Foundations of Risk Management- II

Multifactor Models

CAPM is a single factor model where the dependent variable is the Expected return on security and independent variable is the Market Risk Premium.

A multifactor model would look like:

$$E(R_i) = R_f + \beta_1(\text{Factor 1}) + \beta_2(\text{Factor 2}) + \beta_3(\text{Factor 3})$$

One of the best examples of a multifactor model is the Fama-French three factor Model:

$$E(R_i) = R_f + \beta_1 (E(R_m) - R_f) + \beta_2(HML) + \beta_3(SMB)$$

The first factor is the same as CAPM, the second factor is the difference between return on stocks with high B/P ratio (Value stocks) and stocks with low B/P ratio (Growth stocks), the third factor is the difference between returns on stocks with lower market cap and stocks with high market cap. The R^2 of the model (coefficient of determination) which represents the explanatory power of the model went up significantly after the inclusion of two more variables.

Arbitrage Pricing Theory

The APT states that if two stocks have the same factor exposures and same sensitivity to risk factors, they should have the same expected return. If not, then it gives rise to an arbitrage opportunity. Consider two IT stocks; Infosys and TCS.

$$E(R_i) = R_f + \beta_1 (E(R_m) - R_f) + \beta_2(\text{Change in USD/INR})$$

If β_1 and β_2 are same for both the stocks, the expected return should be the same. If the expected return on Infosys is 12% and that on TCS is 10%, it implies Infosys is undervalued relative to TCS. One can exploit the arbitrage opportunity by buying Infosys and Selling TCS. In this case, the investor would be neutral to the risk factors as he is short one stock and long the other stock, both with same factor exposures and same factor sensitivities. This is known as convergence trading, pairs trading or a relative value trade. He makes a risk free return of 2%.

Learning from Financial Disasters

The Common Threads in Lehman, Continental Illinois and Northern Rock

All three funded long term assets through short term liabilities which were not stable.

In general banks borrow short term and lend long term. During normal times the term structure of interest rates is upward sloping. However during times of panic, the term structure of interest rates becomes inverted. Something similar happened in India in the case of Dewan Housing Finance which lend to real estate developers by issuing short term debt. After IL&FS crisis, short term money markets became tight and Dewan was not able find takers for its debt.

Banks have to continuously address this trade off between lower interest rates at the short end of the yield curve and the funding liquidity risk. This strategy brings about during periods of crisis.

It is important for banks to have a diversified base as much as it is to have a diversified asset portfolio.

Constructing and Implementing a Hedging Strategy

Metallgesellschaft AG

- Metallgesellscaft was a German energy trading firm.
- It used to enter into long term supply contracts for crude. It was vulnerable to the risk of crude prices going up.
- It used to hedge this risk by going long near month crude futures. The strategy used to work well as crude market was in backwardation which gave it a positive roll yield.
- A sudden fall in crude prices resulted in huge MTM losses on its long futures positions. The firm did not have the liquidity to pay the additional margin to hold positions as collections from clients were long term in nature and were due only later.
- As a result the firm was forced to liquidate/unwind its hedges, resulting in a cash loss. Unfortunately the crude market flipped into contango. Prices also recovered thereafter resulting in the company having to buy crude from the open market at higher prices to fulfil its long term supply contracts. The company incurred a loss to the tune of USD 1.3Bn and could not sustain operations.
- The key risk pertinent to this case study is basis risk. There was a mismatch between the maturity of its underlying exposures and its hedges. The company was adopting what is called a stack and roll hedge strategy as opposed to a strip hedge strategy. The company failed to recognize the risk associated with the stack and roll strategy and this resulted in a severe liquidity crisis, resulting in forced liquidation of its hedges, thereby making it vulnerable to commodity price risk.

Rogue Trading and Misleading Reporting

Barings Bank

Barings Bank had a license to operate at SIMEX which was not being utilized. They sent Nick Leeson to start operations there. He was mandated to capitalize on arbitrage opportunities in Nikkei between the Tokyo Stock Exchange and the Osaka Stock Exchange.

One day one of his subordinates sold Futures instead of Buying and that's when Nick found out about the error account 88888.

The account was an error account and was not monitored closely by the head office.

Nick Leeson started taking riskier, unauthorized speculative positions and hid losses in the error account.

Rogue Trading and Misleading Reporting (Cont.)

One day he was running a short straddle on the Nikkei in anticipation that the Nikkei would not move much overnight. However the Kobe earthquake struck resulting in a huge drop in Nikkei. In order to recoup losses on his short straddle, Nick went long Nikkei futures in anticipation of a quick recovery which too failed to materialize. He then fled leaving a note on his desk reading "I am sorry" but was caught and had to serve his sentence in Changi prison. While in prison he wrote the book "Rogue Trader".

The key takeaway from this case study is lack of senior management oversight. Consistent outperformance should also raise a red flag. There was also a conflict of interest as Nick himself was in charge of execution, verification, settlement and reporting of trades which made concealing losses easy. This case study was the turning point in Risk Management. The structure of a modern day treasury and segregation of roles between Front Office, Mid Office and Back Office evolved post this incident. Traders are also required to go on a mandatory leave annually so that any irregularities can surface.

Financial Engineering

Risk of Complex Derivatives: BT and P&G case

- Bankers Trust proposed complex leveraged swaps to companies like P&G and Gibson Greetings to lower their funding costs.
- In the swap with P&G, BT would pay P&G a fixed rate for 5 years while P&G would pay a floating rate which was the commercial paper rate minus 75bps plus a spread*. If rates remained stable, P&G would pay CP rate – 75bps. The floating rate would however, increase significantly if rates rose during the period. For example, a 100bps increase in rates produced a 1035bps spread over the commercial paper!
- In 1994 when Alan Greenspan raised the Federal Funds rate by 250bps, P&G incurred colossal losses on swaps.
- P&G sued BT for misrepresenting the risk embedded in the complex swap transactions.
- BT's reputation took a beating and it was eventually acquired by Deutsche Bank.

Financial Engineering (Cont.)

***The complex formula for the spread that P&G had to pay is shown below:**

$$Max\ \{0, \frac{\left(98.5\ *\ (\frac{5y\ CP\ rate}{5.78\ \%})\ -\ (30\ y\ Treasury\ price)\right)}{100}\}$$

Financial Engineering (Cont.)

Excess Leverage and Complex Financial Instruments: Orange County

Robert Citron, the treasurer of Orange County (municipality) of California borrowed through the repo market and controlled investments worth USD 20Bn with assets of only USD 7.7Bn (Highly leveraged).

Citron used the borrowed funds to purchase complex inverse floaters whose coupon payments decline when interest rates rise.

The strategy resulted in huge losses (USD 1.5Bn) when the Federal Reserve hiked rates by 250bps in 1994. The fund's lenders stopped rolling over their repo agreements and Orange County was ultimately forced to file for bankruptcy.

Financial Engineering (Cont.)

Investing in AAA tranches of sub-prime CDOs: Sachsen

- Sachsen was a Landesbank (German state owned bank).
- Landesbank was typically specialized in wholesale banking i.e. Lending to regional small and mid sized companies.
- Sachsen opened a unit in Dublin to set up SPVs to hold large volumes of highly rated US Mortgage Backed Securities (MBS). Sachsen bought MBS and sold them to investors including US. corporates.

  (Dublin is considered to be a tax haven and many US corporates held cash in Dublin, creating a natural demand for investment products.)
- Though the SPVs were off the bank's balance sheet, they enjoyed guarantee from the bank.
- SPVs were too large compared to Sachsen's balance sheet. When the subprime crisis struck in 2007, bank's capital was wiped out.
- The bank was ultimately sold to another Landesbank, Landesbank Baden Wurttemberg.

Reputation Risk

Volkswagen Emission Cheating Scandal (Dieselgate/Emissiongate)

- World's leading automobile manufacturer, Volkswagen had programmed its diesel engines to comply with US emission norms only during regulatory testing through a 'defeat device' but not during real world driving.
- Volkswagen senior officials acknowledged the wrongdoing. Volkswagen CEO Mr Martin Winterkorn had to step down as a direct result of the scandal.
- The damage to Volkswagen brand was significant, especially in the US market. Its share price fell by over a third as the scandal unfolded and the firm faced Billions of Dollars in potential fines and penalties.
- The company had to recall millions of cars worldwide and had to set aside €6.7Bn to cover costs. This resulted in the company posting its first quarterly loss in 15 years!

Corporate Governance

Enron was a behemoth in the energy sector. The CEO of Enron was Jeffrey Skilling. Enron's business model was very complex. Its financial statements were confusing for investors and analysts.

The auditor of the firm was Arthur Andersen which was also the consultant – a conflict of interest.

Corporate Governance (Cont.)

The firm manipulated its books of accounts through three malpractices:

- **Revenue Recognition:** Instead of showing only the fee income, it used to show the entire revenue of projects on which it used to consult, thereby inflating its top line. Its Revenue increased 750% from USD 13.3Bn in 1996 to USD 100Bn in 2000 (unprecedented in an industry in which Revenue typically grew at 2-3% annually).
- **MTM accounting :** It was one of the first Non financial companies to use MTM accounting for its derivatives. The derivatives it used to enter into, were very complex and difficult to value eg. Weather derivatives.
- **Use of Special Purpose Entities:** Enron did not disclose the guarantees to its SPEs in its financial statements. If any of the SPEs defaulted on its debt payments it would have been Enron's liability to make the good payments.

The analysts and investors were not able to reconcile the company's cash flows with the income statement and that's when concerns started rising about the quality of Enron's reporting. The stock price of the company fell from a high of USD 90 to less than USD 1 in months.

Corporate Governance (Cont.)

The Worldcom scandal happened an year later and both these cases together resulted in a very important legislation coming about i.e. The Sarbanes Oxley Act , the salient features of which are as follows:

- Constitution of Public Company Accounting Oversight Board, i.e., Auditor of Auditors
- Restricting auditing companies from offering non-audit services, i.e., Rotation of auditors
- Senior management to take individual responsibility for accuracy and completeness of financial reports
- Enhanced financial disclosures
- Corporate and criminal fraud accountability
- White Collar crime penalty enhancement

Anatomy of the Great Financial Crisis of 2007 - 2009

Genesis of the Crisis

- Post the dot com bubble burst in the year 2000, the US Federal Reserve had kept rates extremely low for too long. Fed was behind the curve in hiking rates.
- 2/20 ARMs (Adjustable Rate Mortgages) with teaser interest rates in initial period that reset to market rates subsequently had gained a lot of traction. Lending standards were extremely low. Since the lenders were happy with the collateral and the house prices were heading one way up, but they were not doing the necessary credit due diligence of borrowers.
- People borrowed to buy homes. Between 1997 and 2006, price of a typical American house grew 124% which gave homeowners an incentive to refinance. People borrowed against the increase in home equity to buy second and third homes. This is how household balance sheets became highly leveraged.
- Statistics reflect the inflating house price bubble. Median home price to median household income which ranged between 2.9-3.1 during 1980-2001, grew to 4.0 in 2004 and 4.6 in 2006. US household debt as a percentage of disposable personal income reached 127% in 2007 from 77% in 1990.

How It All Came Apart?

- When the US Federal Reserve started hiking rates and when the rates on mortgages reset to market rates, several less credit worthy (sub-prime) borrowers started defaulting.
- The banks started foreclosing properties of borrowers who had defaulted. Supply of homes for sale increased, resulting in falling house prices.
- Falling house prices in turn reduced the equity of other homeowners and reduced their incentive to repay, resulting in further defaults.
- Availability of credit to banks froze. Lenders started questioning the quality of assets as house prices fell and became reluctant to extend further short term loans.
- Banks had funded long term assets such as mortgages through short term liabilities such as Asset Backed Commercial Paper and repos.

How the Crisis Became Systemic?

In order to reduce the exposure to mortgages on their balance sheets, the banks sold them to special purpose vehicles. These SPVs issued securities to investors backed by cash flows from these mortgages. The pool of mortgages was called a Collateralized Mortgage Obligation (CMO). The securities were called Mortgage Backed Securities (MBS). If the pool comprised of loans other than mortgages such as credit card loans/auto loans, it was called a Collateralized Debt Obligation (CDO) and the securities were called Asset Backed Securities (ABS). This process is known as securitization.

(This was the shadow banking system in operation. In India's case, investors invest in Mutual Funds and these mutual funds buy bonds of NBFCs and HFCs which on lend to retail, SME and MSME clients. Therefore, In case of instances of default like IL&FS and Dewan Housing Finance, the risk is not just confined to specific entities but to the entire financial system.)

The securities were classified into Principal Only (PO) and Interest Only (IO) securities. Further these were trifurcated into Senior, Mezzanine and Junior tranches. The first risk of default was borne by the Junior tranches and therefore investors in the Junior tranches commanded the highest yield. Top Wall Street investment Banks such as Lehman Brothers were underwriters to such securities.

How the Crisis Became Systemic? (Cont.)

There were instances when the credit desk of the bank had offloaded the mortgages while the investment desk of the same bank regained exposure to the underlying mortgages by buying these securities. Pension funds, Insurance companies were also buyers of these securities.

The credit rating agencies were also to blame. Despite the underlying pool comprising of subprime mortgages, the securities issued on the back of cash flows from that pool were given top investment grade ratings. (Likely on account of a false sense of comfort on underlying collateral)

Several Investment banks also sold Credit Default Swaps on these MBS and when there were defaults on the underlying mortgages, these investment banks had to make good the losses.

Causes

- The US Federal Reserve keeping rates too low for too long.
- Predatory Lending (Reduced Lending standards). The Originate to Distribute model resulted in relaxed underwriting standards.
- Underestimating the default correlation in a portfolio comprising of retail mortgages: Retail lending is generally considered safe as default correlations are generally low. However, during times of stress the correlations break down and this is what happened.
- Securitization: The Risk pervaded the entire financial system on account of structured products and financial engineering.
- Inability of Rating Agencies to flag concerns.

The Aftermath

The Subprime crisis was the worst shock to the US economy since the Great Depression of 1929 with unemployment rate soaring to 10%.

The US Federal Reserve had to resort to unprecedented unconventional monetary policy measures such as cutting federal funds rate to zero, Quantitative Easing (QE) and Operation Twist.

The US Congress passed the Emergency Economic Stabilization Act under which the government launched the USD 700Bn TARP (Troubled Asset Relief Program) to purchase toxic assets from financial institutions. The government introduced the Dodd-Frank Wall Street Reform and Consumer Protection Act. One of the Provisions under the act, the Volcker rule, restricts banks from entering into certain kinds of speculative investments.

The Aftermath (Cont.)

The government introduced the primary dealer credit facility under which the Federal Reserve lent PDs through repos.

Depository institutions were funded Under the Term auction facility.

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