors that fail modelability tests, known as Non-Modellable Risk Factors (“NMRFs”); and***

*f) create a new and more robust approvals processes for obtaining regulatory approval for IMA use and requiring these approvals to occur at the level of individual desks rather than granting firm-wide approval.*

*Although not a stated objective of the BCBS, industry quantitative impact study (“QIS”) exercises have demonstrated[2], that the market risk changes will* ***also likely increase the aggregate level of market related RWA in the US banking system if implemented without any modifications****. This impact would be distributed unevenly, imposing a* ***significant capital penalty on banks with large trading books****. Depending on how it is implemented, the FRTB could also have a disproportionate impact on some types of products/markets versus others. For example,* ***the way securitization exposures are calculated under the Basel FRTB standards could discourage market making in that sector. Similarly, less liquid markets (e.g., certain corporate bonds and emerging markets) could also see a reduction in market making activity; this is because these types of products/markets are more like to fail the FRTB’s modelability tests, resulting in more punitive capital treatment under the Basel standards****. We will discuss these potential impacts among others in future blogs.*

***When will the FRTB be implemented?***

*While the global standards have been finalized at the Basel level, important outstanding questions remain about the implementation of the final rules in each jurisdiction. Perhaps the most obvious uncertainty concerns the timing of FRTB implementation. The final BCBS standards set January 1, 2022, as the deadline for national implementation, but in March of last year the BCBS agreed to push back that date to January 1, 2023, to give banks additional time to respond to the COVID-19 crisis. Given the complexity of the FRTB changes (along with the remaining Basel III Endgame reforms to other RWA requirements), it was widely assumed that proposed rulemakings would be issued in all the major jurisdictions by the end of 2020 at the latest. This timeframe was seen as necessary to provide for significant public input on the proposed changes and to ensure that there was an adequate amount of time between finalization of national rules and the final go-live date for banks to build, test and validate the necessary systems and models required to implement the FRTB.*

*However, as of late August 2021, only a few jurisdictions (such as Hong Kong) appear to be on track for full implementation by the 2023 deadline. The EU has issued implementing regulations relating to the FRTB, with standardized reporting requirements due to come into effect by September 2021 and full implementation pushed out to 2024. Of note, the U.S. banking regulators had yet to issue a formal FRTB proposal, or indeed a proposal to implement other elements of the Basel III Endgame reforms, having focused much of their attention over the past year on dealing with the response to the pandemic. This strongly suggests that the timeline for U.S. implementation (and likely most other jurisdictions) will extend into 2024 or possibly later. While a further delay is viewed as almost inevitable, neither the BCBS nor U.S. regulators have, as of this writing, confirmed a new implementation date for the FRTB.*

*Although much of the focus has been on the implementation timeline, important substantive issues remain undecided. While the FRTB is an internationally agreed minimum standard, national regulators are afforded flexibility and discretion in how they implement it (discretion that has often been used by U.S. regulators to “gold plate” other Basel Accords). In recent public comments made at the BPI-SIFMA Prudential Conference[3], Federal Reserve General Counsel Mark Van Der Weide committed to a “robust and faithful” implementation of the FRTB and the related Basel III endgame proposals, but also acknowledged that the agencies retained the flexibility to modify the standards to fit unique U.S. legal requirements and business/market structures, as well as to determine the scope of applicability of the reforms. We will discuss some of the outstanding substantive issues later in this blog series.*

***What are the core components of the FRTB?***

*The finalized BCBS framework outlines two approaches that firms can adopt to calculate their market risk capital requirements – the Standardized Approach (“SA”) and Internal Models Approach (“IMA”). All banks must implement the SA; however, some firms may additionally opt for the IMA subject to initial and continued conformance to stringent model performance standards. Consistent with the goal of establishing a clearer boundary between the credit and trading books, the final rule also significantly revised the approach to classifying firm positions as either trading or banking exposures. Below is a high-level description and graphic of each of the key elements of the final FRTB standards.*

***Data, Reporting and Testing Changes***

*In the FRTB, the BCBS makes changes to the way market risk data is gathered, reported, monitored, and verified for accuracy. At a high-level, these changes include:*

*• Implementing a more granular desk level model review and approval process;*

*• Requiring desk level profit and loss attribution tests (“PLAT”) and back testing to be performed on a daily basis;*

*• Expanding the substance of intra-day monitoring and measurement of market risk; and*

*• Applying more granular assessments of model performance.*

***Trading Book Definitions***

*As noted above, one of the main concerns about the existing market risk framework was that it was* ***insufficiently prescriptive in its classification of trading instruments, allowing for significant arbitrage to occur between the trading and banking books****, and leading to inconsistent interpretations between firms. The BCBS addressed their concerns in the FRTB framework by:*

* *Defining* ***a new boundary based on whether the bank intends to trade an asset or hold it to maturity;***
* *Providing a presumptive list of trading book assets and Regulatory Trading Desks (“RTDs”);*
* *Imposing more restrictive rules for internal transfers between bank and trading booking, including prohibiting any capital relief as a result of reclassification;*
* *Placing a restriction on recognition of internal risk transfers (only external risk transfers are recognized under the framework); and*
* *Imposing a more robust framework for hedging recognition to focus on their effectiveness during periods of stress.*

***Standardized Approach (SA)***

*The SA is the* ***default market capital requirement for all banks that fall within the scope of the FRTB,*** *regardless of whether a firm pursues IMA accreditation for the permitted asset classes on a desk-by-desk basis. Importantly, because the IMA approach is subject to initial and continual performance testing, the SA serves as a fallback if a firm fails to meet the performance goals and is the only approach available for correlation trading.[4] As noted above, the SA is significantly more risk sensitive than current standardized approaches. However, that enhanced risk sensitivity – which occurs primarily through the introduction of a new Sensitivities-Based Approach (“SBA”) – is reliant on data obtained from a bank’s pricing models to derive capital requirements. That means that many firms will have to build significant new modelling capacities to meet the requirements.*

*The SA capital risk charge is comprised of three components: the SBA, the Default Risk Charge (“DRC”) and the Residual Risk Add-on (“RRA”). The SA capital charge is calculated using the sum of the SBA, DRC and, if applicable, the RRA charge.*

***Sensitivities-Based Method (“SBA”)***

***The SBA is a form of Parametric VaR******with regulatory weights and correlations.*** *Banks are required to compute risk factors (i.e., observable or measurable market data that is likely to influence the valuation and therefore the profit and loss (“P&L”) generated by a financial instrument) sensitivities (Delta, Vega, and Curvature)[5] for seven regulatory defined risk classes.[6] These risks are then aggregated across buckets, which are sets of instruments of the same risk class sharing the same characteristics and therefore a similar risk profile (a bucket may mean, in this context, a currency or commodities). Moreover, to capture changes in correlations due to financial stresses, banks are required to use three different correlation scenarios (low, medium, and high) to calculate three separate risk charges for each of the regulatory defined risk classes. Following the calculation methodology, the firm sums the all the risk class charges and then uses the largest as the SBA charge (see Figure 3 below for a visual representation of this process).*

***Default Risk Charge (“DRC”)***

*The framework includes a* ***DRC to capture “jump-to-default risk” i.e., credit spread risk****.* ***Only certain portfolio types are exposed to this type of risk, so instead of seven risk classes under the SBA, the risk classes are reduced to three under the DRC: debt instruments, equity products, and securitizations.*** *To determine the aggregate DRC, firms are required to apply differing risk weights, formulas, and expectations regarding netting across the three asset classes.*

***Residual Risk Add-on (“RRA”)***

*The final component of the SA is the RRA, which is designed to* ***capitalize exposures that are not adequately captured by the SBA****. Generally, this charge is applied to* ***more complex transactions where the exposure is difficult to quantify (e.g., products in incomplete markets, products having correlation risk).***  *The methodology applies a simplistic formula that aggregates all residual instruments’ gross notional amount multiplied by a risk weight of 0.1 percent of or in the case of exotic (i.e., highly complex) instruments, 1.0 percent.*

***The Internal Models Approach (IMA)***

*The IMA fundamentally changes the approach to modeling market risk by reforming the measurement methodology and expanding model performance requirements. Most importantly, IMA replaces the long standing VaR-based approach for quantifying market risk with an Expected Shortfall (“ES”) approach. As noted above,* ***while VaR does a good job of capturing risk in normal markets, an ES approach is more effective in capturing the “fatter tail” distributions of risk typical of stressed markets when multiple asset classes move in tandem.***

*The IMA also* ***removes the Incremental Risk Charge introduced in Basel 2.5 and replaces it with a Default Risk Charge*** *(referred to here as an “IMA DRC”), which acts (as it does under the SA) to capture losses that stem from* ***an obliger defaulting****. It places* ***limits on the benefits of hedging, netting and diversification and no longer permits correlation trading positions capital to be estimated with internal models****. Lastly, the framework implements asset class-specific liquidity horizons which more rigorously incorporates the impact of stress periods; and introduces the concept and approach for non-modellable risk factors.*

*The use of internal models and their on-going performance is subject to considerable supervisory scrutiny under the FRTB as well as subject to quantitative requirements. Internal models are also now subject to regulatory approval at the trading desk level.* ***For a desk to qualify for IMA, they must demonstrate that a model is supported by adequate P&L attribution tests and back testing results.***

*P&L attribution is not a new concept to market risk management; however, it is new to the capital framework in the level of specificity that is included in the new framework****. For initial and continued approval, the framework requires daily comparison and analysis of P&L statements generated by a bank’s front-office, also known as hypothetical P&L (“HPL”), with the results produced by middle/back office, also known as risk-theoretical P&L****. The framework applies quantitative limitations on the amount of unexplained P&L and the variability of the unexplained between the two systems. Failure to meet those requirements results in loss of IMA approval and application of the standardized approach.*

*Bank testing requirements are equally stringent. The framework requires a comparison of the VaR measure calibrated to a one-day holding period against each of the Actual P&L (“APL”) and HPL over the prior 12 months. Specific requirements to be applied at the bank-wide level and trading desk level are set out by the BCBS and back testing of the bank-wide risk model must be based on a* ***VaR measure calibrated at a 99th percentile confidence level.*** *Finally, the scope of the portfolio subject to bank-wide back testing must be updated quarterly based on the results of the latest trading desk-level back testing, risk factor eligibility and P&L attribution tests. Again, failure to meet the performance requirements will result in the loss of IMA status.*

*In short, these new requirements make qualifying for use of IMA an extraordinarily difficult and resource intensive exercise. For those trading desks that do succeed in obtaining approval to use this approach, there are three components that are used to calculate the IMA capital charge: Expected Shortfall or ES; modellable risks and non-modellable risks; and a default risk charge. For desks where the bank cannot or chooses not to pursue IMA qualification, they must calculate capital charges using the SA.*

***Expected Shortfall (“ES”) Method***

*The* ***ES and VaR are both used to measure portfolio risk****. However, the ES is a significantly more conservative measure, since it measures the expected value of all changes in the portfolio value in the tail of the P&L distribution that exceed the VaR.* ***To account for this additional conservatism, the BCBS lowered the confidence interval from 99 percent requirement under the VaR approach to 97.5 percent under the ES****.* ***Additionally, the ES must be calculated for a maximum stress period over the bank’s total history of observations verses the current look back******period of one year or 270 days****. Consequently, this approach, while superior to VaR for capturing tail risk, is also far more data and resource intensive.*

***Modellable and Non-Modellable Risk Factors (“NMRF”)***

*The path to determining the capital charge under the IMA is dependent on the ability of a firm to model risk factors. A risk factor’s model-ability is determined by a series of quantitative criteria regarding the frequency, observability, and durability of a risk factor’s pricing information. Importantly, the firm must continually assess the eligibility of these risk factors to be included in the IMA models. If a firm cannot or no longer can support the model-ability of a risk factor, the firm must apply a capital add on which is calibrated under a stress scenario. Instances of NMRF are more likely in more thinly traded and less liquid markets, and the issue of how NMRF are defined continues to be a subject of significant debate (and will be discussed in a future blog).*

***IMA Default Risk Charge (“IMA DRC”)***

*While migration risk is captured in ES, the IMA framework separately capitalizes default risk. The IMA DRC replaces the Incremental Risk Charge and will apply to credit positions as well as equity positions. The IMA DRC will also include a floor for the probability of default.*

***Conclusion***

*The FRTB represents a sweeping overhaul of the way banks calculate their trading risk capital charges and will have wide ranging impacts on the business models of banking organizations and funding markets for many years to come. As U.S. regulators move closer to a proposed rulemaking, we will release a series of blogs on some important outstanding issues that still need to be addressed prior to implementation. These include ongoing concerns around the design of the P&L attribution tests, the NMRF framework, and the interaction between the FRTB and other existing domestic capital requirements.*

***46. How could the Basel III treatment of trading books be improved?***

***Shortcomings of previous regime:***

***1. Shortcomings of the framework exposed by the financial crisis***

*The recent crisis exposed material weaknesses in the capital treatment of banks’ trading activities. Some of the most pressing deficiencies of the trading book regime were addressed by the July 2009 revisions to the market risk framework, while others have been dealt with as part of Basel III. However, the Committee has agreed that a number of the market risk framework’s fundamental shortcomings remain unaddressed and require further attention. The Committee has agreed that the future trading book regime must address the weaknesses set out below, which are discussed in more detail in Annex 1. The crisis and pre-crisis experience highlighted a number of shortcomings in the trading book regime. These can be broadly categorised into weaknesses arising from:*

*(a) The overall design of the regulatory capital framework, especially the inclusion of instruments exposed to credit risk in the trading book;*

*(b) The risk measurement methodologies used under the models-based and standardised approaches; and (c) The valuation framework applied to traded instruments.*

*In combination, these shortcomings resulted in* ***materially undercapitalised*** *trading book exposures prior to the crisis.*

***1.1 Weaknesses in the design of the regulatory capital framework***

*While the undercapitalisation of trading book exposures has often been the result of the methodologies used for risk measurement and valuation (both of which are discussed later in this section), elements of the overall design of the regime also contributed to, and amplified, the problems exposed during the crisis. These include:*

***• The role of the regulatory boundary:*** *The Committee believes that its definition of the regulatory boundary has been a key source of weakness in the design of the current regime. A key determinant of the boundary is banks’* ***intent to trade****, an inherently subjective criterion that has proved difficult to police and insufficiently restrictive from a prudential perspective in some jurisdictions. Coupled with large differences in capital requirements against similar types of risks across either side of the boundary, the capital framework proved susceptible to arbitrage. For example, prior to the crisis, it was advantageous for banks to classify an increasing number of instruments as “held with trading intent” (even if there was no evidence of regular trading of these instruments) in order to benefit from lower trading book capital requirements. During the crisis the opposite movement of positions from the trading book to the banking book was evident at times in some jurisdictions.*

*•* ***The lack of credible options for the withdrawal of model approvals:*** *The design of the current framework does not embed a clear link between the models-based and standardised approaches either in terms of calibration or in terms of the conceptual approach to risk measurement. In part as a consequence of this, a key weakness of the design of the current framework has been the lack of credible options for the withdrawal of model approval. This can be a particular problem in stress periods, where supervisors witness a deterioration in model performance at the same time as raising new capital becomes very difficult.*

***1.2 Weaknesses in risk measurement***

*In addition to the flaws in the overall design of the framework, risk measurement under both the models-based and the standardised approaches proved wanting:*

*•* ***Shortcomings of the models-based approach****: The metric used to capitalise trading book exposures was the* ***10-day value-at-risk (VaR) computed at the 99th percentile****, one-tailed confidence interval. By construction, this is a measure aimed at capturing the risk of short-term fluctuations in market prices. While a 10-day VaR might be useful for day-to-day internal risk management purposes, it is* ***questionable whether it meets the objectives of prudential regulation which seeks to ensure that banks have sufficient capital to survive low probability, or “tail”,*** *events****. Weaknesses identified with the 10-day VaR metric include:***

***1. its inability to adequately capture credit risk;***

***2. its inability to capture market liquidity risk;***

***3. the provision of incentives for banks to take on tail risk;***

***4. and, in some circumstances, the inadequate capture of basis risk.***

*Perhaps more fundamentally, the models-based capital framework for market risk relied on a bank-specific perspective of risk, which might not be adequate from the perspective of the banking system as a whole.* ***The pro-cyclicality of VaR-based capital charges based on recent historic data and the large number and size of backtesting exceptions observed during the crisis serve to highlight regulatory concerns with continued reliance on VaR.***

*•* ***Shortcomings of the standardised approach****: Although the crisis largely brought to the fore problems with the models-based approach to market risk, the Committee has also identified important shortcomings with the standardised approach. These include a lack of risk sensitivity, a very limited recognition of hedging and diversification benefits and an inability to sufficiently capture risks associated with more complex instruments.*

***Weaknesses in valuation practices***

*The recent crisis highlighted the importance of robust valuation practices, especially of* ***complex or illiquid financial instruments****, in times of stress. Different valuation methodologies can have a very material impact on estimated capital resources. Therefore, in assessing capital adequacy, supervisors need to be confident that valuation methodologies are in line with prudential objectives. It is at least as important to have prudent, reliable and comparable estimates of capital resources as to have prudent, reliable and comparable estimates of capital requirements. The crisis highlighted key weaknesses in the valuation framework, including the lack of application of prudent valuation adjustments and the emergence of valuation uncertainty as a key source of solvency concerns.*

*The 2009 revisions to the market risk framework (“Basel 2.5”) The key elements of these revised market risk standards were:*

*•* ***The introduction of the IRC****: In recognition of the fact that the 10-day VaR metric does not sufficiently capture banks’ exposures to credit risk, the 2009 amendments introduced an additional capital charge intended to capture both default risk and credit rating migration risk. The IRC is estimated based on a one-year capital horizon at a 99.9 percent confidence level, consistent with the treatment of credit exposures in the banking book. However, it also takes into account the liquidity of individual instruments or sets of instruments. Unlike the banking book treatment of credit risk, it allows banks to estimate their own asset value correlation parameters.*

*•* ***The introduction of stressed VaR****: In addition to the 10-day VaR requirements, the 2009 amendments require banks to calculate a “stressed VaR” measure.* ***The stressed VaR is intended to replicate a VaR calculation that would be generated on the bank’s current portfolio if the relevant market factors were experiencing a period of stress****. It should be based on the* ***10-day, 99th percentile, one-tailed confidence interval VaR measure, with model inputs calibrated to historical data from a continuous 12-month period of significant financial stress****. The introduction of stressed VaR is intended, in part, to dampen the cyclicality of the VaR measure and to mitigate the problem of market stresses falling out of the data period used to calibrate the VaR after some time.*

*•* ***Alignment of the treatment of securitisation exposures across the banking book and the trading book****: As of July 2009, the Committee as a whole had not agreed that modelling methodologies used by banks adequately captured the risks of securitised products. As a result, it agreed to apply the standardised capital charges based on the banking book risk weights to these exposures. However, the Committee agreed on a limited exception for certain correlation trading activities, where banks are allowed by their supervisor to calculate capital charges based on the CRM. This new model is subject to a strict set of minimum requirements, including the regular application of specific, predetermined stress scenarios and a floor expressed as a percentage of the charge applicable under the standardised approach.*

*•* ***Improved risk factor coverage of internal models****: Banks are now explicitly required to incorporate all risk factors in their VaR models that are deemed relevant for pricing purposes, or to justify their omission. Basis risks are also expected to be captured by banks to the satisfaction of the supervisor, as well as event risk (not covered in IRC), which must be included in the VaR measurement. Banks can no longer rely on a surcharge model to capture these risks.*

*•* ***Enhanced prudent valuation guidance****: The Committee extended the scope of the prudent valuation guidance to all instruments subject to fair value accounting, including those in the banking book. The Committee also clarified that regulators retain the ability to require adjustments to the current value beyond those required by financial reporting standards, in particular where there is uncertainty around the current realisable value of an instrument due to illiquidity. This guidance focuses on the current valuation of the instrument and is a separate concern from the risk that market conditions and variables might change before the instrument is liquidated (or closed out).*

*In December 2010, the Committee issued the Basel III rules text, covering details of reforms to bank regulatory standards agreed by the Governors and Heads of Supervision and endorsed by the G20 Leaders earlier that year. Three changes of the Basel III package relate to the capital treatment of trading activities and market risk:*

*•* ***Capital charges against credit valuation adjustment (CVA) volatility risk****: The Committee made a number of amendments to strengthen the counterparty credit risk framework. Among the most important elements of the reform package was a requirement that banks be subject to a capital charge against potential mark-to-market losses associated with deterioration in the creditworthiness of a counterparty (CVA risk). Most of the affected instruments, such as OTC derivatives and securities financing transactions (SFTs), are held in the trading book.*

*•* ***Treatment of unrealised gains and losses****: Under the changes to the definition of capital, unrealised gains and losses will no longer be filtered out of Common Equity Tier 1 capital. This means that changes to the valuation of all financial instruments held at fair value for accounting purposes will flow directly through to regulatory capital resources.*

*•* ***Eligible capital for trading book risks****: As part of the general improvements in the quality of eligible regulatory capital, Tier 3 capital, previously available to meet market risks, will no longer form part of the regulatory capital structure.*

***Drawbacks of the current market risk regime***

*The July 2009 amendments to the market risk framework were judged by the Committee to be an essential immediate response to the severe undercapitalisation of banks’ trading books. But from the onset, the Committee also recognised the need for initiating a longer term, fundamental review of the risk-based capital framework for trading activities. In part this is because the current treatment of market risk exposures, while a material improvement relative to the previous regime, does not address all of the shortcomings highlighted in Annex 1 and suffers from a number of drawbacks:*

*•* ***The framework lacks coherence****: The current framework does not have a single, overarching view of how trading risks should be categorised and capitalised, leading to the concern that some capital charges appear overlapping, for example, the additive approach taken for VaR and stressed VaR. Moreover, the diverse array of capital charges within the amended framework requires the development and validation of several distinct sets of models. These not only require a substantial amount of bank resources to maintain but have also put a severe strain on supervisory oversight.*

*•* ***The boundary issue has not been fully addressed****: The July 2009 revisions to the market risk framework made only minor amendments regarding the set of products that should be excluded from the trading book. However, securitisation exposures other than those eligible for the correlation trading portfolio are treated broadly consistently across the regulatory boundary in the 2009 revisions. In spite of those amendments, similar risks continue to be treated differently across the balance sheet. For example, interest rate risk is only capitalised under the Pillar 1 regime if the bank runs this risk in its trading book. Differences in capital requirements across the regulatory boundary can foster incentives for banks to shift instruments to the regulatory regime that treats them more favourably. Where the boundary is not well monitored, banks could act upon those incentives.*

*•* ***Market liquidity risk is not evenly captured****: Although the July 2009 revisions introduce elements that better capture market liquidity risk, they are not comprehensive or complete. The IRC and CRM metrics introduce the concept of varying liquidity horizons to account for the fact that banks might be unable to exit risk positions in short time periods due to market illiquidity. But* ***the IRC and CRM*** *cover mainly credit-related exposures and focus on default and credit rating migration risk. Similarly, stressed VaR implicitly captures variations in* ***liquidity premia*** *in times of stress. However, stressed VaR is still based on a 10-day holding period which is, almost by definition, insufficient to capture the risks associated with market illiquidity. Moreover, stressed VaR implicitly assumes that the markets most likely to turn illiquid in the future are those that turned illiquid in a previously observed period of stress.*

*•* ***The bank-specific notion of risk is upheld****: Many of the new approaches are still based on a bank-specific view of risk. For example, stressed VaR still relies on an implicit assumption that all banks can exit or hedge their risks within a 10-day horizon, which was not the case in the recent crisis as many banks tried to exit risk positions simultaneously.*

*•* ***Standardised approach problems remain unaddressed****: The July 2009 revisions to the market risk framework did not fundamentally change the standardised approach for market risk. The revisions did adjust some risk weights for equity specific risk and required banking book risk weights for the capitalisation of specific interest rate risk in securitisations. But the structural shortcomings of the standardised approach remain unaddressed.*

*• There remains a lack of credible options for withdrawal of model approval: Aside from multipliers on VaR and stressed VaR, there are limited options for supervisors to deal with poorly-specified internal models. The approaches adopted to backstop the CRM (standardised floor and supplemental capital add-ons from prescribed stress tests) suggest possible alternatives for limiting the reliance on models. The evaluation of backtesting results also suggests a need for regulators to determine specific areas of imprecision, versus focusing on the top-of-the-house risk measure.*

*•* ***The relationship between the capital charges for CVA risk and the trading book regime has not been clarified****: The introduction of the new capital charge for CVA risk under Basel III uses elements of the market risk framework. In fact, in the advanced approach, CVA risk is measured through the internal market risk models. This makes it advisable to consider the treatment of CVA risks in the revised market risk framework.*

***Options for a new boundary to address current observed weaknesses***

*No new boundary will fix all known issues with the current boundary without presenting some further difficulties. Therefore, in considering alternative options, their advantages and disadvantages need to be assessed. The Committee recognises that any disadvantages and unresolved issues identified from the ultimate choice of boundary will need to be addressed by other changes to the capital regime. This clearly includes the proposed revisions to trading book capital requirements stemming from the fundamental review. The Committee has considered a range of options for the basis of a revised trading book boundary, in addition to the removal of the boundary:*

*(a) Trading intent of bank management (a “trading evidence-based boundary”);*

*(b) Functions provided by the bank, eg market making or underwriting;*

*(c) Real or perceived liquidity of instruments;*

*(d) Risk characteristics of instruments; and*

*(e) The valuation methodology applied to an instrument (a “valuation-based approach”).*

*Boundary options based on the characteristics of instruments, or the functions provided by the bank, have conceptual merits. Nevertheless, they were considered to be too subjective to deliver a boundary that could be subject to demonstrably consistent implementation within, and across, all jurisdictions. Of the remaining three boundary options considered, the Committee felt that the benefits of considering the liquidity of instruments could be better incorporated into revised capital requirements for the trading book (rather than in the definition of the trading book itself). The Committee therefore believes that there are two approaches that are most likely to meet the described objectives whilst addressing the issues of the current boundary. These approaches are described in more detail below, and a detailed comparison is included in Annex 3. A.*

***A trading evidence-based boundary***

*The trading evidence-based boundary is an enhanced version of the current intent-based boundary. As such, it retains the link between the regulatory trading book and the set of instruments which a bank deems to be held for the purposes of trading (or to hedge trading book risk positions), adding more objective evidential requirements to support this principle. Fundamental to this version of the boundary is a view that a bank’s intention in holding an instrument determines the risk management strategy applied to it, and therefore is the relevant characteristic for regulators in determining its capital requirements. The proposed enhancements to the core principle of “trading intent”, the most prominent of which are set out below, are intended to provide more objective criteria for entry to the trading book and therefore make the boundary more enforceable and consistent across jurisdictions:*

*• As an entry requirement, instruments must be held for trading purposes (or to hedge trading book risk positions) and marked to market daily, with valuation changes recognised through the P&L account, using market data that are sufficiently robust to support this frequency of valuation.*

*• Banks would be required to have formal policies and documented practices for determining what instruments should be included in the trading book. This would include a description of what constitutes trading or hedging activity, and therefore what instruments should customarily be held in the trading book.*

*• Banks would be subject to a requirement that internal control functions conduct ongoing evaluation of instruments both in and out of the trading book, to assess whether the bank’s instruments are being properly assigned as trading or nontrading instruments in the context of the bank’s trading activities. Banks would be required to provide objective evidence that trading instruments are actively managed. This would include setting, and enforcing, limits both on an instrument and on a risk position basis. Also, in addition to clearly documented hedging strategies, banks would be required to monitor market liquidity levels (including availability of market data) and also to specify an expected maximum holding period for instruments, with potential penalties (such as required valuation adjustments/increased supervisory scrutiny) if that period is exceeded.*

*• There would be stricter requirements on the feasibility of trading an instrument, which would supplement a requirement to have trading/hedging intent. These would include proof of access to relevant markets for trading and hedging (such as historical data on trading in those markets, or a plausible plan for how a bank would trade on a market in which it had limited experience). Banks would also need to meet minimum standards related to the periodic monitoring and assessment of the risk of trading instruments.*

*• If the above supervisory criteria are not met, banks would be required to designate their instruments to the banking book. At the same time, there would be a strict limit on the ability of banks to move instruments between the trading book and the banking book after initial designation at their own choice, with movement only allowed in extraordinary circumstances which would be defined in the framework. Possible examples could be a major publicly announced event, such as a bank restructuring. Many of these controls – such as the requirement for trading policies and procedures – are not new, but would be strengthened with the more detailed objective metrics to be specified. A feature of this approach is that two banks could hold the same instrument but allocate it to different books, depending upon their intention with respect to the instrument, as long as the criteria specified above are met. Thus, banks could continue to have material exposures to fair valued instruments located in the regulatory banking book that are subject only to credit risk, and not to market risk, Pillar 1 capital requirements. As such, further consideration would need to be given to whether banking book capital requirements should be adjusted to address the risk posed by such instruments.*

*Possible advantages and disadvantages of the trading evidence-based approach*

***Advantages***

*• An instrument held with trading/hedging intent, provided it is feasible that it can be freely traded or completely hedged in the short-term, appears to naturally fit into the market risk framework. The proposed changes would seek to introduce more objective conditions to improve its enforceability.*

*• This approach requires fewer changes to the current boundary relative to valuation-based approaches (described below), and therefore would result in less disruption to banks and supervisors upon introduction.*

*• The instruments within the trading book would more closely resemble the instruments held within the parts of banks that are internally described and risk managed as “trading”, as well as to trading risk metrics, which should make the framework simpler for banks to implement, and easier for supervisors with trading expertise to oversee.*

***Disadvantages***

*• The trading book boundary would still be under the control of banks, allowing them (restricted to some extent by the new conditions on the boundary) some flexibility to choose the designation of their instruments provided they are willing to fair value them daily through P&L and accept treatment in the trading book as long as the bank holds the position.*

*• There would remain a set of fair valued instruments in the banking book, which would not receive Pillar 1 market risk capital requirements.*

*• The consistency of the approach would rely on each jurisdiction performing sufficiently reasonable judgments on the feasibility of trading in different markets – leading to potential disparities in application across jurisdictions.*

***A valuation-based boundary***

*The core principle of the valuation-based boundary would move away from the concept of “trading intent” to instead construct a boundary that focuses on aligning the design and structure of regulatory capital charges with the risks posed by an instrument to the regulatory capital position of a bank. This approach would recognise the link between capital resources and capital requirements and attempt to more fully address the fact that market price changes in all instruments held at fair value immediately impact the solvency of banks. To achieve this objective, one option would be to require any fair valued balance sheet asset or liability to be subject to market risk capital charges. Strictly defined, however, this could result in a potentially large number of non-traded assets and liabilities requiring market risk capital (for example, including assets such as patents, property). A more feasible approach, which the Committee believes would avoid this complication, would be to only apply the boundary to fair-valued financial instruments. Moreover, a strict link between accounting fair value and market risk capital requirements would also potentially misalign market risk capital requirements with the instruments whose fair value movements impact capital resources under Basel III. To address this, the Committee proposes that the boundary be reduced in scope to ensure that it only covers those financial instruments where a movement in their value could lead to a reduction in capital resources under the Basel III definition of capital requirements – this aligns capital requirements with risks to capital resources. Under this approach, in current accounting terms, the new trading book would include held for trading financial instruments, available for sale financial instruments and other financial instruments to which fair value is applied either as an option or a requirement. The Committee would need to consider whether the framework’s current definition of financial instruments20 is sufficiently clear to ensure consistent enforcement. A new “trading book” under this approach would likely be significantly larger than the current trading book for many banks, increase the number of banks subject to market risk capital requirements and may differ across banks and jurisdictions due to differences in accounting standards. However, as previously discussed, this boundary would not necessarily lead to a wider scope of modelled risk positions. Potential adjustment to the valuation-based boundary: Whilst conceptually sound, the above valuation-based approach could, in some circumstances, disincentivise prudent hedging of interest rate risk in the banking book because hedges held at fair value would be split from the hedged risk position. The Committee is considering a potential adjustment to the valuation-based boundary such that banks could be permitted to include some fair valued financial instruments in the banking book if they can provide clear evidence that those financial instruments are specifically used to hedge other banking book risk positions as part of interest rate risk management arrangements. Under this option, the trading book boundary would be again partly under the control of banks, allowing them some flexibility to choose the designation of their instruments Possible advantages and disadvantages of the valuation-based approach*

***Advantages***

*• All financial instruments held at fair value and so subject to market risk (because changes in fair value could lead to a reduction in capital resources under the Basel III definition of capital) would be required to have market risk capital against that risk.*

*• The trading book boundary would more closely align with the accounting divide between instruments that are recorded at fair value, and instruments that are recorded at amortised cost. Supervisors could expend less resource monitoring the regulatory boundary, with auditors, as part of their current duties, verifying accounting classification. Some of the goals of auditors and supervisors could be better aligned.*

*• The default choice of whether to hold a financial instrument in the trading book or not would be largely dependent on the accounting rules and filters in the Basel III framework.24 Although the accounting rules may still leave flexibility when designating financial instruments at fair value, arbitrage opportunities are likely to be reduced.*

***Disadvantages***

*• The link to accounting fair value would make the trading book boundary largely dependent on decisions and changes made by accounting standard setters, and auditors’ interpretation of those standards, neither of which are under the control of the Committee.*

*• Jurisdictional differences in accounting, for example with regard to tainting of held to maturity securities, could result in large disparities in the scope of the trading book across banks in different countries and potentially significant increases in their regulatory trading book portfolios.*

*• The set of fair value financial instruments may encompass instruments that a bank does not trade. Thus, the boundary would not align with banks’ internal risk management practices for trading activities.*

***Changes common to both boundary options***

*Regardless of the final choice of the core principle underpinning a future boundary, there are a number of issues/improvements common to both options:*

*• To encourage market discipline, a set of disclosure requirements regarding the composition of the trading book would also be developed. For example, banks could be required to publish detailed information about the nature of instruments included in the trading book.*

*• The ability to change the designation of an instrument between trading book and banking book at the bank’s own choice would be significantly restricted either through the explicit limitation imposed by the trading evidence-based boundary or through the link to the fair value accounting requirements in the valuation-based approach.*

*Stronger, more specific, prudent valuation requirements would be developed and applied to all fair valued financial instruments, regardless of trading book or banking book designation.*

***47. How will trading businesses change as a result of Basel III capital rules for banks’ trading books?***

*The revised approach to the regulation of banks’ trading books –focusing on capturing deep losses during systemic crises and a tougher approach to internal-risk modeling – will limit lucrative arbitrage and trading opportunities.*

*The Basel Committee on Banking Supervision (BCBS) wants to make banks treat the assets in their trading books more like those in their banking books by forcing them to hold increased capital against assets designated for trading.*

*Historically, lower capital requirements for trading book assets had encouraged banks to shift assets from the more expensive banking book into the trading book. However, this left many banks with insufficient capital to cover losses when credit markets collapsed during the crisis.*

*However, the latest BCBS proposals for how banks should calculate risk-based capital requirements at the trading book level, published on October 31, indicate banks are winning the argument that they should continue to be allowed freedom*

*to use their own models to determine how much capital to hold against risky trading activities.*

*The revised rules represent a substantial U-turn for the BCBS, which had originally proposed in 2012to force banks to aggregate their trading desk’ risk weighted assets (RWA), according to prescribed correlations.*

*Fixed correlations were needed, the BCBS suggested, because different banks used different models for calculating risks, which led to an unhelpful fragmentation of oversight approaches among national regulators. All this variation meant that risks were probably being understated and capital reserves were too low.*

*By and large, the industry seems satisfied with the compromise, which allows banks to rely on their own internal credit risk and correlation models, but also requires them to backstop these with a standardized approach based on credit rating agency ratings.*

*The revised rules include new suggestions for making banks’ internal models more robust, as well as changes to the standardized approach that will increase its risk-sensitivity, while making it easier for smaller banks to implement.*

*“It’s tough to be entirely critical of the revised proposals, as it’s clear that some additional level of capital reserve is helpful in a market downturn,” says one market source. “The question is how much is too much.”*

*The BCBS is undertaking a quantitative impact study to determine how the current proposals will perform under various stressed market scenarios, and intends to report the results at the end of the consultation period in January 2014.*

*However, some observers argue that even in their watered down form, the new proposals show that regulators are moving beyond the objective of matching rules to market reality, and are seeking to restructure banks’ incentives for engaging in certain trading activities.*

*Part of the problem, they argue, is regulators are basing the new framework on the idea that a future crisis could be far worse than the one that occurred in 2008.*

*“A major complaint with the current focus on trading book RWA is that if you look at the experience during the crisis, liquidity didn’t dry up in the way that is being assumed here,” says Simon Gleeson, a partner with law firm Clifford Chance in London.*

*“However, these proposals aren’t an attempt to correlate with reality, but rather they seek to build a driver into the system – a disincentive to hold trading assets.”*

*Indeed, the revised trading book RWA proposal is the latest of a raft of reforms, including the liquidity coverage ratio and the credit valuation adjustment charge that seek to decouple banks’ capital reserves from the health of the asset markets they participate in.*

*“There’s a decent policy reason why regulators should not want banks to hold traded assets that are accounted for on a mark-to-market basis,” says Gleeson. “A market crash translates the mark-to-market moves real time into a reduction in bank capital. If a bank is holding a portfolio of non-mark-to-market assets, such as the loans in its banking book, its capital stock is not exposed.”*

*Given the mutually reinforcing direction of regulatory capital reforms and OTC derivatives regulation, several banks have already realigned their business models according to the new incentives, with a sharp reduction in fixed-income inventory and position-taking among leading market makers.*

*Jon Skinner, an independent management consultant based in New York who advises banks on their strategic response to regulatory reforms, says that Basel 2.5 already had a significant impact on market RWA levels and the trading book rules appear to be a refinement of this rather than a major further uptick in RWA.*

*It will be interesting to see how flow-trading dealers will evolve their market risk management and flow trading in response to the combination of market risk RWA rules (Basel 2.5, trading book review) and the Dodd-Frank SEF mandate in the US.*

*“Whilst prop trading is subject to well-publicized regulatory pressures, there is also market risk and hence RWA inherent in pure flow trading. Although the trading book review alone may not place a further burden sufficient to change the trading model, given the SEF trading mandate in the US, dealers may look to optimize market risk RWA in the new environment by adjusting their flow trading business," he says.*

*Under the new regime, this kind of trading operation is now a dying breed.*

***48. What are the key requirements of the Basel stress testing framework? Are they sufficiently stringent?***

*1. Stress testing should form an integral part of the overall governance and risk management culture of the bank. Stress testing should be actionable, with the results from stress testing analyses impacting decision making at the appropriate management level, including strategic business decisions of the board and senior management. Board and senior management involvement in the stress testing programme is essential for its effective operation.*

*2. A bank should operate a stress testing programme that promotes risk identification and control; provides a complementary risk perspective to other risk management tools; improves capital and liquidity management; and enhances internal and external communication.*

*3. Stress testing programmes should take account of views from across the organisation and should cover a range of perspectives and techniques.*

*4. A bank should have written policies and procedures governing the stress testing programme. The operation of the programme should be appropriately documented.*

*5. A bank should have a suitably robust infrastructure in place, which is sufficiently flexible to accommodate different and possibly changing stress tests at an appropriate level of granularity.*

*6. A bank should regularly maintain and update its stress testing framework. The effectiveness of the stress testing programme, as well as the robustness of major individual components, should be assessed regularly and independently.*

*7. Stress tests should cover a range of risks and business areas, including at the firm-wide level. A bank should be able to integrate effectively, in a meaningful fashion, across the range of its stress testing activities to deliver a complete picture of firm-wide risk.*

*8. Stress testing programmes should cover a range of scenarios, including forward-looking scenarios, and aim to take into account system-wide interactions and feedback effects.*

*9. Stress tests should feature a range of severities, including events capable of generating the most damage whether through size of loss or through loss of reputation. A stress testing programme should also determine what scenarios could challenge the viability of the bank (reverse stress tests) and thereby uncover hidden risks and interactions among risks.*

*10. As part of an overall stress testing programme, a bank should aim to take account of simultaneous pressures in funding and asset markets, and the impact of a reduction in market liquidity on exposure valuation.*

*11. The effectiveness of risk mitigation techniques should be systematically challenged.*

*12. The stress testing programme should explicitly cover complex and bespoke products such as securitised exposures. Stress tests for securitised assets should consider the underlying assets, their exposure to systematic market factors, relevant contractual arrangements and embedded triggers, and Principles for sound stress testing practices and supervision 15 impact of leverage, particularly as it relates to the subordination level in the issue structure*

*13. The stress testing programme should cover pipeline and warehousing risks. A bank should include such exposures in its stress tests regardless of their probability of being securitized*

*14. A bank should enhance its stress testing methodologies to capture the effect of reputational risk. The bank should integrate risks arising from off-balance sheet vehicles and other related entities in its stress testing programme.*

*15. A bank should enhance its stress testing approaches for highly leveraged counterparties in considering its vulnerability to specific asset categories or market movements and in assessing potential wrong-way risk related to risk mitigating techniques.*

***49. Which extreme events should stress tests be taking into consideration now?***

*The three key areas stress tests focus on the most are* ***credit risk, market risk, and liquidity risk***

*That guidance identified eight risk categories including credit risk, country and transfer risk, market risk, interest rate risk, liquidity risk, operational risk, legal risk and reputational risk.*

***Ordinary Times***

*Credit risk Defaults may be predicted based on historical data—no strong correlation of defaults*

*Market risk Loss of value linked to performance of asset*

*Operation risk*

*More likely to be institution specific*

***Extreme Events***

*Credit risk Inadequate data for robust quantification or risk— strong correlation of default*

*Market risk Loss of value linked to type of asset (contagion)*

*Operation risk*

*More likely to be environmental*

*Extreme events can be usefully divided into two categories. The fi rst includes identifi able outcomes (often predicted by history) that occur too infrequently to be effectively managed. Think of the fi nancial equivalents of a 1,000-year fl ood, an 8.5 point earthquake centered on Los Angeles or a meteor strike. Hyperinfl ation and systemic bank failures have occurred—we simply feel these events are extremely unlikely to occur at any given moment in time, and their impacts are likely to be so overwhelming that risk mitigation does not appear to be worth the effort.5 At the outer limits, hopelessness sets in. The second category of extreme events is more frightening. These are the inevitably unaddressed risks associated with unidentifi ed events—events for which there is no historical experience. Taleb teaches (among other things) that novel events do occur. Our imagination, and hence our ability to anticipate outcomes, is limited by our experiences. Our habits, however, instruct us to assume continuity*

***Warehousing/Pipeline Risk***

*The current fi nancial crisis brought home a category of underappreciated risk. Banks engaged in active originate-and-distribute activity anticipated very short holding periods for bank-originated assets. These assets were either sold in secondary markets or packaged into securitization vehicles. Warehousing and pipeline risk refers to the event where originating banks are unable to off-load assets due to unexpected changes in market conditions. Involuntary holding of these assets expose the bank to losses due to declining values of these assets.*

***Reputation Risk***

*Reputation risk refers both to the prospect of a decline in value of a bank’s goodwill, as well as the possibility that a bank will feel constrained to undertake certain transactions in order to maintain goodwill. This particular risk manifested during the current crisis. Banks involved in securitization activities frequently transferred assets to formally independent (and bankruptcy remote) corporate entities (often called Special Purpose Entities). Once these assets were transferred, they no longer appear on the bank’s balance sheet. Nor were they treated as off-balance sheet items, unless the bank was contractually obligated to intervene in event of default or other stress. Many banks re-acquired distressed assets from Special Purpose Entities, notwithstanding the absence of a contractual obligation to do so. Recognition of this moral obligation is explained by concerns by banks for their reputations. Banks realized avoidable fi nancial losses in order to avoid investor wrath. Given this history, it is likely that implicit puts will be recognized when securitization markets eventually re-emerge. Extreme Operational Risks Operational risk describes the residual category of identifi able risks beyond credit and markets risks. These include both internal and environmental risks. Internal risks include poor management, losses caused by rogue traders, and fraud. It also includes certain counterparty risks that are not captured under the credit or market risk categories. External risks include those presented by weaknesses in the interlocked fi nancial system, as well as the usual horrors (wars, plagues, insurrections). An operational risk event may be of an unanticipated magnitude— and not adequately provided for. And it may be perversely correlated with other stresses. Consider the Madoff Ponzi scheme. A Ponzi scheme is subject to collapse even under the most benign conditions, but is much more vulnerable during periods of market pessimism and declining asset values. The recognition of losses from such an event (corresponding to discovery and collapse of the scheme) may well compound simultaneous credit and market losses*

*During extreme events salient operational risks are more likely to be external—that is, they cannot be so easily traced to management failures. And so they are more likely be experienced by many institutions—leading in turn to magnifi cation and systemic risk. Not all risks can be anticipated. Indeed, it is diffi cult to manage risks that cannot be imagined (those that are outside of experience) although experience teaches that unanticipated and unimagined events do occur. The liquidity crisis had been imagined by some, who—like Cassandra—were ignored. That said, one might credibly say that the “market” failed to imagine or anticipate such an outcome.*

***Extreme Systemic Risk***

*Basel II directly controls the activities of individual institutions. That said, like all prudential regulation, Basel II is in some sense more concerned by the spillover effects of an institution’s crisis onto the larger banking system.10 In the current fi nancial crisis, bank capital was not only inadequate as measured on an individual institutional basis; it was inadequate on a system-wide basis. There were no suffi ciently well capitalized banks that were able to absorb the capital defi cits (and negative equity) of the failed institutions. Government response in the United States, United Kingdom and elsewhere demonstrated the existence of severe de facto capital defi cits. While institutions remain with well-worn, recognizable names, the effective truth is that the pre-crisis banking sector has been utterly destroyed and what exists today results from an ad hoc public recapitalization. Schwarcz has argued that a better approach to the problem of systemic risk should be located outside particular banking institutions in a “liquidity provider of last resort.” In some sense, Schwarcz anticipated the immediate crisis’ responses, which might be described as a bundle of state-provided liquidity and capital infusions to the broad banking sector.*

***50. Why is Basel II blamed for precipitating the 2008 financial crisis?***

*Among the things that caused the financial crisis was that the Basel II committee and banks underestimated both the risk of losses on their assets and their exposure to the failure of others*

*One weakness of Basel II emerged during the subprime mortgage meltdown and Great Recession of 2008 when it became clear that Basel II underestimated the risks involved in current banking practices and that the financial system was overleveraged and undercapitalized.*

*Basel II’s failure, I argue, lies in regulatory capture, ‘de facto control of the state and its regulatory agencies by the ‘regulated’ interests, enabling these interests to transfer wealth to themselves at the expense of society’.3 Large international banks were able to systematically manipulate outcomes in Basel II’s regulatory process to their advantage, at the expense of their smaller and emerging market competitors and, above all, systemic financial stability. To understand why this happened, I present an analytical framework which sets out the broad conditions under which capture is expected to occur. My framework draws on what I call the ‘neo-proceduralist’ school of global regulation, developed in recent work by Walter Mattli and Ngaire Woods, which emphasizes two types of conditions. The first are so-called ‘supply-side’ conditions concerning the institutional context in which Basel II was drafted, and the second are ‘demand-side’ conditions concerning the extent of societal pressure for new regulation. I argue, however, that the neo-proceduralism can be strengthened as a theory of global regulatory processes by proper temporal contextualization. It is only by conceiving of capture as a process that unfolds over time that we can appreciate exactly how supply- and demand-side factors combined to give large international banks disproportionate influence over the Basel process. As it will later become clear, this theoretical innovation has implications that go beyond Basel II. It allows us to understand not only why the Basel Committee failed to achieve its objectives for the accord, but also why some of the more latest proposals in international banking regulation – despite the tremendous political will behind them – have enjoyed no more success. The failure of these proposals, my analysis warns, is very much a case of history repeating itself.*