Latent Factor Intensity Model

Credit Risk Modelling

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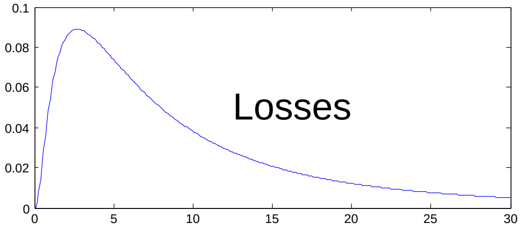
Credit Risk Management

- Oldest risk type
- Deterioration of clients credit quality
- Charachterised (amongst other) by Probability of Default
- Probability of Default: Probability a client will be due 90 days
- On a client level - easy: PD models - Probit & Logit
- Modern credit risk - manage the whole portfolio
- Portfolio credit losses are not normally distributed

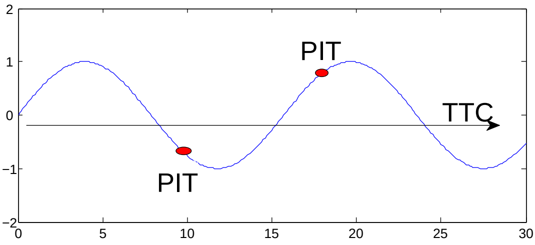


Latent Factor Intensity Model 1/1

- Portfolio view - migration matrices
- Each credit event for each company is modelled as an exponential random variable with some intensity
- Each rating class have its own intensity $\rightarrow$ we assume some degree of homogeneity for companies in the rating classes
- We look at downgrades, upgrades and defaults
- We have three sources of uncertainty: what type of rating event happens, when it happens and which company it is

Latent Factor Intensity Model 1/2

- With the data about our historical portfolio behaviour, we try to pick up common tendencies and movements in credit events
- Period of downgrades and periods of upgrades
- This is assumed to be driven by a unobserved factor - latent factor



Implementation

- No ready made solution $\rightarrow$ Matlab :D
- Number of events defines the length of the sample
- The likelihood function contains a high dimensional (up to 1000) integral with no analytical solution
- The likelihood function needs to be calculated many times in the optimisation routine and each time we need to numerically compute the integral
- Efficient importance sampling by Richard and Liesendfeld (2003) is employed
- Initial 'lame' implementation took 17h to estimate
- Using 4-core CPU and Parallel computing toolbox the time is about 1h (UvA, NL)

Efficient Importance Sampling 1/2

- The high dimensional integral needs to be evaluated numerically - unconditional Monte Carlo integration $\rightarrow$ highly inefficient and slow
- We would like to simulate parths ‘close’ to the real unobserved process - *Contradictio in adjecto*?
- We can ‘calibrate’ the simulation density (importance sampling density - conditional on the date set) to be ‘close’ to the real one
- The EIS contains iterative procedure to get close to the real density using extremely fast least square minimization
- The trick is that the log’s of elliptical densities (for example normal density) are linear in its coefficients - the difference between the ‘real’ and the ‘approximating’ loglikelihood is minimized

Efficient Importance Sampling 2/2

- The video shows the iteration steps with the model parameters known
- The initial paths are almost unconditional and you can see how the 'guesses' are all over the plot
- EIS converges in a few steps (cca 14) very close to the real unobserved factor

Application - Macroeconomic Factors

- So we have the model - we estimated the parameters
- We know the latent factor and we can try to find its relation to macroeconomic factors - GDP growth, CPI, interest rates etc.
- We can include these directly in the model or we can extract the latent factor and find the relationships ourselves - Vector autoregression (VAR) models
- Knowing the relation with the macroeconomy, we can perform specific stress tests - e.g. what would be the loss if the unemployment rose by 3%
- We can also perform general stress tests - simulate the macroeconomy and see the losses

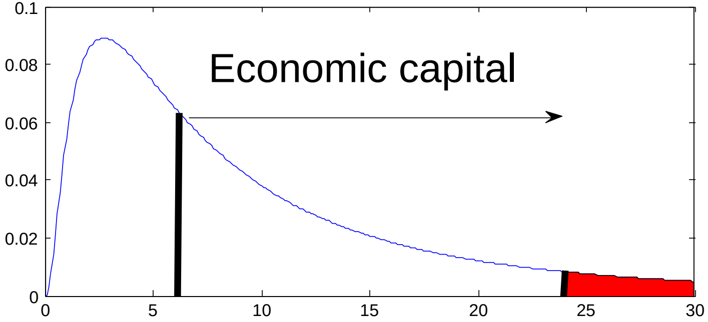
Application - Long- & Short-term Ratings

- Due to the fashion the model is built - on the credit events / migrations - the natural outcome is a migration matrix
- Point-in-time PD - actual probability of default assessed using all information including the state of economy (boom or bust) about a client
- Through-the-cycle Ratings - rating of a client 'averaged' over the whole economic/credit cycle
- Hard to determine with ordinary credit rating models
- Quite easy with our LFIM - for TTC take the 'average' latent factor and voila we have the TTC migration matrix
- For PIT take the actual/forecasted value of the latent factor and generate the migration matrix for a desired time horizon - 1y: quite common practice, multiyear: IFRS 9

Application - Economic Capital 1/2

- We have the model and its links to the economy
- We can simulate all possible states and assess losses in each state
- Than we order them by severity
- The difference between the mean loss and some given percentile is the Economic capital
- $\rightarrow$ some sort of reserve a bank holds against these losses

Application - Economic Capital 2/2



The end

Thank you!

Time for some questions

References

Efficient importance sampling

- Liesenfeld, R., Richard, J.F., 2003, *Univariate and multivariate volatility models: estimation and diagnostics*, Journal of Empirical Finance 10, 505-531.

Latent factor intensity model

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- Koopman, S. J., Kraussl, R., Lucas, A., 2009, *Credit cycles and macro fundamentals*, Journal of Empirical Finance 16 (2009) 42–54