An Empirical Comparison of Default Risk Forecasts from Alternative Credit Rating Philosophies

Daniel Rösch

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

2nd International Conference on Credit Risk

April 14-16, 2004

Montreal

Agenda

- The Problem
- Through-the-Cycle vs. Point-in-Time Forecasts
- Backtesting
- Implications and Discussion

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

The Problem

Regarding Ratings

- What is a Credit Rating?
- How to “link” Ratings and (forecasts for) Probabilities of Default?
- Which kind of PD forecasts to take for regulatory capital?
- Potential consequences w.r.t.
  - accurateness of risk capital
  - procyclicality

The paper seeks to

- analyse and compare TTC and PIT Rating Philosophies w.r.t. their implied forecasts of PDs
- show an application of how to “backtest” these forecasts
- discuss consequences for banks

TTC vs. PIT Forecasts

- Starting point: Standard & Poors Default Data from 1982 up to 2000-> **“Through-the-Cycle Rating”**
- Estimate their implied PD and asset correlation by the latent random effects probit model (see e.g. Gordy/Heitfield, 2000, Hamerle/Liebig/Rösch, 2002):

$$R_{it} = b\,F_t + \sqrt{1-b^2}\,U_{it}$$

$$\lambda(f_t) = P(R_{it} < \beta_0 \mid f_t) = P\left(U_{it} < \frac{\beta_0 - b\,f_t}{\sqrt{1-b^2}}\right) = \Phi\left(\frac{\beta_0 - b\,f_t}{\sqrt{1-b^2}}\right)$$

p-values in parentheses

Grade	b	β_0
BB	0.229 (0.003)	-2.290 (<0.001)
B	0.210 (<0.001)	-1.628 (<0.001)
CCC	0.256 (0.004)	-0.809 (<0.001)

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

TTC vs. PIT Forecasts

- **(Mimicking) Point-in-Time-Rating:** “Add” current information to the rating (e.g. macroeconomic condition, “z”-factors)
- Estimate implied PD and asset correlation by the extended latent random effects probit model (see Hamerle/Liebig/Rösch, 2002, Hamerle/Liebig/Rösch, 2003):

$$\lambda(z_t, f_t) = P\left(U_{it} < \frac{\beta_0 + \boldsymbol{\beta}' z_t - b\ f_t}{\sqrt{1-b^2}} \right) = \Phi\left(\frac{\beta_0 + \boldsymbol{\beta}' z_t - b\ f_t}{\sqrt{1-b^2}} \right)$$

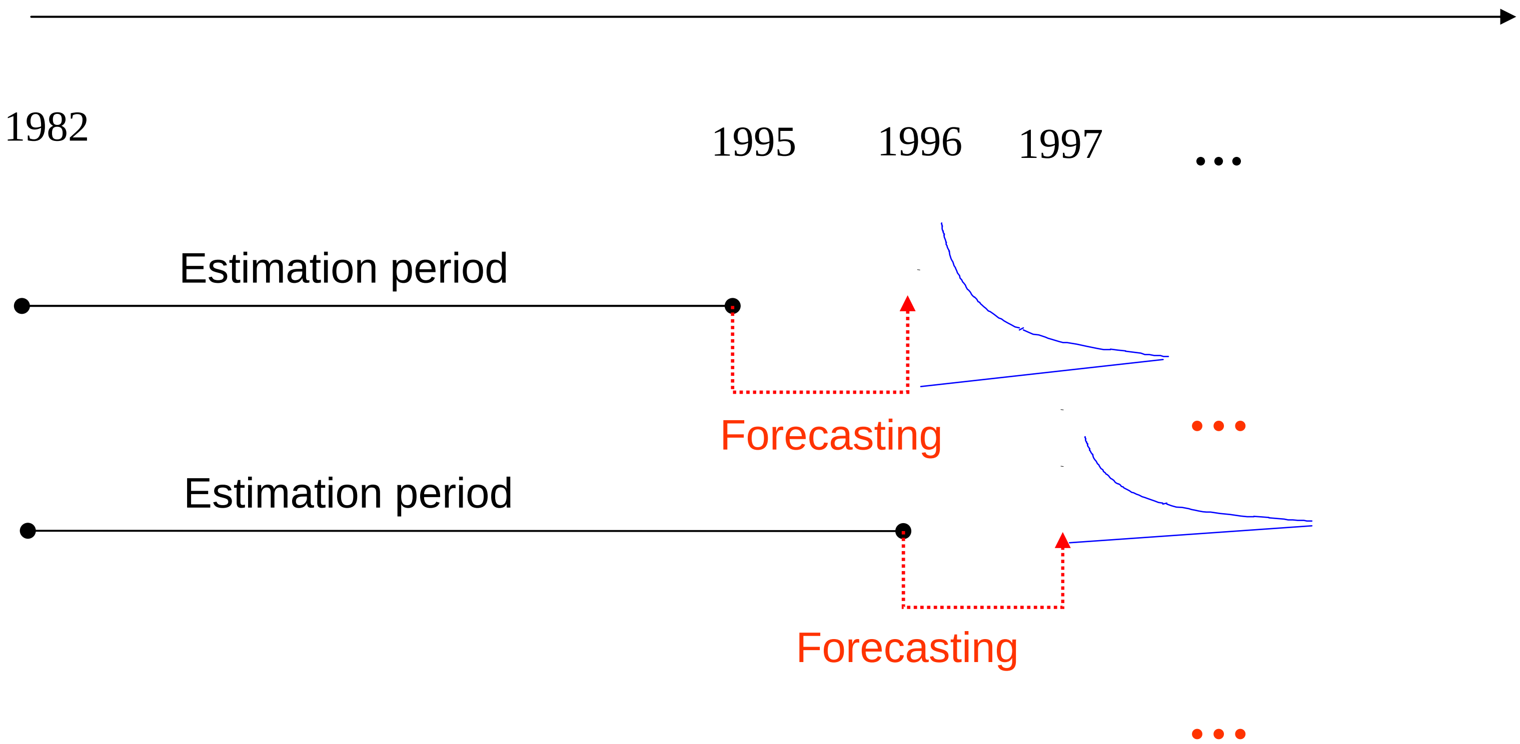
p-values in parentheses

Grade	*b*	β_0	β_1	β_2	β_3	B_4
BB	0.085 (0.333)	-2.791 (<0.001)	0.676 (<0.001) FEDR_1			
B	0.093 (0.010)	-2.104 (<0.001)	3.137 (0.034) DR_B_1	1.453 (<0.001) DSER_2	-0.387 (0.009) DIND_1	7.449 (0.022) RAT4chg_1
CCC	0.048 (0.815)	0.294 (0.264)	-1.798 (<0.001) UNEM_1			

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

TTC vs. PIT Forecasts

- Set LGD=100% and EAD=1 in order to eliminate these effects
- Conduct rolling out-of-time forecasting of the loss distributions using each rating philosophy:



Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

Backtesting

- Altogether we obtain 5 years of out-of-time loss distribution forecasts for each rating and subsequent default realizations
- With these sets the “Berkowitz” backtest is conducted (see Berkowitz, JBES, 2001, Frerichs/Löffler, JoR, 2003):

$$\hat{g}\left(d_{T+1}\right)=\begin{cases}\binom{N_{T+1}}{d_{T+1}}\cdot\int\limits_{-\infty}^{+\infty}\left[\hat{\lambda}\left(f_{T+1}\right)^{d_{T+1}}\cdot\left[1-\hat{\lambda}\left(f_{T+1}\right)\right]^{\left(N_{T+1}-d_{T+1}\right)}\right]\varphi\left(f_{T+1}\right)df_{T+1} & d_{T+1}=0,1,2,\ldots,N_{T+1}\\ 0 & \text{otherwise}\end{cases}$$

$$x_{T+1}=\int\limits_{-\infty}^{q_{T+1}}\hat{g}\left(u\right)du$$ is i.i.d. uniform if the forecasted density is correct

Backtesting

$$z_{T+1} = \Phi^{-1}(x_{T+1}) = \Phi^{-1}\left(\int_{-\infty}^{q_{T+1}} \hat{g}(u)\,du \right)$$ is i.i.d. standard normal if the forecasted density is correct

The Likelihood-Ratio is

$$LR = -2 \cdot \left(L(0,1) - L(\hat{\mu},\hat{\sigma}) \right) =$$

$$= -2 \cdot \left(\left(-\frac{L}{2}\log 2\pi - \sum_{l=1}^{L} \frac{z_{T+l}^2}{2} \right) - \left(-\frac{L}{2}\log 2\pi - \frac{L}{2}\log \hat{\sigma}^2 - \sum_{l=1}^{L} \frac{(z_{T+l} - \hat{\mu})^2}{2\hat{\sigma}^2} \right) \right)$$

$$\hat{\mu} = \frac{1}{L}\sum_{l=1}^{L} z_{T+l} \qquad \hat{\sigma}^2 = \frac{1}{L}\sum_{l=1}^{L} (z_{T+l} - \hat{\mu})^2$$

which is asymptotically Chi-squared (2) distributed if the forecasted distributions are correct

Backtesting

Testresults

Grade	LR „Naive“	LR Through the Cycle	LR Point in Time
BB	5.94 (0.05)	5.48 (0.06)	1.29 (0.52)
B	6.42 (0.04)	3.24 (0.20)	0.30 (0.86)
CCC	2.30 (0.32)	0.29 (0.87)	4.22 (0.12)

p-values in parentheses

- Power of the test is checked via Monte-Carlo simulations

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

Implications and Discussion

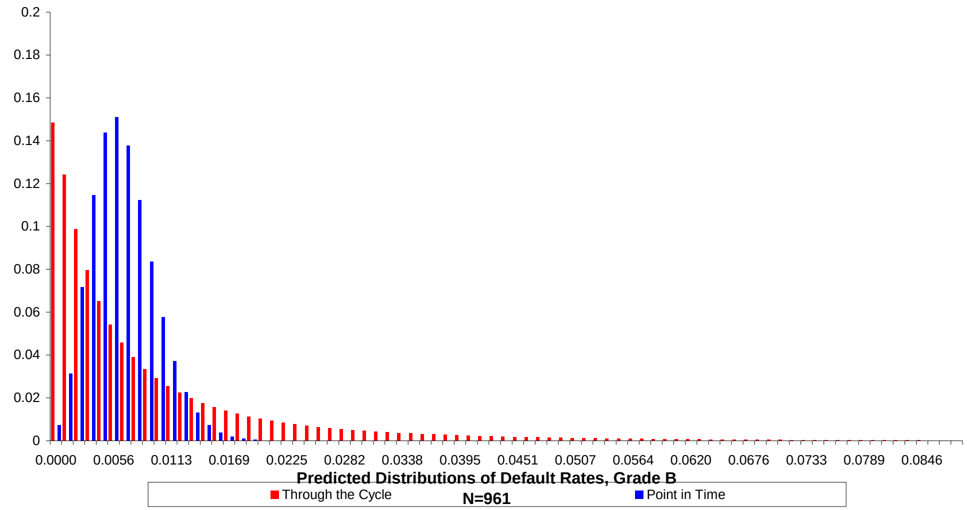
The Rating Puzzle

- Rating, PD, **and correlation** are strongly interweaved
- Through the Cycle rating states similar “risk” over a **multi-year** horizon for borrowers within the same grade (e.g. BB)
- These borrowers may well exhibit very different **one-year** probabilities of default (in the cross-section and over time)
- Hence, one-year default rates of a grade over time are generated by **different default probabilities** and thus are noisy
- Consequently, if historical default rates from TTC are used as forecasts, their noise should be taken into account (by higher correlation)
- PIT PD forecasts are less noisy -> lower correlation!

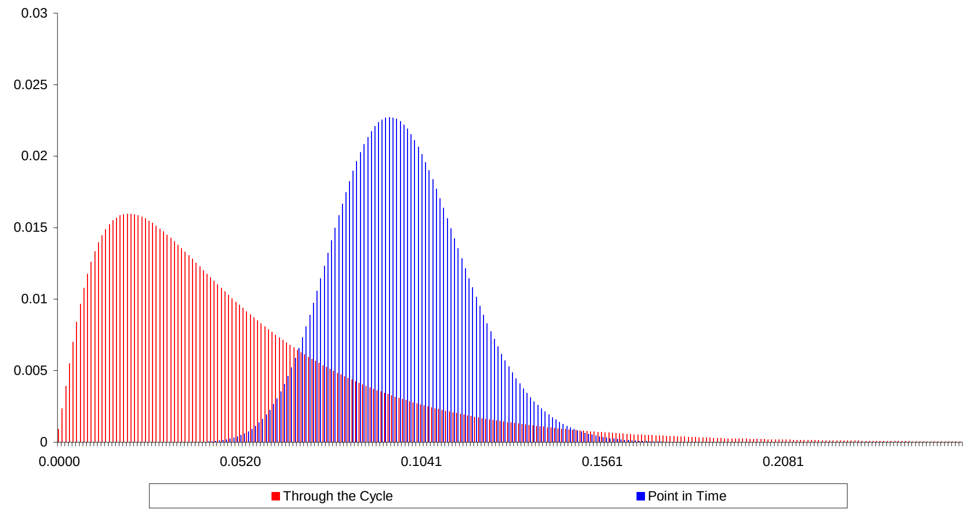
Implications and Discussion

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany

Predicted Distributions of Default Rates, Grade BB
N=887



Predicted Distributions of Default Rates, Grade B
N=961



Implications for Banks and Regulators

- PD forecasts from TTC Ratings are relatively stable over time
- But they are noisy forecasts for true one-year PDs and thus rather unreliable regarding true economic risk!
- TTC Rating PD forecasts may be compatible with (high) asset correlations in the Basel Accord
- PIT PD forecasts fluctuate over the cycle
- But they are more precise estimates for one-year PDs and imply lower asset correlations!
- Procyclicality due to PIT is coherent with economic risk
- If Procyclicality is unwanted: Regulatory guidelines could take this into account: Change the outputs (capital charge rules) instead of the inputs (PD forecasts)

Department of Statistics, Faculty of Business & Economics
University of Regensburg, Germany