Lecture of Banking Analytics – lecture 2
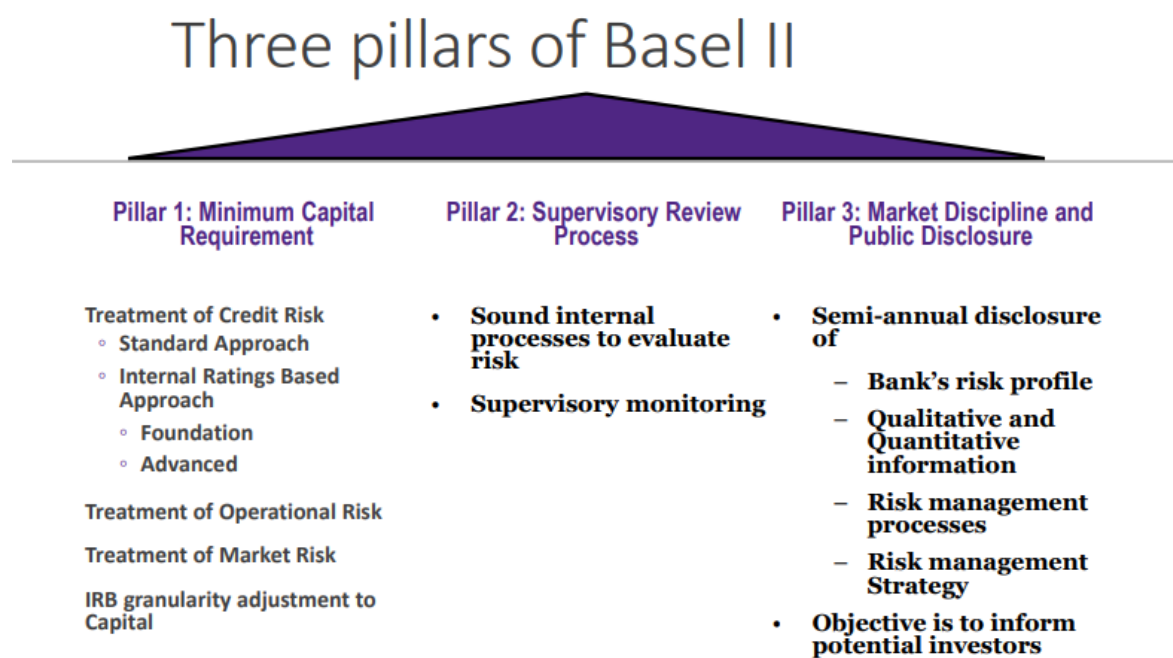
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The Basel Accord

How the Basel came into existence

- After the stagflation crisis in the 70s, world realized that the regulating staff didn't work
  - ➢ They realized that the goal standard was not efficient, injecting money from central bank didn't work, because it never gets the amount right
  - ➢ Creating a market mechanism that automatically regulated how much money people need in their pocket is a good idea
  - ➢ Give that power to private entity is also great idea
    - ✧ Not so true
  - ➢ When banks had the right to print money
    - ✧ They print money when things were good
      - ▫ Made periods of growth worse because it created inflation
    - ✧ They took money off the street when things are bad
      - ▫ Made periods of crisis worse
    - ✧ It is opposite of what we want
- So Basel was created
  - ➢ The Basel committee was created in the 85
  - ➢ It was a team of central bankers from developed economies from G10
  - ➢ They decided to create a common set of rules that will try to tie risk with lending opportunities
    - ✧ If your risk is low, you can give more loans
    - ✧ Not just leave this to supply and demand, but also to risk
- The capital Accords in 1988 set a little bit of money aside to cover risk
  - ➢ Sets a minimum floor of 8% of your risk weighted assets
  - ➢ This is essentially the Basel I
    - ✧ You should have more than 8% of risk weighted assets being the regulatory capital
- But people starting the find holes in the Basel I, in 2006, Basel II came out

Basel II

- It is realized that banks did not only work with the relation between the supervisors (regulators, governments) and the bank. There is a third player, the market (investors)

The three pillars of Basel II

Three pillars of Basel II

Pillar 1: Minimum Capital Requirement	Pillar 2: Supervisory Review Process	Pillar 3: Market Discipline and Public Disclosure
Treatment of Credit Risk ○ Standard Approach ○ Internal Ratings Based Approach ○ Foundation ○ Advanced Treatment of Operational Risk Treatment of Market Risk IRB granularity adjustment to Capital	• Sound internal processes to evaluate risk • Supervisory monitoring	• Semi-annual disclosure of – Bank's risk profile – Qualitative and Quantitative information – Risk management processes – Risk management Strategy • Objective is to inform potential investors

- The pillar 2 greatly enhanced the monitoring factor of regulatory, it includes yearly internal and external auditing

- However, there were a lot of derivatives that caused chain of risk that wasn't being correctly taken into account (this is the market risk side).

- Piller 3 involves what the bank must disclose to the world about what they are doing. It is called the pillar 3 report
  - Good for interview
    - It talked about what they invest, what they are doing, what their thoughts are, what are potential risks, …

Pillar 1 – minimum capital requirements

Credit Risk

Key components for each segment estimate
- ◦ Probability of default (PD)
- ◦ Loss given default (LGD)
- ◦ Exposure at default (EAD)

Expected Loss (EL)=PD x LGD x EAD

Unexpected Loss (UL)= f(PD)xLGDxEAD

E.g. PD=1%, LGD=20%, EAD=1000 dollars➜ EL=2 dollars

Standardised Approach

Internal Ratings Based Approach

The Standardized Approach

- For 10 different products, I need to have at least 30 models (PD model, LGD model, EAD model), need to hire 50 people to achieve this
  - ➢ But small business doesn't have this ability
  - ➢ Government thus allows them to use this standardized approach, where they just need to calculate risk weighted assets, then from those, every operation will have a fixed amount. And it is added to the capital requirements
   - ✦ Fix amount is high or low?
    - ✦ Higher.
- Note that

$$\frac{regulatory\ capital}{risk\ weighted\ asset} > 8\%$$

- Go online, and download the weights and apply the weights to the amount that was lent to the exposure that is exposed
  - ➢ E.g. most retail exposure (e.g. consumer loans, credit card) risk weighted at 75% (i.e. capital requirement is 6% of loan)
    - ✦ If lent $1000, since Basel I require 8%, the capital requirement is $60 need to be saved
    - ✦ It increases the capital that you need to keep
  - ➢ E.g. defaulted loans weighted at 150%+ (i.e. 12% of loan)
    - ✦ If a loan defaulted, the capital required to keep is increased
    - ✦ The capital requirement went from 6% to 12%, so you can't provide loan to at least another person

- Note that
  - ➢ Default means 90 days late in one installment: legal actions can be pursued after that
  - ➢ Write off happens after 180 days, money can be taken from provision to write off this debt

- To sum it up
  - ➢ Take the tables, take the numbers, multiply everything by everything
  - ➢ Sum up everything to get risk weighted assets
  - ➢ Divide that by the capital from the calculation (common stock + preferred stock + …)
  - ➢ Derive at the base number
  - ➢ Compare to what regulators tell you to keep
    - ✧ Required 8%, if my base number is 9%, we are okay
  - ➢ If a bank is running too much risk, they need to constrain credit

Internal Rating Based Approach

- Divide exposures (basically operations) into five categories
  - ➢ Corporate (5 subclasses)
    - ✧ E.g. large caps, …
  - ➢ Sovereign (national bonds)
  - ➢ Bank (interbank lending)
  - ➢ Retail (residential mortgage, revolving, other retail exposures)
    - ✧ Retail is kind of this one group: banking analytics – it deals with how to calculate things for corporate, for sovereign, …
  - ➢ Equity

- First, for every operation, you calculate the risks
  - ➢ E.g. lending to corporation consider their rating
  - ➢ E.g. lending to consumer calculate credit score
- Second, take everything in the portfolio and cut into pieces depending on the risk and define your own rating
- Then, apply provisions to the rating
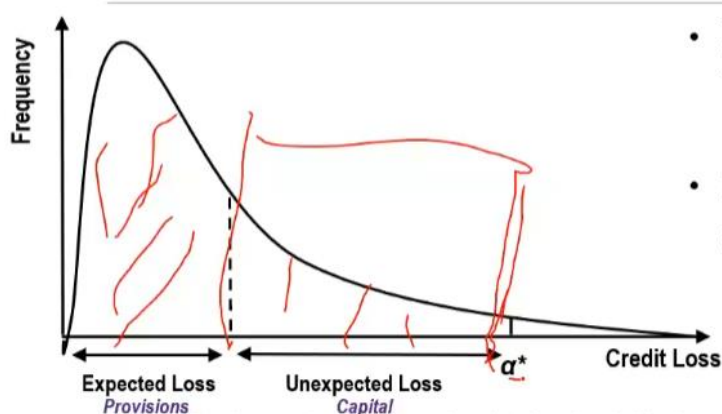
- Expected losses in a segment is $EL = PD \cdot LGD \cdot EAD$
  - Must be covered by profits, so factored into pricing
- Basel Accord is concerned with Unexpected Losses, UL in a segment
  - $UL = K \times EAD = (PD_{99.9\%} - PD_{50\%}) \times LGD \times EAD$

Expected Loss *Provisions*   **Unexpected Loss** *Capital* α^* **Credit Loss**

Basel sets α^* at 99.9%, meaning that there is a 0.1% chance (once in 100 years)
that an institution's capital would fail to absorb the unexpected loss and becomes insolvent!

Capital requirement equation for Basel

Capital needed is

$$\text{Capital } K = \left[LGD \left\{ N \left[\left(\frac{1}{1\text{-}R}\right)^{1/2} N^{-1}(PD) + \left(\frac{R}{1-R}\right)^{1/2} N^{-1}(0.999) \right] - PD \right\} \right] \left(\frac{1+(M-2.5)b}{1-1.5b}\right)$$

○ where N is Cumulative Normal Distribution, N-1 is inverse distribution and R is correlation
○ Only covers unexpected risk; so if R=0, K=0 ; if R=1, K=LGD(1-PD)

•Retail exposures
•M=1 (maturity term disappears)
For Mortgages R=0.15
For Revolving R=0.04
For other retail
$R = 0.03 \left(\frac{1 - e^{-35PD}}{1 - e^{-35}}\right) + 0.16 \left(1 - \frac{1 - e^{-35PD}}{1 - e^{-35}}\right)$

• Corporate exposures
• $b = (.11852 - .05478\ln(PD))^2$
• $R = 0.12 \left(\frac{1-e^{-50PD}}{1-e^{-50}}\right) + 0.24 \left(1 - \frac{1-e^{-50PD}}{1-e^{-50}}\right)$

○ And finally the Risk Weighted Assets will be equal to: $RWA = 12.5 \cdot K \cdot EAD$

- Idea: uses Vasicek one factor extension for Merton corporate credit risk model
  - ➤ This model suggests that a company goes bankrupt when asset level is below debt
    - ✧ Gross simplification of the reality
  - ➤ Model the value of assets using

$$R_i = \mu_i + bX + cU_i$$
$$\text{where } X \sim N(0,1), \ U_i \sim N(0,1)$$

  - ✧ The return is an average trend
  - ✧ U_i factor is the idiosyncratic factor, size of your white noise
  - ✧ X depends on the world, the markets

- The middle part of the equation is the solution for Vasicek model for value at risk at 99.9% risk

$$\left\{ N \left[\left(\frac{1}{1\text{-}R}\right)^{1/2} N^{-1}(PD) + \left(\frac{R}{1-R}\right)^{1/2} N^{-1}(0.999) \right] - PD \right\}$$

  - ➤
- The R is the correlation of the product with the world economy

- ➢ Different products will have different correlations with the economy
- ➢ Is the correlation changing in time or stabling in time?
  - ✧ Changes
  - ✧ But Basel assumes it to be fixed, and exactly the same for every country
    - ▫ Why? To eliminate regulatory arbitrage
- This part is the PD at 99.9%
  - ➢ $$N\left(\left(\frac{1}{1-R}\right)^{1/2} N^{-1}(PD) + \left(\frac{R}{1-R}\right)^{1/2} N^{-1}(0.999)\right)$$
- This part is adjustment by maturity
  - ➢ $$\left(\frac{1+(M-2.5)b}{1-1.5b}\right)$$
  - ➢ Maturity of a portfolio of loans is the time it takes for all the non-idiosyncratic defaults to appear
    - ✧ Most consumer loans are between 3-5 years
    - ✧ Many corporate loans are short-term, many are long-term
  - ➢ So the formula calculates the average maturity of everyone in the portfolio for **corporate/sovereign loans**
    - ✧ For consumers, it should be just 1
  - ➢ so for retail, this does not appear

- A revolving loan is when you have a line of credit and you can take money and then you can pay it back anything above the minimum amount monthly, but you can in principle just pay the minimum amount for years, as long as you are paying interest
  - ➢ E.g. credit card

- This part says that the higher the PD of the loan, the higher the correlation with the economy
  - ➢ $$R = 0.03\left(\frac{1 - e^{-35PD}}{1 - e^{-35}}\right) + 0.16\left(1 - \frac{1 - e^{-35PD}}{1 - e^{-35}}\right)$$
  - ➢ When PD is higher, it is more likely tide to the wind, it is weaker in finance
  - ➢ Can it be 0?
    - ✧ No

- For corporate
  - ➢ • $b = (.11852 - .05478\ln(PD))^2$
  - • $R = 0.12\left(\frac{1 - e^{-50PD}}{1 - e^{-50}}\right) + 0.24\left(1 - \frac{1 - e^{-50PD}}{1 - e^{-50}}\right)$
  - ➢ It is more correlated with the economy than retail exposures
    - ✧ Because they depend on demand and supply

- What happens if PD = 100%
  - ➢ Everything is counted toward provision

➢   No capital requirement
➢   Provisions are worse for the banks because it is hard cold cash as compared to valuation, risk, potential

Conclusions of Basel II Accord

-   Banks are forced to calculate risk for every single operation
    ➢   IRB use complex models per every line of customer, per segment

-   Calibration of credit scoring needs to be strengthened
    ➢   Not just rank customers correctly in terms of default risk but scores must give accurate default probabilities
    ➢   Created large demand for data analyst

Need to model Loss given Default especially for unsecured loans

Lots of emphasis on stress testing models so need to build models with economic conditions to allow stress testing

Banks have to decide whether their PD is point in time or through the cycle
- PD can only be regularly validated if it is short term average and yet Basel Accord wants long term PD. How to go from one to the other?

Operational Risk and Market Risk

Operational Risk
- Basic
- Standard
- Advanced

Basic: Estimate gross income each year
- Capital required = a* Average gross income in last three years

Standard: split into 8 business lines j and estimate income in each business line each year $i = \{1,2,3\}$, $GI_{i-1,j}$.

$$capital = \frac{\sum_{i=1}^{3}\left(\sum_{j=1}^{8} a(j)GI_{i-1}(j)\right)}{3}$$

Advanced: Estimate frequency of loss events and severity of loss events and hence obtain distribution of losses. Regulators will check both models
- Use 99.9% VaR level to set capital

Market Risk

Used in 1996 amendments to Basel 1 to cover risk in bank's propriety trading.

Standardised Approach
- Worry about specific (share traded) and general (market movement) risks
- Set aside % of trade to cover separately
  - Interest rate risk
  - Equity risk
  - Foreign currency risk
  - Commodity risk
  - Option risk

Internal model Approach
- VaR approach (interest rate model for example must have a least 6 factors
- Use 10 trading day risk horizon
- Must use at least one year's data

$$K_t = \max\left(\frac{k\sum_{i=1}^{60} VaR_{t-i}}{60}, VaR_{t-1}\right) + specificrisk$$

Basel III

- It's shown that countries implemented Basel II and countries that did not were having the same result after the crisis.
  - ➢ Basel II is not effective
  - ➢ Basel III was created to plug the holes

- Basel I was just beliefs,
- Basel II included the three pillars, LGD, EAD, and all the complex calculations.
- Basel III is about changing the behaviour of banks so that they behave in a way that was reasonable for the world
  - ➢ In particular, the changes are about how the capital was held and the multiplier in from of what required on Basel II
  - ➢ First of all, it changes core capital requirement to 57% from 25% in Basel II, and 75% in Tier 1 as opposed to 50% in Tier I
    - ✧ European Union require 100% Tier 1, 75% core
  - ➢ Capital conservation buffer: extra capital on top of Basel II capital
    - ✧ Keep another 32% of Minimum Capital Requirements as core Tier 1 capital which translate to an extra 2.5% (raise the minimum capital requirement to 10.5% from 8%)
    - ✧ To absorb losses in times of financial stress. As it gets used up less dividends allowed
  - ➢ Countercyclical capital buffer: it is the lever that regulator has, to measure whether the economy is good or bad
    - ✧ When the economy is good, capital requirements go up, it can go all the way to extra 2.5% (13%)
    - ✧ When the economy is bad, the regulator can start losing the lever to allow the banks to give more loans
    - ✧ It also means that when the economy is good, it can lose up to 10% of available loans in the

economy
- ✧ It aims to make bank give loans in a relatively stable rate, whether the economy is good or bad
- ➤ Globally systemically important banks add on up to 3.5% in extra requirements (16.5% - absolute maximum capital requirement)

- Depends on which Basel the country follows, the average capital requirement can be different

Major Changes in Basel III over II

- Better capital quality
- Capital conservation buffer
- Countercyclical buffer
- Leverage ratio: a leverage ratio is the amount of capital to total asset (not risk-weighted)
- Liquidity ratio
    - ➤ In every office, you should have enough liquidity to respond
    - ➤ Across all offices, there should be a certain amount of cash circulating
    - ➤ In a month, banks should have provision to cover at least 30 days of a significant stress period.
    - ➤ This provision should be composed of "unencumbered high quality assets", defined as 60% Tier 1 as a minimum
    - ➤ To response to high demand of currency
    - ➤ Net stale funding ratio

- Comparison

Requirements	Under Basel II	Under Basel III
Minimum Ratio of Total Capital To RWAs	8%	10.50%
Minimum Ratio of Common Equity to RWAs	2%	4.50% to 7.00%
Tier I capital to RWAs	4%	6.00%
Core Tier I capital to RWAs	2%	5.00%
Capital Conservation Buffers to RWAs	None	2.50%
Leverage Ratio	None	3.00%
Countercyclical Buffer	None	0% to 2.50%
Minimum Liquidity Coverage Ratio	None	100% of 30 days
Minimum Net Stable Funding Ratio	None	TBD (2018)
Systemically important Financial Institutions Charge	None	2.5%

Basel IV

- For globally/regionally systemically important banks, the extra capital requirements range from 1.5% - 4%; an extra 0.5% increase compared to Basel III
  - ➢ European banks need more capital. They need an extra 0.5% capital conservation buffer (11% minimum)
- Set constraints on the use of IRB models
  - ➢ It sets a floor of 72.5% when compared to standard model.
  - ➢ The difference between standard and IRB is huge before. A standard bank can bring the capital down from 100 to 60 by implementing IRB
    - ✧ Have incentives to spend money implementing complex models
- Removal of IRB approach for Low Default Portfolios
  - ➢ Low Default Portfolios: portfolio with default less than 20%
- More detailed disclosure of reserves

Estimation of PD in Basel Accord

- What happens in the crisis for non-financial parties such as people who took mortgage.
  - ➢ You took a $1 million mortgage to pay for the $1 million house, you paid $150,000 and still owes $850,000 to the bank

- ➢ The crisis came, and the value of the house went down to $500,000.
- ➢ You need to renew your mortgage, but the bank cannot lend you more than 90% of the value of the asset
- ➢ So you need to come up with $400,000 by yourself
- ➢ Made the crisis even worse
- It is shown that even though governments were injecting money into companies (not people), there was still a lot of suffering
  - ➢ So governments started to inject money to people and give relatively little money to companies

- A default is considered to have occurred with regard to a particular obligor when either or both of the two following events have taken place
  - ➢ The bank considers that the obligor is unlikely to pay its credit obligations to the banking group in full without recourse by the bank to actions such as realising security
  - ➢ The obligor is past due more than 90 days on any material credit obligation to the banking group
    - ✧ After 90 days, the chance of you coming back and paying back is marginal
    - ✧ Only 20-25% people can really recover and come back
    - ✧ If come back, then you go to a special portfolio called the deteriorated portfolio
      - ▫ It contains loans that are defaulted and cured or inactive default but not written off
      - ▫ They require special provisions (150%)
  - ➢ Overdrafts will be considered as being past due once the customer has breached an advised limit or been advised of a limit smaller than current outstanding

- Basel has put a floor of 0.03% on PD

Definition of PD

- PD is the long-run average of 1 year realized default rates for that facility for borrowers in that grade
  - ➢ Calculated at a one year horizon
  - ➢ People with similar risk are grouped into one grade

- Retail credit risk
  - ➢ The standard credit score for 90 days overdue is the "bad" definition
  - ➢ The calculation is point in time
  - ➢ Regulator may or may not have changed definition to 180 days overdue
    - ✧ If changed, then we have to redo the whole thing over again

- Corporate credit risk
  - ➢ The ratings agencies claim to be measured the long run risk but in reality that is not the case

Measuring PD in corporate/sovereign lending

- If you are incorporated, you will use some model that comes from the rating agencies
  - ➢ Each one of the agencies use different models with different assumptions
  - ➢ S&P and Fitch gives PD
  - ➢ Moody's gives expected loss

- Problem with rating companies
  - ➢ Rating agencies only rate large companies, so banks need own models for unrated borrowers
    - ✧ The agencies say that for smaller companies, they could use the ratings they made for large companies in the same line of business.

- For retail risks
  - ➢ Models construct ratings functions which give each loan a rating (can be translated into PD) using historical results
  - ➢ Rating functions obtained
    - ✧ Subjectively or rule based
    - ✧ Scorecard based (logistic regression, discriminant analysis)
    - ✧ Based on commercial corporate credit risk models
      - ▫ Credit Metric/Credit Risk plus etc.
    - ✧ Internally developed methods
    - ✧ Benchmarking; using observable measures – bond spreads to compare unrated company with rated company

- Key takeaways
  - ➢ Corporate PD and retail PD are completely different and calculated differently
  - ➢ A scorecard and a PD are not the same
    - ✧ A credit score is something that measures your risk today
    - ✧ The PD is going the measure the risk of you and everyone else similar to you over the long term
    - ✧ Score: retail, short-term
    - ✧ PD: either retail or corporate, long-run