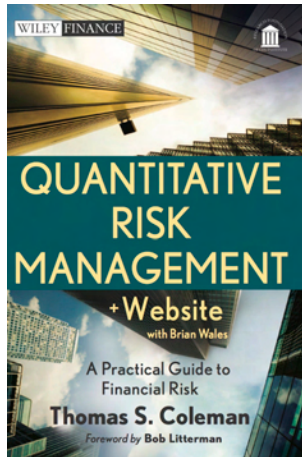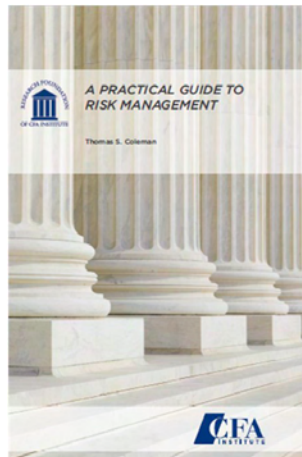GREENWICH LIBRARY / CFA SOCIETY STAMFORD
Greenwich, CT
Thursday September 6th 2012
How to Think About Risk Management

First, let me thank the Greenwich Library for hosting this event and the CFA Society Stamford for helping to organize and inviting CFA members.

Quantitative Risk Management
complete 550-page book
http://www.wiley.com/buy/1118026586

A Practical Guide to Risk Management
First 5 chapters
http://www.cfapubs.org/toc/rf/2011/2011/3

Coleman - Risk Management   2

Research Foundation
of CFA Institute

I also want to thank the Research Foundation of the CFA Institute. The Research Foundation is a not-for-profit organization established to develop and disseminate research for investment practitioners, and they commission research monographs. They asked me to produce a short, roughly 100-page, guide to risk management. When I got to 350 pages I knew there was a problem. The Research Foundation and Wiley worked together, with the Research Foundation publishing the first five chapters as a research monograph and Wiley publishing the complete book.

Overview

- How to Think about Risk Management
  - Risk management as management
  - Thinking about risk and uncertainty
  - An overview of quantitative techniques – volatility and VaR, Marginal Contribution and Best Hedges
- Further Reading
  - ***A Practical Guide to Risk Management*** (first 5 chapters) - www.cfapubs.org/toc/rf/2011/2011/3
  - ***Quantitative Risk Management***, Wiley (complete book) - http://www.wiley.com/buy/1118026586
  - Slides - www.closemountain.com/papers/CFA_CT_120906.pdf

Coleman - Risk Management   3   **Research Foundation of CFA Institute**

o First let me give an overview of what I will talk about – some of the topics and themes from my Wiley book (published in April) *Quantitative Risk Management*.

o The first and most important point is that "Risk Management" is, first-and-foremost, management.

- Although "Risk management" is usually talked about as a specialized, separate discipline, if we want to understand events in today's world, from rogue traders to subprime losses to complex financial organizations, we have to change the focus of risk management from numbers and quantitative specialization to old-fashioned management – managing people, processes, and institutions. Managing risk is at the core of managing a financial business because risk is at the core of any financial business.

o But even though we need to focus on risk management as old-fashioned management, we do need to understand and use the modern quantitative tools that have been developed over the past years. Financial markets are complex and require using and understanding the quantitative tools we have.

o So I will actually focus most of my time today on an introduction to quantitative tools.

- But we have to remember that these quantitative tools are only useful when allied to common sense and experience, when used to actually **manage** the risk.

o Turning to quantitative risk measurement, I will cover two topics:

o First: How to think about risk and uncertainty

o Second, an overview of the most widely-used quantitative tools, tools that every manager should be comfortable with. These are:

- Volatility and VaR on the one hand,
- Portfolio tools (marginal contribution and best hedges) on the other

o Managers need a clear understanding of how to think about risk, how to measure risk, and how to alter risk. Without that understanding, and without these tools, it is very difficult to manage in today's financial markets. So I will spend some time today going over how to think about and how to measure risk.

Further Reading

o *A Practical Guide to Risk Management*, published in July 2011 by the Research Foundation of the CFA Institute, this monograph covers how to *think* about risk.

o *Quantitative Risk Management*, published April 2012 by Wiley in their finance series, extends the Research Foundation monograph by detailing the mathematical tools and techniques necessary to actually measure risk. Because it is the two parts – measuring risk and then using those numbers to actually manage risk – that makes a successful financial organization. One thing I am particularly pleased with in this volume is the re-written chapter 5 that explains the *ideas* behind the quantitative measures – just what I am trying to do today.

4 – WHO AM I

Who am I?

- Educational Background
  - Physics undergraduate at Harvard, PhD economics University of Chicago
  - Taught economics and finance for four years
- Practical Experience
  - Over 20 years ago moved from academics to finance
  - Trading and quantitative model-building on a derivatives desk
  - More recently founded and managed a macro-global hedge fund
  - Short stint as risk manager at a large hedge fund
  - Recently moved back to University of Chicago – helping to run the Becker Friedman Institute for Research in Economics
- Trading and Management
  - I want to emphasize – I come from a trading and management background – not from "risk management"

My View of Risk Management

- Challenging some conventional wisdoms
  - Good Risk Management is old-fashioned management, not fancy mathematics
  - Mathematics and numbers *are* important, but only part of the answer
- Managing People, Processes, Institutions
  - People most important – all problems, all successes, come from people
  - Incentives, compensation, principal-agent problems
- "Risk Management" Should Not be a Separate Department and Cannot be Delegated

Coleman - Risk Management   4   Research Foundation of CFA Institute

o   My views challenge some of the conventional wisdoms of the "Risk Management" industry

o   Most importantly, risk management is old-fashioned management, not mathematics.

o   Mathematics and quantitative tools are important, but they alone do not make good risk management.

- Please understand that I am not arguing against quantitative tools. I am myself a quant, trained originally as a physicist then as a mathematical economist. Rather I am arguing for using those tools in the service of managing a financial business.

o   Risk management is as much the art of managing people, processes, and institutions as it is the science of measuring and quantifying risk.

o   People are the most important. All the problems, and all the successes, come down to people.

o   Compensation, incentives, and principal-agent problems are critical

- What are principal-agent problems? A classic is where managers of a firm do not have the same goals as the owners. For example owners want managers to work hard but working hard is, well, hard work – managers may want to take it easy.

- Owners need to think about how to motivate managers. What sort of incentive, compensation, and monitoring schemes will push managers to do the right thing and dissuade them from doing the wrong thing?

- Similarly managers need to think about motivation and incentives for subordinates; investors need to think about motivation and incentives for portfolio managers.

- The bottom line is that it is all well-and-good to know the right risk decision, but we also need to think about how to motivate people throughout the organization to execute that decision.

- Motivating people involves compensation and incentive schemes, systems for monitoring compliance, etc.; both the carrot and the stick.

- Thinking carefully about where people's incentives lie, trying to design incentive schemes that align incentives, is hard but has large rewards. It is also something not usually considered within the purview of "Risk Management" but it should be.
- o Following on from this view that "Risk Management" is management, is the conclusion that "Risk Management" cannot be a separate department and cannot be delegated. It remains the responsibility of anyone who contributes to the profit of the firm, from the board down through the CEO to the individual trading or portfolio manager.
  - This may be where I diverge most significantly from the conventional wisdoms

6 – RISK AND UNCERTAINTY

Risk and Uncertainty

- What is Risk? – Start from Fundamentals
  – Possibility that P&L is different from what is expected
- P&L Distribution

| A. Coin Toss Bet | B. Hypothetical Yield Curve Strategy |
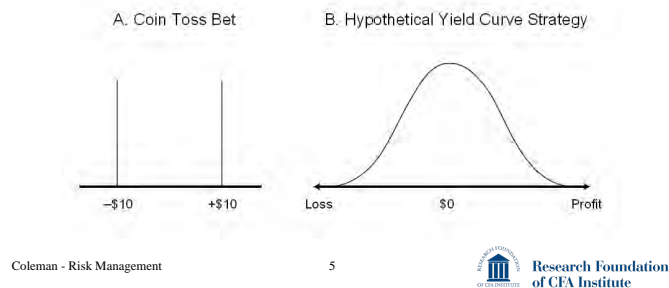
- o OK, having emphasized that risk management is first and foremost management, I am now going to shift gears and talk about the quantitative side. Because the quantitative side is important; we need to understand the quantitative tools, some of the technical issues that arise in measuring risk.
- o First, I will talk about Risk and Uncertainty in somewhat general terms, then turn to specific risk measurement tools.
- o The first issue is how to think about risk and uncertainty
  - For a financial firm we care about the P&L and really only the P&L – only money matters. This may not be exactly and precisely true, but it is pretty close to the truth.
  - Given that we focus on the P&L, we can define risk as: *The possibility that P&L is different from what is expected or anticipated; risk is randomness and uncertainty in the P&L.*
- o To talk about randomness in the P&L, we want to look at the P&L **Distribution**. What is the distribution? The graphs give a view of what I mean

- The first graph shows a simple business: we flip a coin and win $10 heads, lose $10 tails. The picture shows the possible outcomes with the probabilities. The horizontal shows the P&L (-$10 or +$10) and the vertical show the probability of each (1/2 for each). This is a complete description of the business. This distribution shows us all the possible P&Ls.
- Panel B is some hypothetical yield curve strategy, where we may make a large profit or large loss, but most likely we will make or lose just a little.
- Again the horizontal shows the possible P&Ls, the vertical shows the probability of each possible P&L. There are many possibilities but the most likely cluster around zero.

o The P&L distribution is the description we need for coming to grips with risk and randomness.

7 – RISK AND UNCERTAINTY – cont'd

Risk and Uncertainty – cont'd

- Becoming Comfortable With Randomness And Uncertainty
  - Randomness not intuitive
    - Birthday problem
  - We humans not good thinking about randomness
- Should Not Throw Up Hands and Give Up
  - Physics not intuitive – yet we use it all the time
  - Mathematics and probability are tools to supplement intuition
- Learn to Embrace Uncertainty and Randomness

Coleman - Risk Management   6   Research Foundation of CFA Institute

o The real key to understanding risk is to become comfortable with randomness and uncertainty. But as humans we like certainty and would prefer to think of future events as fixed, determined. In fact they are uncertain, fluid, dynamic, and we have to learn to embrace that uncertainty.

o The problem is that randomness and uncertainty are not intuitive and do not come naturally to us. There are many paradoxes and puzzles in probability that show this, and they often point us in the direction of better understanding. I discuss many of them in my books. One nice example is the birthday problem. It is easy to state:

- Say you enter a room where there are 19 other people, so now there are 20 in total. What is the probability that two of the 20 people in the room will share the same birthday? (Same day of the year.) The first reaction is to think the probability is small because there are, after all, 365 days to choose from. In fact, the probability is just over 41%, a number that I always find surprisingly

high. And it only takes 56 people to raise the probability to more than 99 percent. Almost certainty that in a room with 56, two will share the same birthday out of 365 possible days on the calendar.

- Why does this happen? I don't have a good explanation, but it is true. This is what the mathematics tells us, and reality follows the mathematics. (cf Aczel p. 71)

o This is just one example that shows we humans are not very good at thinking about randomness. We need to work at it.

o But just because we may not be good at it, just because we need to work at it and practice, this does not mean we should throw up our hands and give up. My conclusion, and this is well-supported by more formal research, is that there are big benefits when we think carefully and thoroughly about randomness and uncertainty.

o Unfortunately, some researchers and commentators say "we humans are not very good at thinking about probability and randomness – so we need to turn elsewhere". This is the basis of much "behavioral economics". This is patently silly.

o Look at physics. Physics is notoriously non-intuitive. We don't throw out relativity or quantum mechanics

- For relativity we use mathematics to incorporate it into GPS timing software so we can find our way to that dinner at our boss's house.
- For quantum mechanics, in spite of Einstein's objection about "spooky action at a distance" (and believe me, if you haven't read about it, quantum entanglement really is spooky), we harness quantum effects to build the lasers in everything from DVD players to the internet backbone.

o Turning back to risk and uncertainty, research has shown that sound statistical (and probabilistic) thinking can be enhanced, both through training and through appropriate tools and techniques.

o Consider the following example. We are following a mutual fund and trying to figure out whether this mutual fund performs better than the S&P or not. Someone has told us that virtually no mutual funds outperform the S&P, that on any particular day there is no better than a 50/50 chance – a coin flip – that the fund will do better than the S&P. But we follow our fund for a full year and looking back we find that for 10 days (between March 7th and March 18th, 10 trading days) our fund outperformed the S&P. Ten straight days. We know that the chance of getting heads 10 straight flips in a row is very low. So does this provide evidence against the statement "no mutual funds outperform the S&P better than flipping a coin"? Actually no.

- What is the chance that we flip a coin 10 times and get 10 straight heads? It is 0.1% or roughly 1/1000. Pretty low. That would make us think that our fund is pretty good, it actually does better than 50/50 in beating the S&P.

- But that would be plain wrong. If we flip a coin every day for a year, roughly 255 working days, the probability of getting a streak of 10 or more heads *sometime* during the year is about 11% – or better than 1/10. Reasonably high. So finding that there were 10 straight days *sometime* in the year is not strong evidence that our fund is good at beating the S&P.
- The point is, following our intuition might be misleading but thinking carefully can lead us to the right answer.

o To understand, appreciate, and work with risk, we have to move away from rigid, fixed thinking and expand to consider alternatives. We must give up any illusion that there is certainty in this world and embrace the future as fluid, changeable, and contingent. In the words of Gigerenzer (2002), "Giving up the illusion of certainty enables us to enjoy and explore the complexity of the world in which we live" (p. 231).

8 – RISK TOOLS

Risk Tools

- Focus on the *Intuition* Behind the Numbers
  - Fundamental tension – Mathematics vs. Management
- Volatility (σ, standard deviation) and VaR (Value at Risk)
- Portfolio Tools (Contribution to Risk, etc.)

o It is all well-and-good to talk about "embracing uncertainty" but for business we have to have concrete numbers we can work with.

o But there is a fundamental tension – between the mathematics necessary for getting the numbers and the management knowledge and intuition necessary for using the numbers effectively.

- We need the technical tools with all the mathematics
- But managers (no mathematicians) must use the tools and understand the intuition

o So, in the rest of today's talk, I will try to focus on the intuition

o First, I turn to Volatility (σ, standard deviation) and VaR (Value at Risk)
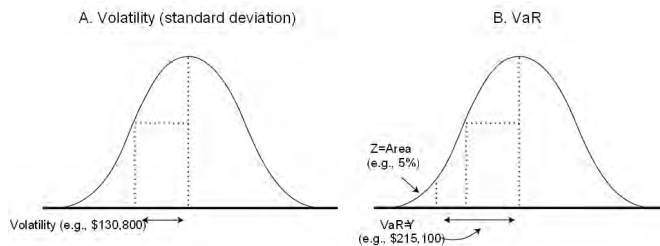
- These are the two most-used numbers in quantitative risk measurement. If you know nothing else you should know what these numbers mean, what they tell you, but also why they are not the whole answer.

9 – VOLATILITY AND VaR

Volatility and VaR

- Remember – We Care About P&L Distribution
  - Volatility and VaR tell us scale or dispersion – summary measures for the distribution
  - Very simple concepts – graphically

A. Volatility (standard deviation)   B. VaR

Z=Area (e.g., 5%)

Volatility (e.g., $130,800)   VaR (e.g., $215,100)

Coleman - Risk Management   8   Research Foundation of CFA Institute

- Remember that fundamentally it is the P&L distribution that matters – something like the picture on slide 6 or the pictures below
  - P&L along the bottom (large profits to the right, large losses to the left) and the probability of each outcome on the vertical.
  - The P&L is generally clustered around zero, with some chance (but not much) of big gains or big losses
  - The bell-shaped curve shown here is typical for many assets. But even if the P&L doesn't look exactly bell-shaped the idea of graphing the P&L versus the probability (the distribution) is what we want to use.
- What we really care about is the distribution, and if we knew the full distribution we would know everything about the possible P&L.
- Usually, however, we don't use the full distribution. We will use summary measures that tell us things about the distribution – because the full distribution is too difficult to measure or too complicated to easily grasp or because we simply want a convenient way to summarize the distribution.
- The most important aspect of the distribution, from a risk perspective, is the spread or dispersion – how spread out is the distribution?

- That is why we look at volatility and VaR – they are two very straightforward measures of the spread of the P&L distribution.
- Volatility – also known to statisticians as standard deviation or by the symbol sigma – is the most well-known measure of dispersion. It just measures the spread or dispersion of the distribution.
  - The easiest way to grasp what volatility tells us is to look at the picture – volatility is the spread of the curve.
- The mathematical definition does not really matter at the moment (go to my books or any basic statistics text) but there are two important aspects:
  - We can calculate volatility for any distribution using a simple formula ("any distribution" is not strictly true but it's good enough for our purposes)
  - When the distribution is pretty well-behaved (when it looks pretty-much like the graphs) then roughly 30% probability lies outside $\pm 1\sigma$.
- For the distribution shown ($20mn of a 10-year Treasury bond) the volatility is $130,800. This means that roughly one day out of three the P&L will be worse than -$130,800 or better than +$130,800.
- VaR – also known as a quantile to statisticians – also measures the spread or dispersion, it just measures it from a slightly different perspective. Again it is really easy to understand when we look at the graph
  - VaR is the point on the horizontal where we have probability 5% to the left – in other words a 5% probability of worse P&L.
  - We have to remember that VaR always needs to be quoted with the probability – the graph shows the 5% VaR but we could also ask for the 1% VaR – this would be further to the left – worse P&L.
  - One note of warning – sometimes the VaR is quoted as "5% VaR" – meaning 5% worse; sometimes as "95% VaR" – meaning 95% better. In my book I generally try to quote it as "5%/95% VaR" just to keep straight that it means 5% chance things will be worse, 95% chance things will be better.
  - For the distribution shown ($20mn 10-year Treasury) the 5% VaR is $215,100

Using Volatility (or VaR)

- "Scale" for Standard Trading Conditions
  - Tells us how big P&L might be
  - P&L outside vol roughly 30% or 1 day out of 3
  - P&L less than 5% VaR roughly 5% or 1 day out of 20
- To Compare Different Assets
  - E.g. Bond and CAC equity index futures
  - P&L matters – money is still money
- To Combine Assets
  - P&L adds, but volatilities do not – diversification
- Extreme Events – more later

Coleman - Risk Management   9   Research Foundation of CFA Institute

o There are four uses for volatility or VaR:

- Telling us the scale or dispersion for standard trading conditions

- To compare across assets

- To combine assets

- To measure extreme events – we will come back to this – very difficult and I want to focus some particular attention on this

**"Scale" or Dispersion for Standard Trading Conditions**

o Remember, we really care about the distribution of the P&L, the graph shown on the previous slide

o The volatility and VaR are nothing more nor less than simple ways to summarize the spread of the distribution.

o Nothing magical about them, they just tell us how spread out the P&L is likely to be

o It is all well-and-good to know the *value* of volatility and VaR but how do we use the numbers?

o Let's illustrate by an example, an example to measure the scale of the P&L. Continue with the $20mn worth of a 10 year US Treasury bond. The P&L will look roughly as in the figures on slide 9 and the upper left in slide 10 – volatility $131,000, 5%/95% VaR $215,000.

o How do you use that information? What does it tell you?

o Volatility works best for "Standard Trading Conditions" – meaning day-to-day trading, events towards the center of the distributions, not extreme events out in the tails.

o Volatility = $131,000 means roughly 1-out-of-3 trading days will see P&L outside of $131,000 – worse than -$131,000 or better than +$131,000. (Roughly 1-out-of-7 days see loss worse than -$131,000.) Is that a lot or a little?

- Depends on your perspective. For most individuals, making or losing $131,000 once every three days is probably a lot. On the other hand for an investment portfolio with $500mn in capital it's trivial (only 0.03% of the capital).
- Basically, you want to ask yourself whether $131,000 is large or small. Would you be fired if you lost that much? Would nobody notice because it's so small?
o What we have done, and it is really valuable, is to set the scale of what you should expect to make or lose during standard trading conditions.

11 – VOLATILITY TO COMPARE AND COMBINE

Volatility to Compare and Combine

- $20mn 10-year UST; €7mn ($9.1mn) CAC
  - Very different – how to compare? Use volatility (or VaR)
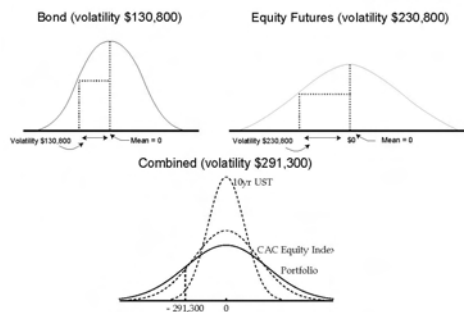
Comparison

o We just saw how to use volatility to get a scale or size of a position – for the $20mn US bond position, volatility = $131,000 means we should expect to see that P&L (or more) roughly once every three days.

o But we can use volatility (and VaR) to do more – to compare across different assets and to aggregate different assets into an overall portfolio.

o I want to emphasize – there is no substitute for good judgment, experience, and plain old-fashioned common sense. These numbers, and these quantitative tools and techniques, supplement our judgment and experience, they do not substitute for them. We cannot rely on these tools and forget everything we have learned.

- It is like GPS – a great tool but you cannot rely on it blindly. My father has a farm in West Virginia. The state road passes by. It is a dirt road, and at our house it comes out of the mountains, down from five miles that is virtually impassable to anything but 4-wheel drive. But it

is a state road. On some GPS systems it shows as a preferred route through the mountains. One day two motorbikes (Harleys, not dirt bikes) stopped at our house – absolutely shattered because they had followed GPS and come down those five miles.

- We should never rely on technical tools (whether volatility or GPS) to the exclusion of experience, common sense, and local knowledge.

o Having said that, volatility can be an incredibly useful tool for comparing across assets, particularly for assets that we are not intimately familiar with.

o Say we have $20mn of a 10-year US Treasury and €7mn of CAC equity index futures. Say I trade in US fixed income and have a good idea of how much risk there is in $20mn-worth of a bond. But €7mn of CAC futures? Not such a clear idea. That is $9.1mn notional, but is that more or less risky than the $20mn bond?

- These are very different securities
- UST is a cash instrument; CAC is futures, a derivatives
- UST is US fixed income; CAC is French equity index
- UST is a real asset and requires $20mn cash for up-front purchase; CAC is a futures and requires no up-front (apart from margin, which is only to ensure you can make good on any losses).

o But money is money and profit or loss is absolutely the same for the two (remembering, of course, to translate from € to $ or vice versa).

o The top graphs show the comparison, the P&L distributions

o I always like to think about the underlying P&L distributions, the graphs, because it helps solidify in my mind what the volatility (or VaR) actually means.

o The P&L distribution for the UST is less spread out.

- The UST volatility is $130,800, the CAC volatility is $230,800

o The UST is less risky. There is less chance of big losses. (But also, obviously, less chance of big gains.)

o Now, this comparison should not be the final say, we should look at these two securities more closely. **BUT** this volatility comparison gives us a much better idea than we had before.

- Even though the UST is more than twice as much notional, it is almost half as risky.
- We don't want to take these numbers as gospel. There may be a lot hidden in this – we don't know how likely extreme losses are, how the bond and the futures might move together or separately, but nonetheless we're much further ahead than we were before.
- We now know that, at least under standard trading conditions, roughly 1-day-in-3, the CAC futures position is more risky. And we have a good idea of how much more risky.

Combining or Aggregating

o Now let's turn to combining or aggregating, because securities are usually combined into portfolios.

o The comparison of the assets on their own is incredibly valuable, but we want to look at the risk together, in a combined portfolio

o I won't go over the details of *how* we do the combining, but take my word that we can combine the P&L distributions in a reasonable way.

- The top two graphs show the UST and the CAC P&L distributions separately.
- The bottom graph shows the UST and the CAC overlaid over the combined P&L distribution

o The key thing about the combined distribution is that it is less wide than just the sum of the UST plus the CAC. The volatility of the combined is less than the sum of the two volatilities:

- Combined = $291,300
- Sum = $361,600 = $130,800 + $230,800

o This is portfolio diversification

12 – Volatility and VaR Tips

Volatility and VaR

- Some "Tricks of the Trade" for Volatility and VaR
- Calculating Volatility
  - Use history to calculate standard deviation of changes
  - On Bloomberg, **HVT**. How many days?
- Calculating VaR
  - Quick-and-dirty – gross-up volatility
  - For normal: 1.65x for 5%, 2.33x for 1%, 2.7x for once-per-year
- Time Scaling
  - $\sqrt{t}$ – from daily to annual (255 days) multiply by 15.97

Coleman - Risk Management   11   Research Foundation of CFA Institute

o There is a whole range of tricks-of-the-trade and short-cuts people use in dealing with volatility and VaR. Here are a few of them

o Calculating Volatility

- This can be a very difficult and complicated area, but a quick-and-dirty answer is almost always better than knowing nothing. Simply looking at historical data (always look at price changes or returns, not the level of the price) and calculating the standard deviation is a good start.
- Bloomberg's HVT does this quickly and easily

- The biggest question, however, is "how much history"? "How many days"? I have no good answers, except to say that you want to use enough to get a reasonably reliable answer (more than 20 days) but not so many that you are looking so far back that the history that is no longer relevant. But sometimes you have to look into long past history to see extreme events (and I'll talk a little more about that later).

o Calculating VaR
  - Quick-and-dirty – just gross-up volatility.
  - If you look back to slide 9 you'll see that the VaR is just a point further out than the volatility on the horizontal axis of the distribution. So for any given distribution the VaR will just be XxVol.
  - For normal distribution: 1.65x for 5%, 2.33x for 1%, 2.7x for once-per-year.
  - For our $20mn UST, volatility is $130,800. 5% VaR is $215,000 (1.645x130,800)
  - BUT BEWARE THE NORMAL DISTRIBUTION. Financial markets have more extreme losses than the normal. We'll talk about this shortly.

o Time Scaling
  - Often we get the volatility or VaR for one day and want to scale up to see what it might be for one year.
  - Quick-and-dirty – multiply by $\sqrt{t}$. Say volatility is $130,800 daily (for our UST). This translates (very roughly) to $2.09mn annually. (Multiply by $\sqrt{255}$ or 15.97)

o Measure as Percentage of Portfolio
  - $20mn of UST, daily vol $130,800, 0.65% daily, 10.4% annually

13 – PORTFOLIO TOOLS

Portfolio Tools

- Volatility and VaR Only Take Us So Far. Need:
  – Sources of risk
  – How trades alter risk
  – Simple representations for complex portfolios
- Marginal Contribution and Best Hedge
  – Marginal Contribution – risk decomposition
    • Beware name confusion (RiskMetrics)
  – Best Hedge – what size trade provides "best hedge" and how risk changes

o Now I turn to Portfolio Tools. These are often not covered in as much detail in standard discussion of "risk management". But they are vitally important.

o Volatility and VaR are excellent tools but they only take us so far. Litterman (1996) says this well:

Volatility and VaR characterize, in slightly different ways, the degree of dispersion in the distribution of gains and losses, and therefore are useful for monitoring risk. They do not, however, provide much guidance for risk management. To manage risk, you have to understand what the sources of risk are in the portfolio and what trades will provide effective ways to reduce risk. Thus, risk management requires additional analysis—in particular, a decomposition of risk, an ability to find potential hedges, and an ability to find simple representations for complex positions. (p. 59)

o Three sets of questions:

- Sources of Risk

- How specific trades alter or reduce risk

- Simple representations for the portfolio

o I will discuss the first two of these today

o Easiest to see by example, to which we turn on the next slide

14 – PORTFOLIO TOOLS – EXAMPLE

Portfolio Tools – Example

- Continue with $20mn 10-year UST; €7mn ($9.1mn) CAC Futures
  - Portfolio vol $291,300
  - Contribution: 30% bond, 70% CAC futures
  - Best hedge with CAC is short €950k

	Positio'n (stand-alone) Volatility	Marginal Contribution	Best Hedge Pos'n	Volatility at Best Hedge	% Volatility Reduction	All-or-Nothing Cont'n
$20.0mn 10yr UST	$130,800	28.7%	-8.47	$224,100	23.1%	$60,490
€7.0mn CAC Equity	$230,800	71.3%	-0.95	$126,900	56.4%	$160,600
Portfolio Volatility	$291,300	100.0%				

Coleman - Risk Management   13   Research Foundation of CFA Institute

o Continue with $20mn 10-year UST and €7mn ($9.1mn) CAC Futures

o Overall portfolio vol is $291,300, but how much is due to UST and how much CAC?

o With only two assets this isn't so hard. We can look at the stand-alone vols (shown in the first column) and see that the CAC is much more volatile, and conclude that it probably contributes most of the risk. But real-life portfolios never consist of just two assets and the stand-alone volatilities just

do not work. The diversification in a real portfolio means the stand-alone volatilities just don't add to the overall volatility.

o This is where the marginal contribution to risk enters. The marginal contribution works for complicated portfolios because it <u>is</u> additive – it sums to the overall volatility. The marginal contribution to risk takes portfolio correlations and diversification effects into account. It decomposes the overall portfolio risk (volatility or VaR) into <u>additive</u> components due to each particular asset or risk factor. Technically it tells us how much the overall risk changes when there is a small (marginal or infinitesimal) change in each one of the assets or risk factors.

o Marginal contribution to risk helps us see the sources of risk. According to the table, 29% bond, 71% CAC.

o In this case, even though the notional on the UST is much larger, it contributes much less of the risk

o For complex portfolios the marginal contribution can bne very useful. In some cases the marginal contribution will be negative – small increments in an asset or risk factor actually *reduces* overall portfolio risk. This simply means that the asset is hedging the rest of the portfolio.

o But, BEWARE NAME CONFUSION. RiskMetrics calls this "Incremental VaR" and uses "Marginal VaR" for something else.

• This is a major problem, because we never know exactly what someone is talking about.

o The other tool I will talk about is "Best Hedge".

• Focus on one particular asset or risk factor in the portfolio. In this case let's focus on the CAC futures.

o Ask "What would be the amount of this single asset that would best hedge the rest of the portfolio?" In this case, short €950k of the CAC futures would be the best hedge for the rest of the portfolio. (Here "the rest of the portfolio" is just the UST, but in general it will be everything else apart from the CAC futures.)

o This is another way of getting a handle on the importance of this particular asset or risk factor. It tells us what a finite or large change in the asset would do. Most importantly, we need to look at the resulting portfolio volatility when we move to this new position in the CAC futures. Here:

• Portfolio of €7mn CAC + everything else has vol $291,300.

• Portfolio of short €950k CAC + everything else has vol $126,900.

• Reduces the vol by 56.4%

o Huge reduction. Tells us three things:

• This asset (CAC futures) is really important because moving to the optimal hedge reduce vol substantially

- We can do a pretty good job of hedging the overall portfolio by selling €7.95mn CAC futures (selling out existing €7mn and going short an additional €0.95mn)
- The portfolio behaves somewhat like being long €7.95mn CAC futures (since selling that amount optimally hedges the portfolio)

o Just to mention briefly, because other people talk about it, there is the "All-or-Nothing Contribution".
- What the portfolio vol would be if we reduced this particular asset or risk factor to zero.
- Again, beware of name problems. RiskMetrics calls this (bizarrely) "Marginal Vol" or "Marginal VaR", even though there is nothing marginal about it.

o I think Best Hedge more useful – because it tells us how much we should buy or sell to get the biggest change in vol.
- But this is a matter of personal preference. You should use the tools that help you to get a view into the portfolio.

o This is only a brief introduction to portfolio tools, and remember that they really become useful for a realistic portfolio with many positions.

15 – VaR AND EXTREME EVENTS

VaR and Extreme Events

- Extreme Events – VaR usually used for this
  - 5% VaR – P&L worse 5% or roughly 1-out-of-20 days
  - Could also look at 0.4% VaR – roughly once-per-year
- Be Careful with Extreme Events
  - Really hard to measure extreme events
  - Often larger than we expect
  - Maybe use simple rule-of-thumb: once-per-year = 4σ
    - Normal says once-per-year = 2.7σ
- Thinking of VaR
  - "Statistically worst-case loss" – really misleading
  - Much better: "a regularly occurring event with which we should be comfortable" (Litterman)

Coleman - Risk Management   14   Research Foundation of CFA Institute

o VaR tends to focus more on extreme events – losses in the far left end of the tail.

- Think back to slide 9 – the point on the left end of the tail.

o For $20mn UST, 5%/95% VaR = $215,000 means roughly 1-out-of-20 trading days will see losses worse than -$215,000.

- Is that a lot or a little? Again depends on perspective. For most individuals, probably a lot. For an institutional portfolio with $500mn in assets, probably very little.

o Note that this tells you basically the same thing as volatility – how often or with what probability you should expect to see losses like this.

o The most important difference in using and thinking about volatility and VaR is that volatility is focused more on standard or usual trading conditions (1-out-of-3 trading days) while VaR is more focused on extreme events – 1-out-of-20 or once-per-year.

- I tend to use volatility more than VaR, but I think VaR is used more in the industry.
- I won't go into much detail today about the differences, the pros and cons. I discuss that in more detail in my Wiley book

o Really important: VaR <u>does not</u> tell you your worst loss. The worst loss is always worse than you think it could be – in this case it would be losing the whole $20mn (with a US Treasury that's unlikely, though less unlikely than a few months ago).

- VaR tells you only that you should expect loss of $215,000 <u>or worse</u> 1-out-of-20 trading days. VaR gives you the scale.

o We can go out further in the tail, say to 0.4%/99.6% VaR (once-per-year), but we need to be really careful in measuring extreme events. It is really hard.

o Extreme events are often larger than we expect

- Financial P&L tends to have "fat tails" relative to the normal distribution that we often think of. This means that extreme events actually occur more often than predicted by the normal distribution (and we often use the normal, or bell-shaped, distribution).
- In 1998, with LTCM, they had estimated annual vol at 15bp – move from April through August was 50bp – more than 3σ in only 6 months – because of Russian debt default
- In 2008, AAA credit spreads rose from 50bp to about 400bp – I don't know how many sigma, but really large.

o These events catch us by surprise. Partly that's because unexpected events, extreme events, happen unexpectedly – they are extreme. But partly it's because, collectively, we have short memories. LTCM estimated 1σ as 15bp, but they were only using a few years of history. If they'd looked back to the early 1990s they would have seen large moves. Crises and panics happen periodically.

- A question for the audience – prior to 2010, who defaulted more recently (and more often since, say, 1850) – Germany or Greece? In fact Germany defaulted in 1939 (Greece I think 1932?) and during 19th c Germany 5 times, Greece 4, during 20th c Germany twice, Greece once.

- We have short memories about these kinds of things. We need to look far back in history, to learn something about markets, human behavior, panics and asset crashes, when we want to study and understand extreme events.
  - Because extreme events don't occur very often, it is hard to measure them with any precision
  - Sometimes, using a simple rule-of-thumb is as good as fancy mathematics
    - Using the normal distribution we would say once-per-year events would be about 2.7σ (2.7 times larger than the volatility)
    - Litterman suggests a rough rule-of-thumb: once-per-year events are actually 4σ ($4 \times$ volatility)
    - Personally, I think this is not a bad approach – it is simple to use, simple to explain, and works pretty well.

Thinking of VaR

- VaR tells us about the scale or dispersion of the P&L distribution. That is incredibly valuable, but sometimes people get carried away and talk as if VaR tells us everything. It does not.
- People talk about VaR as the "Statistically worst-case loss"
  - This is really misleading. No matter what probability we choose (5%, 1%, 0.1%) something worse will always happen.
- A much better way to think about VaR is as "a regularly occurring event with which we should be comfortable" (Litterman). The probability tells us how regularly occurring
- I repeat, NEVER TALK ABOUT VaR AS A WORST-CASE LOSS. That is really wrong.

Risk Management is Management

- Return to Risk Management as Management
- Remember Randomness and Uncertainty
  - Numbers don't give us certainty – just the scale of our uncertainty
- Delicate Balance – Practice old-fashioned judgment, take advantage of quantitative tools
- Extreme Events particularly difficult

Coleman - Risk Management   15   Research Foundation of CFA Institute

o In conclusion, I return to the theme of "risk management as management" – because it is such a critical lesson.

o There are three issues I want to highlight

Remember Randomness and Uncertainty

o We really need to remember that the numbers we've talked about don't give us certainty. There's a temptation to fall into the "illusion of certainty" – that just because we have a number it provides certainty.

o In fact volatility and VaR just tell us the scale of our uncertainty.

o And we need to be particularly careful, particularly respectful, when talking about extreme events, when using VaR with really small probabilities. It is really hard to measure extreme events. Anyone who tells you otherwise is just wrong. We can get estimates, make guesses, but we have to learn to live with uncertainty.

Delicate Balance

o Two objectives to balance:

- Practice old-fashioned judgment and use experience

- Exploit quantitative tools in the service of managing people, process, organization

o Hard to balance because management and quantitative risk measurement require different skills, training, backgrounds, talents. But it is something a successful firm must master.

Extreme Events Particularly Difficult

- o Of all the risk management challenges, extreme events are possibly the most challenging
- o Best response – recognize our limitations, embrace uncertainty, and build a robust, flexible organization that can withstand and respond to unexpected shocks, while at the same time exploiting opportunities.

18 – CONCLUSION and QUESTIONS

- o Thank you for the opportunity to talk to you today.
- o I hope you have enjoyed this. I also hope that I may have given a slightly different view of "Risk Management".
- o And I would be happy to answer questions