Università della Svizzera italiana

Lugano, 20 gennaio 2005

Default probabilities and business cycle regimes:

a forward-looking approach

Chiara Pederzoli

Università di Modena e Reggio Emilia

Motivation:

- Importance of business cycle effects on risk measurement
- Risk-sensitivity / Procyclicality trade-off in Basel II

Plan of the presentation:

1) Basel II and the procyclicality issue
2) Possible ways to deal with procyclicality
3) Model in Pederzoli and Torricelli (2005)
4) Publicly available Italian default data

Time dimension of credit risk

Dependence on the general economic conditions through systematic risk factors:

Evidence of correlation between credit risk factors and macro-economic conditions: e.g. Wilson (1997), Nickell et al. (2000), Carey (2002), Bangia et al. (2002), Altman et al. (2002)

In particular:

Bangia et al. (2002): recession and expansion regimes in transition matrices

Procyclicality

Amplification of the business cycle due to the **risk-sensitivity** of capital requirements

→ reduction in the capital ratio during recession and viceversa, i.e. reduction in lending when the economy is in a downturn

$$\frac{RC}{\sum_i w_i A_i} \geq 8\%$$

Jackson et al. (1999) → procyclicality in Basel I

Many concerns about procyclicality in Basel II, e.g. Danielsson et al. (2001), Borio et al. (2001), Lowe and Segoviano (2002), Kashyap and Stein (2004), Gordy (2004), ...

Business cycle and credit risk models:

Where?

A) Rating Systems:

- Rating Assignment
- Rating Quantification (Probability of Default)

B) Loss Given Default

C) Exposure at Default

D) Correlations

Review: Allen and Saunders (2003)

Focusing on (A):

Rating Assignment:

- Point in time
- Through the cycle

Rating Quantification:

- Unconditional PDs
- Time-varying / business cycle dependent PDs

Rating systems in current practice

- Rating Agencies: through the cycle ratings logic (pessimistic scenario)
- Banks: typically point in time logic (based on accounting or market data)

Basel II requires:

- through the cycle ratings;
- PDs estimated as long-run averages;

→ neutralization of the business cycle effects

→ time dimension of risk neglected

Three ways to deal with procyclicality in IRB

1. Smoothing inputs to the capital function

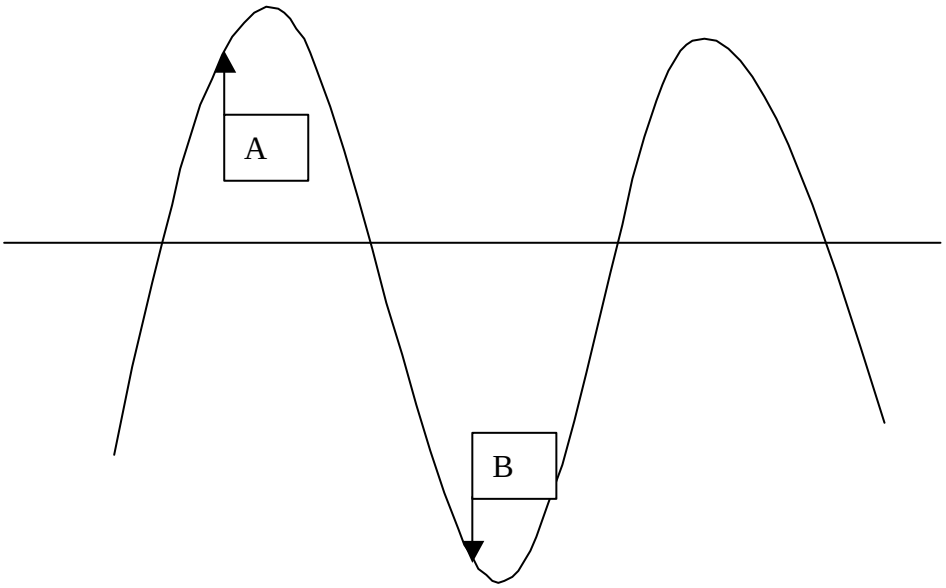
2. Flattening the capital function itself

3. Smoothing the output of the capital function

Including the time dimension of risk → economic conditions over the credit horizon (typically one-year)

Two views of the business cycle:

1) business cycle too irregular to be predicted → current conditions as the best forecast for future conditions
2) business cycle –at least partly- predictable → appropriate forecast over the credit horizon



The model proposed in Pederzoli and Torricelli (2005) aims at:

- including business cycle effects;
- smoothing procyclicality by introducing economic forecasts in the PDs estimation.

→ *ttc* ratings + time-varying forward-looking PDs

PDs estimation based on:

1. Conditional expansion and recession PDs for each rating class;
2. Recession probability forecasts.

Models for business cycle dependent PDs estimation

- Specific macroeconomic variables (e.g. GDP), continuous values
  → CreditPortfolioView
- Business cycle as discrete variable, typically two values (expansion and recession)
  → Bangia et al. (2002)

Why a discrete binomial model?

- Evidence of good representativeness (e.g. Bangia et al. (2002))
- Econometric models for prediction of the buisness cycle states more accurate and stable (e.g. Estrella et al. (2003))
- From a regulatory point of view less variability in the binary representation

The proposed model

A.1 One-period model: period length equal to the credit horizon *k*, $k \in N$.

A.2 Business cycle state over [t, t+k] binomial variable:

$$S_{t+k} = \begin{cases} E & P(E) \\ R & P(R) \end{cases}$$

S_{t+k} = business cycle state over [t,t+k];

E = expansion state;

R = recession state;

P(E) = probability of an expansion over one period;

P(R)=1-P(E) = probability of a recession over one period.

A.3 *P(R)* conditioned on the information available in t, I_t

$$P_t(S_{t+k} = R) = P(S_{t+k} = R \mid I_t) = f(b' x_t)$$

x_t = vector of explanatory variables for the business cycle regime, $x_t \in R^n$;

b = vector of coefficients.

A.4 Default rate for each rating class stochastic variable with state-dependent distribution:

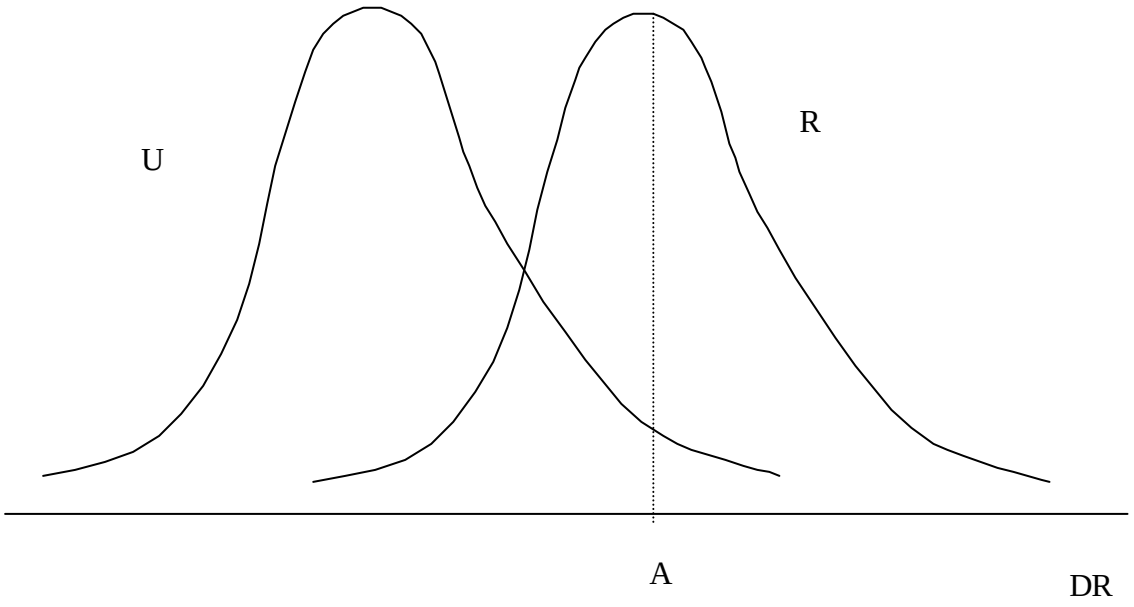
$$f(DR_{t+k} \mid S) = \begin{cases} f_E(DR_{t+k}) & if\ S = E \\ f_R(DR_{t+k}) & if\ S = R \end{cases}$$

DR_{t+k} = default rate over [t, t+k];

f_E = probability distribution of the default rate conditional on the state of expansion;

f_R = probability distribution of the default rate conditional on the state of recession.

Conditional and unconditional default rate distribution



→ ex-ante mixture distribution:

$$f_t(DR_{t+k}) = P_t(S_{t+k} = E) \times f_E(DR_{t+k}) + P_t(S_{t+k} = R) \times f_R(DR_{t+k})$$

By defining the conditional default probabilities as:

$$PD_E = E(DR \mid E) \qquad PD_R = E(DR \mid R)$$

the ex-ante (unconditional) default probability on [t, t+k] is:

$$PD_t = E_t(DR_{t+k}) = \int DR_{t+k} f_t(DR_{t+k}) dDR_{t+k}$$
$$= P_t(S_{t+k} = E) \times PD_E + P_t(S_{t+k} = R) \times PD_R$$

→ analogous to Basel II if *P(E)*, *P(R)* long-run sample proportion

→ but *P(E)*, *P(R)* forward-looking over the credit horizon

Time inconsistency:

Basel II (and credit risk models in general): k = one year

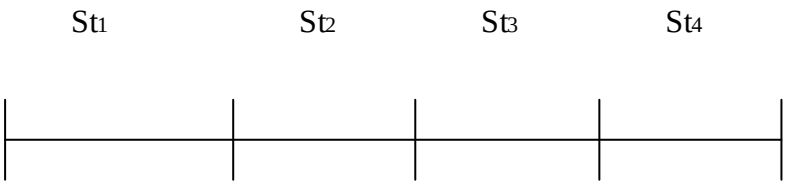
Business cycle chronology → months/quarters

By dividing [t,t+k] in n sub-periods of lenght k/n:

$$S_{t_i} = \begin{cases} E \quad if \quad [t_{i-1}, t_i] \quad \text{exp}ansion \\ R \quad if \quad [t_{i-1}, t_i] \quad recession \end{cases} \qquad i = 1,...,n$$

$$t_i = t + i \times \frac{k}{n} \qquad i=0,...,n$$

k = 12 months; n = 4.



→ Forecast over each quarters

→ Alternatively, proxy consistent with procyclicality target:

forecast of S_{t4}

Application to Italian data

United States:

(application in Pederzoli and Torricelli (2005))

- Transition and default data from Standard&Poor's (Bangia et al. (2002))
- NBER business cycle chronology

Italy:

- Quarterly default data from Bank of Italy (1990 Q1-2002 Q4)
- ISAE/ECRI business cycle chronology

Default data from Bank of Italy

(*Base Informativa Pubblica*):

Quarterly default rates

Default rates calculation:

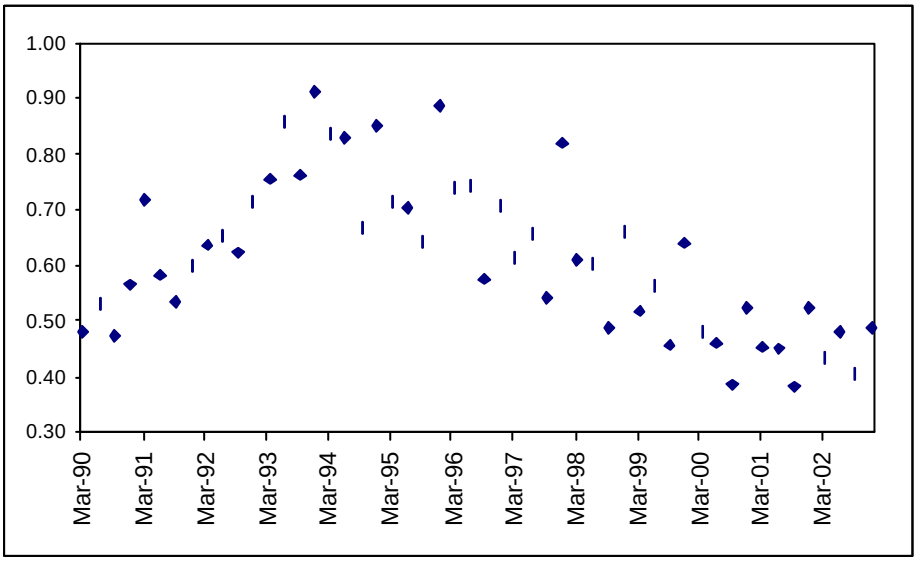
default rate $DR_{t,t+k}$ for the period [t,t+k]:

$$DR_{t,t+k} = \frac{D_{t,t+k}}{PL_t}$$

$D_{t,t+k}$ = defaults flow over the period [t,t+k]

PL_t = stock of performing loans at time t

Quarterly percentage default rates historical series



Expansion and Recession regimes in the default rates

Business Cycle chronology:

- ISAE (*Istituto di Studi e Analisi Economica*)
- ECRI (*Economic Cycle Research Institute*)

ISAE chronology

Peaks	Troughs
Oct-70	*Oct-71*
Mar-74	*May-75*
Feb-77	*Dec-77*
Mar-80	*Mar-83*
Mar-92	*Jul-93*
Nov-95	*Nov-96*
Dec-00	

	Full sample	Expansion	Recession
# periods	44	35	9
mean DR	0.00643	0.00622	0.00727
std DR	0.00129	0.00127	0.00096

neglecting 2001, 2002 (likely structural break)

Proxy for ratings

→ borrower's geographic area (South, Centre, North)

→ borrower's dimension (Small Business, Large/Medium Corporates)

Proxy:

- global loan size < 500.000 euro → Small business
- global loan size > 500.000 euro → Medium/Large corporates

Conditional PD estimates by 'rating class'

	Recession	Expansion
South Small	0.01212	0.01043
South Medium-Large	0.01842	0.01551
Centre Small	0.00763	0.00705
Centre Medium-Large	0.01174	0.01069
North Small	0.00480	0.00409
North Medium-Large	0.00702	0.00546

Recession Probability Forecast

Probit Model:

$$P_t(R_{t+k} = 1) = \Phi(b' X_t)$$

$$R_t = \begin{cases} 1 & recession in\ quarter\ t \\ 0 & \exp ansion in\ quarter\ t \end{cases}$$

$$X_t = \exp lanatory\ \text{var}\ iables$$

$\rightarrow$ Domestic and international financial variables (Artis et al. (2004))

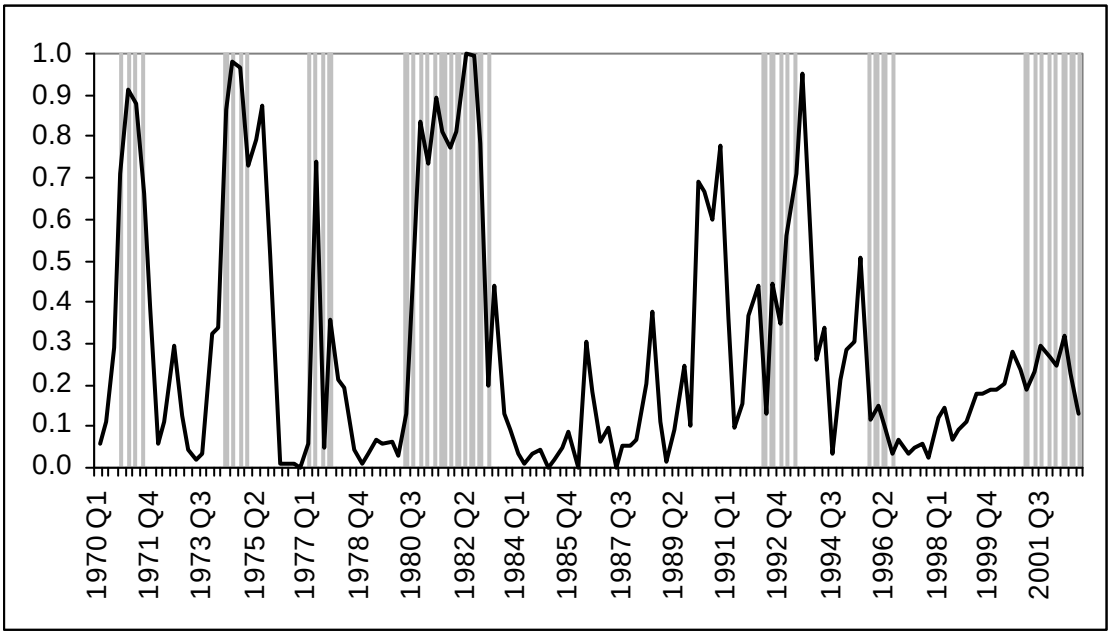
- Short and long interest rates from Italy, Germany
- Term Spread from Italy, Germany, US
- Equity Indices return from Italy, Germany, US

Sample: 1970 Q1 – 2002 Q4

Selection based on SIC criterion:

→ German term spread

→ Italian long term interest rate

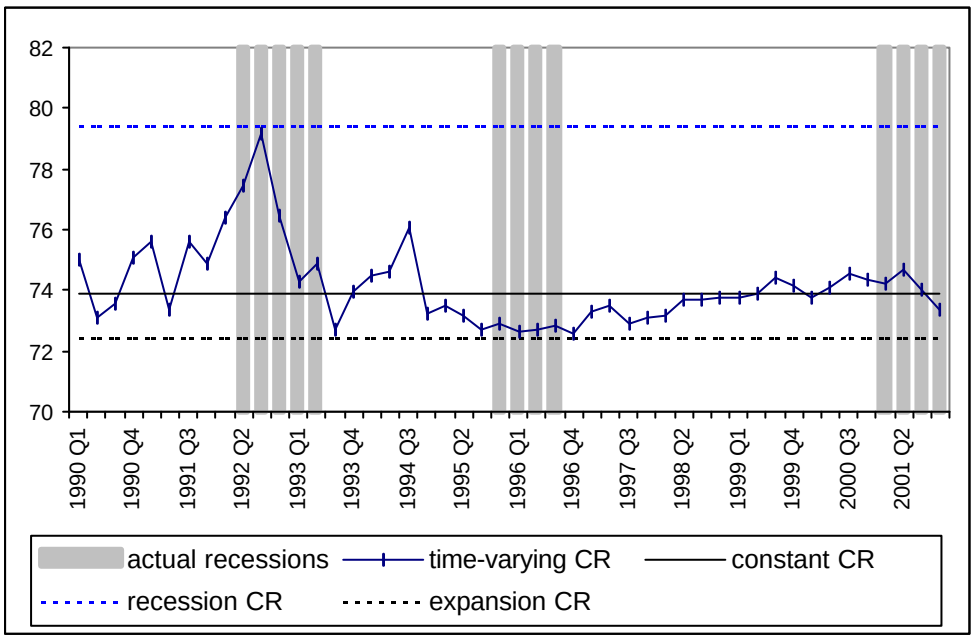


Capital Requirements

Foundation IRB Approach

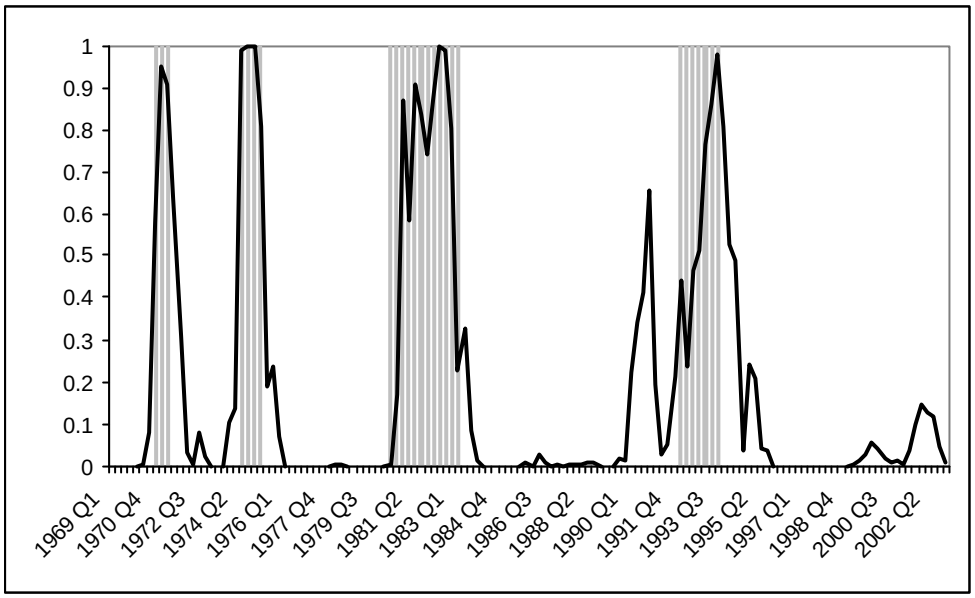
LGD = 45%, M= 2,5, EAD=100

Capital Requirements (CR)

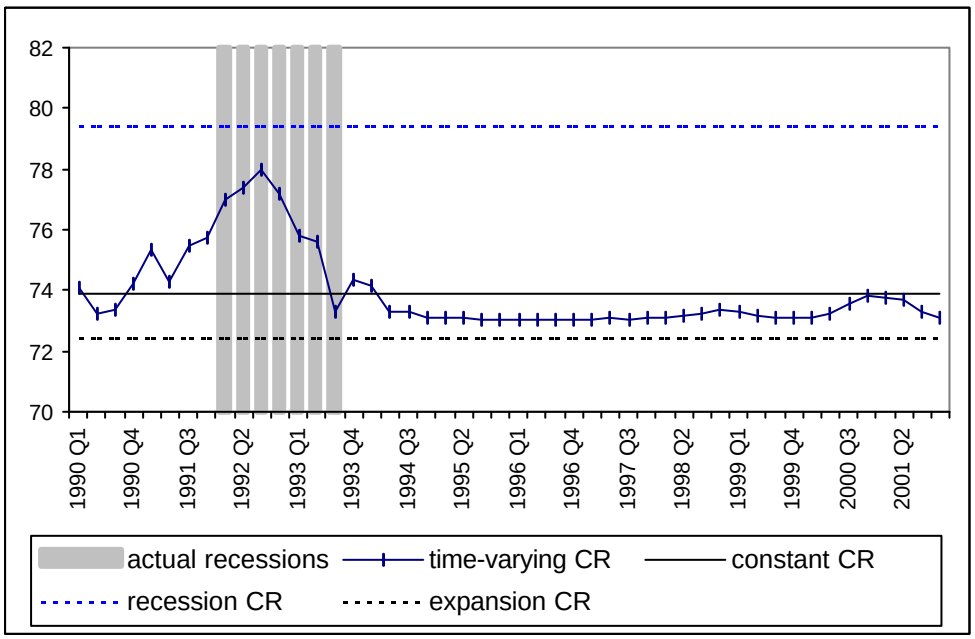


→ ISAE or ECRI?

Recession probability forecast – ECRI chronology



Basel II Capital Requirements (CR)



Open points

1. Which chronology does better represent italian default rates dynamics?
2. European business cycle? Relationship with default rates.