Forward-looking estimation of default probabilities with Italian data

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Abstract

The solution adopted in Basel II to deal with procyclicality of capital requirements implies a reduction in risk-sensitivity that contradicts the original spirit of the document. To preserve risk-sensitivity and to dampen procyclicality at the same time, Pederzoli and Torricelli (2005) set up a model based on a business cycle forecast in the estimation of the default probability and provide an application for the US. This paper checks the robustness of the approach with Italian data, where alternative business cycles chronologies are used and ratings have to be approximated. Findings suggest that the model performance depends on the chronology used.

Keywords: Basel II, business cycle, capital requirement, default probability, procyclicality

JEL: G21, G28, E32

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1. Introduction

The new banks' capital adequacy framework known as Basel II (BCBS, 2004) has - among other things - made capital requirements (for credit risk) more risk-sensitive thus raising concerns about possible fluctuations in the capital requirements over the business cycle due to their risk-sensitivity (procyclicality). Provided that credit risk components are correlated with macroeconomic conditions[1], capital requirements will tend to be high in recessions and low in expansions, possibly exacerbating the business cycle through the credit supply.

In order to avoid this undesirable side-effect, Basel II implicitly requires to assign ratings in a "through the cycle logic" (see BCBS (2004), par 415) and to estimate default probabilities (PDs) as long-run averages. This solution is somewhat in contrast with the purpose of making the capital requirements risk-sensitive in that the time dimension of risk is neglected and can be also criticized because it causes a loss of transparency (see Gordy and Howells, 2004).

The procyclicality issue is enhanced when credit risk measures reflect the current economic conditions, while capital requirements should in principle reflect the economic conditions prevailing over the credit horizon considered. Among others (see Gordy and Howells(2004) for a survey), a way to tackle procyclicality is to exploit economic forecasting as in Pederzoli and Torricelli (2005). Specifically, the basic idea underlying the article is to use a risk measure which increases in anticipation of a recession over the credit horizon and vice versa decreases in anticipation of an expansion. Such a measure in fact determines a reduction in the risky exposures before the recession and an increase in lending at the bottom of the cycle. This implies a smoothing effect on the business cycle turning points. The model is applied to US data, which particularly lend themselves to an application since default data by rating class are available and the business cycle chronology by NBER is widely accepted. The results over the entire period are encouraging since the capital requirement generally increases/decreases in anticipation of recessions/expansions.

The aim of the present paper is to apply the model to the Italian case by exploiting some useful default data provided by the Bank of Italy. However, their use requires some preliminary work with

respect to the US case. First, no distinction by rating is available and hence an approximation for a rating system has to be provided. Second, due to the lack of agreement in the literature, alternative business cycle chronologies are considered and compared, namely the one by ISAE (Istituto di Studi e Analisi Economica) and the one by ECRI (Economic Cycle Research Institute).

The present paper is organised as follows. In the next Section the model proposed in Pederzoli and Torricelli (2005) is briefly recalled. Section 3 illustrates the issues connected with the dataset, its use within the model for capital requirements and the results of the implementation with Italian data. The last Section provides conclusions.

2. The model

Capital requirements which anticipate the business cycle can dampen procyclicality compared to capital requirements reflecting the current economic conditions. Based on this premise, the purpose of the model proposed in Pederzoli and Torricelli (2005) consists in including a business cycle forecast in the credit risk measure defining the capital requirement. This approach is also consistent with the view expressed e.g. in Borio et al. (2001): risk is highest in the boom, particularly if financial imbalances occur and high default rates observed during a recession are just a materialization of the risk built up during the previous expansion. The model is based on a binary representation of the business cycle (expansion and recession) and on the relation between PDs and the business cycle phases. Based on the empirical evidence (e.g. Bangia et al. (2002)) of expansion and recession regimes in the default rates by rating class, an expansion and a recession conditional distribution are considered. Specifically, the distribution of the default rate is a mixture of the two conditional distributions, weighted by the probability of the business cycle states over the credit horizon. While we refer to Pederzoli and Torricelli (2005) for a detailed description of the model, in the following we recall its basic framework.

The distribution of the default rate is represented as follows:

$$f_t(DR_{t+k}) = P_t(S_{t+k} = E) \times f_E(DR_{t+k}) + P_t(S_{t+k} = R) \times f_R(DR_{t+k}) \quad (1)$$

where: *[t,t+k]* = credit horizon*;* DR_{t+k} = default rate over *[t, t+k]*; S_{t+k} = state over *[t,t+k]*;

$f_{E/R}(DR_{t+k})$ = probability distribution of the default rate over the period *[t, t+k]* conditional on the state of expansion (E)/recession(R);

$P_t(S_{t+k} = R) = P(S_{t+k} = R \mid I_t)$ = probability of a recession over *[t,t+k]* based on the information in *t*; $P_t(S_{t+k} = E) = P(S_{t+k} = E \mid I_t) = 1 - P_t(S_{t+k} = R)$ = probability of expansion over *[t,t+k]* based on the information in *t* .

Hence the PD for each rating class over the horizon *[t,t+k]* is estimated as the expected default rate:

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

where: PD_E, PD_R conditional default probabilities.

The recession probability is then estimated based on a set of explanatory variables available in t:

$$P_t(S_{t+k} = R) = g(\beta' x_t) \qquad (3)$$

where: g = standard normal/logistic distribution function; x_t = vector of explanatory variables for the business cycle regime, $x_t \in R^n$; β = vector of coefficients of the explanatory variables, $\beta \in R^n$.

3. The Italian case

The implementation of the model takes place in three phases: 1. Identification of the expansion and recession regimes in the default data and estimation of conditional PDs for each rating class; 2. Business cycle forecast: estimation of the recession probability for each period of the sample considered according to eq.(3); 3. Estimation of the time-varying PDs for each rating class according to eq.(2) and calculation of the capital requirements using the Foundation IRB Basel II formula. In the following subsections the default data provided by the Bank of Italy are illustrated, focusing on the way they have been exploited in the present work. Moreover the dating and forecasting of the Italian business cycle is discussed and eventually the model is implemented to calculate the capital requirements over the period 1990-2002, as better specified below.

3.1 The default data

The Bank of Italy (Banca d'Italia, 2003a) within the so called *Base Informativa Pubblica (BIP)* [2] provides the default rates of the borrowers of the whole Italian banking system. The borrowers considered are non-financial companies and family businesses and the default rates are provided also for sub-groups.

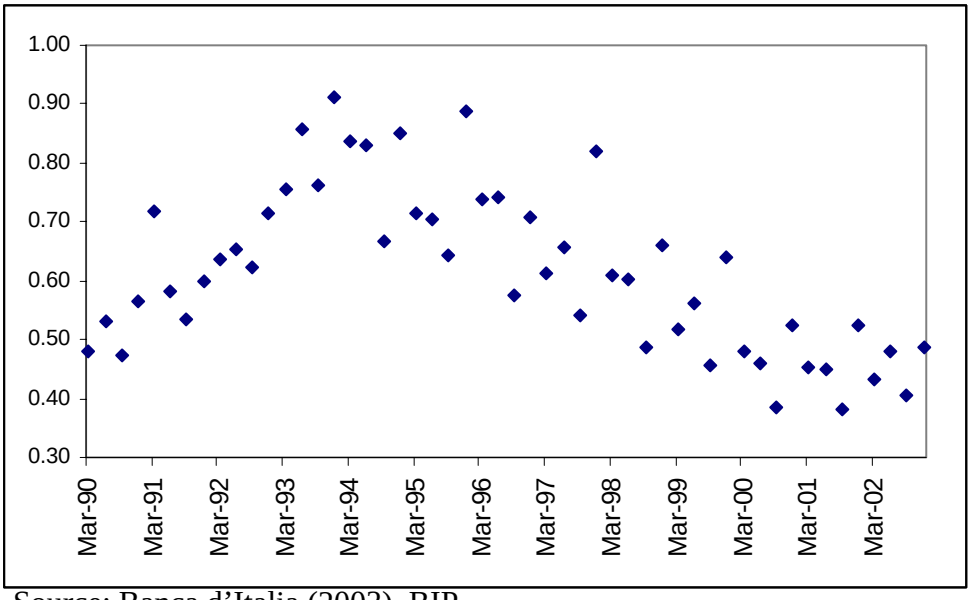
The default rate $DR_{t,t+1}$ for the period [t,t+1] is calculated as follows

$$DR_{t,t+1} = \frac{D_{t,t+1}}{PL_t} \qquad (4)$$

where: $D_{t,t+1}$ = defaults flow[3] over the period [t,t+1]; PL_t = stock of performing loans at time t.

The default rates published in 2000 are annual and they are calculated backward until 1985; from December 2002 quarterly instead of annual data are available, dating back to 1990. In this work the quarterly data are used since they are more appropriate to represent the link with the business cycle. As a consequence the period analysed goes from the first quarter of 1990 to the fourth quarter of 2002. The time series of the quarterly default rates for the whole sample is presented in Figure 1.

Fig. 1 Quarterly percentage default rates 1990 Q1 – 2002 Q4



Source: Banca d'Italia (2003), BIP

Borrowers are grouped by several criteria. As for the exposure size, represented by the global debt of each obligor towards the Italian banking system, the data set breaks borrowers in three categories defined by the thresholds of 125,000 and 500,000 euros. As for the geographic area, the categories are the following[4]: North-West; North-East; Centre; South; Islands.

Basel II requires banks to separate obligors by rating classes and to estimate a PD for each class as a long-run average of realised default rates. Since in the default data published by the Bank of Italy a distinction by rating is not available, we use an approximation which exploits the available classification. Sironi and Zazzara (2003) analyse the annual default rates and suggest using the categorisation available as a rough approximation for a rating system. The exposure size is used as a proxy for the dimension of the obligors, identifying three sectors, namely the small business, the middle market and the large corporate, which can be considered to have different risk features. In this work the first two segments are taken to represent small corporate, while the third is taken to represent the medium and large corporate[5]. As for the geographic area, the obligors are collected by North, Centre and South, whereby the North including both North-East and North-West and the South including islands in order to reduce the number of categories.

Table 1 presents the segmentation adopted as a proxy for rating classes and the relative quarterly average default rates as estimates of the unconditional PDs[6].

Table 1 Unconditional quarterly PDs for approximated rating classes

	South		Centre		North	
Total	Small	Medium-Large	Small	Medium-Large	Small	Medium-Large
0.0064	0.0108	0.0161	0.0072	0.0109	0.0042	0.0058

Source: own calculations from Banca d'Italia (2003a), BIP

As expected, default rates are higher for obligors in the South than in the North of Italy. By contrast, it is surprising to observe higher default rates for medium and large corporate firms compared to the small ones even if it may be argued that the third segment represents the medium

more than the large corporate firms, since the Italian banks' lending activity is mainly addressed to the small and medium enterprises (SMEs)[7]. A possible explanation for the higher default rates for the medium firms is that they are characterised by higher leverage compared to small businesses, which rely more on their own funds.

3.2 The link between business cycle and default rates

The time series shown in Figure 1 reveals particularly low default rates over the last few years, a fact that is somehow unexpected since this is a period of low economic activity. The same stylized fact can be observed in many European countries, as shown in BIS (2003). It is often argued[8] that a reduction in bank portfolio's risk has occurred because of a more careful selection of the borrowers, which is likely to be related to the importance recently given to risk management and supervisory control. An additional explanation is the growing credit risk transfer market. In sum, a structural break is likely to have occurred in the default rates series, even if its actual occurrence can be investigated only once more data will be available. This presumed structural break motivates the decision to exclude the more recent data (i.e. 2001 and 2002) from the application.

The aggregate default rate series illustrated in Figure 1 clearly suggests some relation with the state of the economy, as the highest default rates correspond to the 1992-93 recession period; however, two regimes are not so apparent. In order to test the existence of the two regimes, a chronology of the Italian business cycle is necessary. While for the US business cycle the chronology by the NBER is widely accepted, in general there is not such an agreement for the European countries. The Economic Cycle Research Institute (ECRI) provides a business cycle chronology for the main European countries based on the NBER methodology[9]. However, in the specific case of Italy, the *Istituto di Studi e Analisi Economica* (ISAE) provides a different chronology, owing to the selection of the relevant variables motivated by the specific features of the Italian economy. We refer to Altissimo et al. (2000) for the methodology adopted, the selected variables and the resulting chronology. To implement the model the ISAE chronology is firstly adopted (Table 2).

Table 2 ISAE business cycle chronology

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

In order to analyse the link of the quarterly aggregate default rates with the business cycle, the defaults rates are grouped according to the business cycle regime prevailing over each quarter[10]. Table 3 presents the mean and standard deviation of the default rates both over the whole period (unconditional PD) and over expansion and recession periods respectively (conditional PD).

Table 3 Conditional and unconditional PDs estimates

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

Source: own calculations from Banca d'Italia (2003a), BIP

The average default rate in recession is higher than the one in expansion and the standard deviation is reduced by separating the two regimes. The difference between recession and expansion PDs is statistically significant[11]. The two regimes are then considered and tested for each 'rating class'. The conditional quarterly PDs by 'rating classes'are shown in Table 4.

Table 4 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

Source: own calculations from Banca d'Italia (2003a), BIP

3.3 Regime probability forecast and capital requirements

While the US business cycle has been widely analysed, only a few works deal with the Italian business cycle, particularly when the issue of forecasting is restricted to the binary representation of the business cycle, i.e. to binary choice econometric models. Estrella and Mishkin (1997) test the predictive power of the interest rate term spread for the business cycle regimes within a probit model with quarterly data for France, Germany, Italy, United Kingdom and United States: the variable is quite successful in predicting recessions only for Germany and United States. More recently Artis et al. (2004) perform regimes forecasting for the same countries[12] within a logit model with more satisfactory results. Based on the argument that "small" countries, such as Italy, are partly driven by larger economies, they introduce international explanatory variables. In fact, compared to the estimation with domestic variables only, they obtain a better recession probability forecast for Italy when German variables are included. However, they use monthly data and limit the forecast to a three month horizon, while in many practical cases longer horizons are more relevant. PricewaterhouseCoopers (2003) performs a similar analysis on quarterly data, with a two-periods forecasting horizon. Both studies use the ECRI chronology. In this work a regime prediction is produced within a probit model with a four quarters horizon. Several financial variables are considered as possible predictors, including international variables as in Artis et al. (2004). The choice of considering only financial variables has two main motivations: the timely availability of this data-type from a users' point of view; the evidence (e.g. Estrella and Mishkin (1998) on US data) of real activity variables being good predictors over short horizons (one or two quarters ahead) but worse predictors over longer horizons. As for the choice of the international variables, the German financial ones are considered since the Italian financial system is traditionally linked with the German one (Monetary Snake, EMS and EMU). Moreover, consistently with Artis et al. (2004), also US variables are considered as it is likely that they drive the Italian market, in particular the equity one. The set of variables considered is listed in Table 5[13].

Table 5 Predictors data set

	Short-term Interest Rate (SR)	**Long-term Interest Rate (LR)**	**Term Spread (Spread)**	**Stock Market (Equity)**
Italy	3-Months Interbank Deposit Rate	10 years Government bond yield	LR-SR	Comit general Share price index
Germany	3 Months Frankfurt inter-bank offered rate, FIBOR	Government Bond Yield (9-10 years)	LR-SR	DAX Share price index
United States			LR-SR	S&P 500 Composite price index

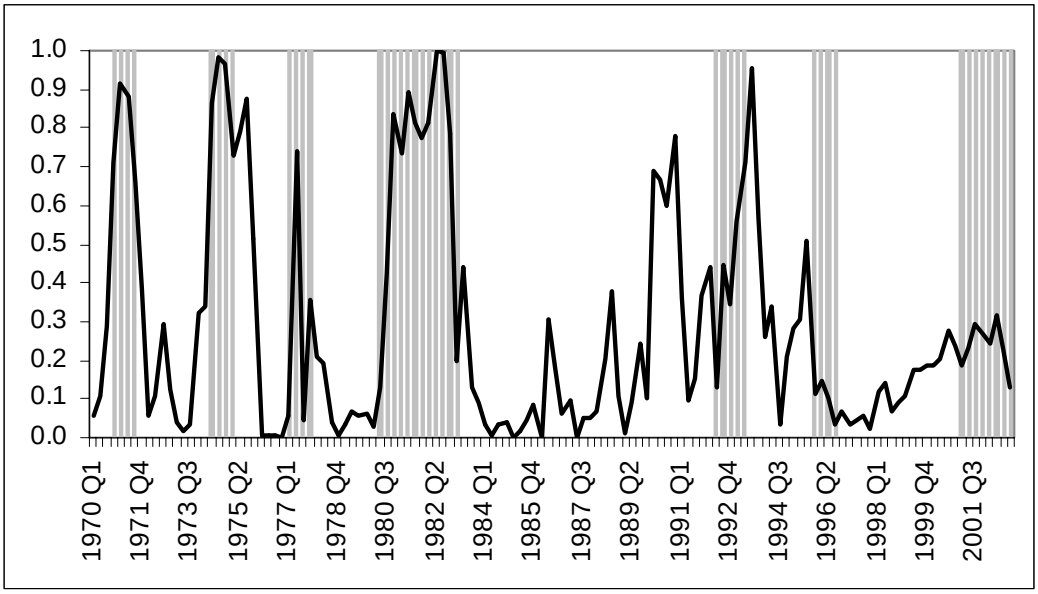
Source: Datastream

Based on the business cycle chronology from 1970 Q1 to 2002 Q4, the German term spread and the long term Italian interest rate are selected as predictors according to the Schwartz Information Criterion (SIC). The coefficients are estimated over the period 1970 Q1 – 1989 Q4 and used for forecasting up to four quarters ahead, i.e. up to 1990 Q4; the procedure is then repeated augmenting the estimation sample every four quarters. The fitted (in sample) recession probability (up to 1989 Q4) and the forecast one (from 1990 Q1 onwards) are compared with the ISAE chronology in Figure 2.

While the in-sample fit is satisfactory, with just a slight (one quarter) delay in the eighties' recession, the out-of-sample recession probability results are mixed. The recession probability increases irregularly from the beginning of the '90s and the actual 1992-93 recession is predicted with some delay while the 1996 recession is correctly anticipated. The last recession is only slightly signalled, with the predicted probability increasing from 2000 Q1, and the statistical analysis of the prediction confirms the graphical analysis. The measure of goodness of fit depends on the number of times the model correctly predicts the recessions by assigning them a probability greater than a half. However, it has to be stressed that, for this model to be useful, the recession probability must increase above the sample proportion when a recession is going to occur, even if such probability

does not exceeds the 0.5 threshold. In the specific case of this application, the recession probability (i.e. proportion) implicit in the PDs estimation sample (1990 Q1 – 2000 Q4) is 20%. Hence it is important to have a recession probability above this level when recessions occur, which has been the case for several recessions in this study[14].

Figure 2 Recession Probability Forecast (ISAE chronology)

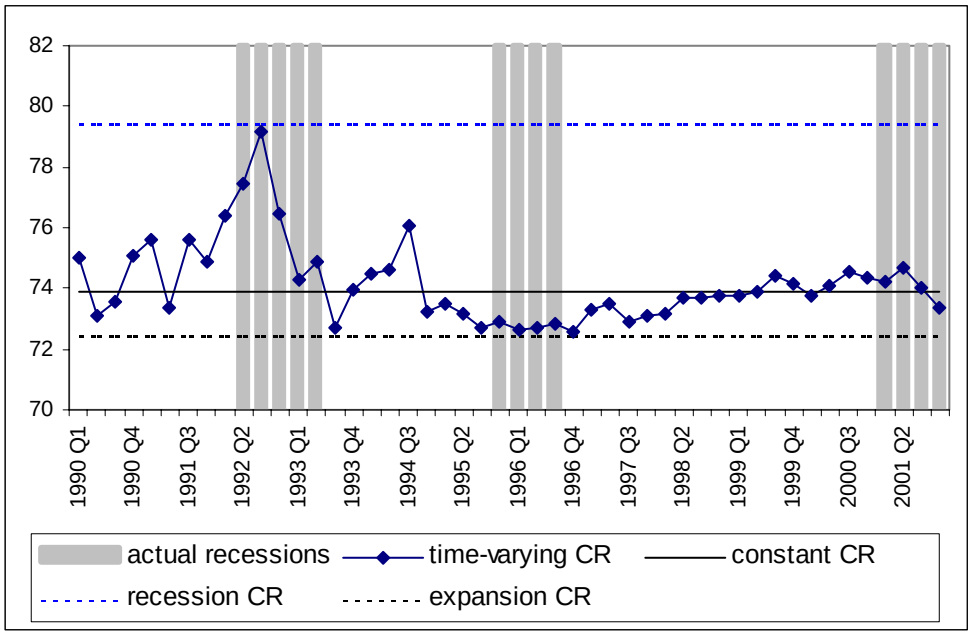


The black line is the recession probability fitted up to 1989 Q4 and predicted four quarters ahead from 1990 Q1 onwards. The grey bars represent the actual recessions as from the ISAE chronology.

In order to apply the Foundation IRB Basel II formula for capital requirements, the one-year PDs for each rating class have to be estimated. The quarterly conditional PDs are converted into annual ones and combined with the recession probability forecasts to obtain the time varying one-year PDs defined by the model.

The capital requirement is calculated for a constant portfolio of 100 exposures to each 'rating class'[15]. The resulting capital requirement with quarterly revision is presented in Figure 3, where it is compared to the capital requirements calculated with constant PDs.

Fig.3 Basel II Capital Requirements (ISAE-based)



The actual recession are defined by the ISAE turning points. The model time-varying (quarterly revised) capital requirement (CR) is plotted against the constant CR based on long-run average PDs. The lower and upper bounds are defined by the expansion/recession CR based on expansion/recession average PDs. The CRs are drawn at the estimation time.

The capital requirements increase in anticipation of the 1992-93 recession: it increases up to the second quarters of recession and then decreases, reaching an average level in the second part of the recession. This result is quite positive in terms of procyclicality, since the capital requirement is high at the peak of the cycle and it decreases at the trough, smoothing in this way the turning points of the business cycle. The results are instead unsatisfactory for the following recession: the capital increases too early and it is very low at the beginning of the recession as well as at the end. After the 1996 recession, the capital changes only slightly, and increases above the unconditional level starting from 1999 Q3: even if very slightly, the capital increases in anticipation of the 2001 recession and it decreases again during the recession.

The results obtained are not surprising, as they hinge on two elements: a sharp distinction of the two regimes in the default rates and a satisfactory recessions forecasting. As for the former one, despite the statistical evidence in favour of the two regimes, the actual default rates series in Figure 1 does not show a clear pattern: while the '92-'93 recession is very evident in the high default rates, the

same does not hold for the following recession. This remark immediately leads to reconsider the alternative ECRI chronology, which is reported in Table 6.

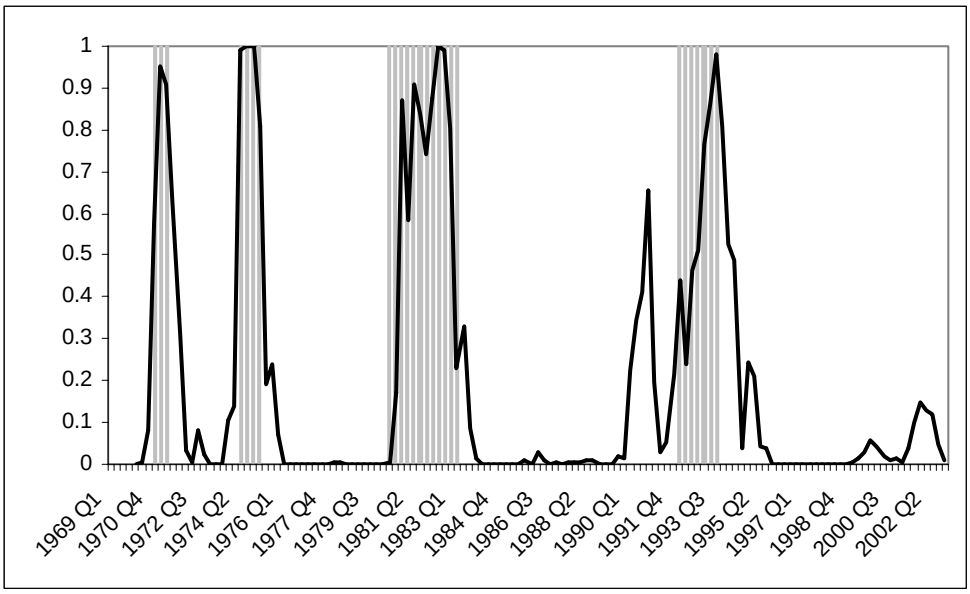
Table 6 ECRI business cycle chronology

Peaks	Oct-70	Apr-74	May-80	Feb-92
Throughs	Aug-71	Apr-75	May-83	Oct-93

Source: www.businesscycle.com

Regardless of the precise dates of the turning points, the most important difference lies in the fewer recessions reported by the ECRI compared to ISAE: in particular, the '92-'93 recession is the last recession reported by ECRI. In general, ECRI seems to classify as recessions only the most severe economic downturns, while the ISAE considers slighter fluctuations as well. For a rough comparison, Figure 4 depicts, ceteris paribus, the recession probability forecasts for the ECRI chronology.

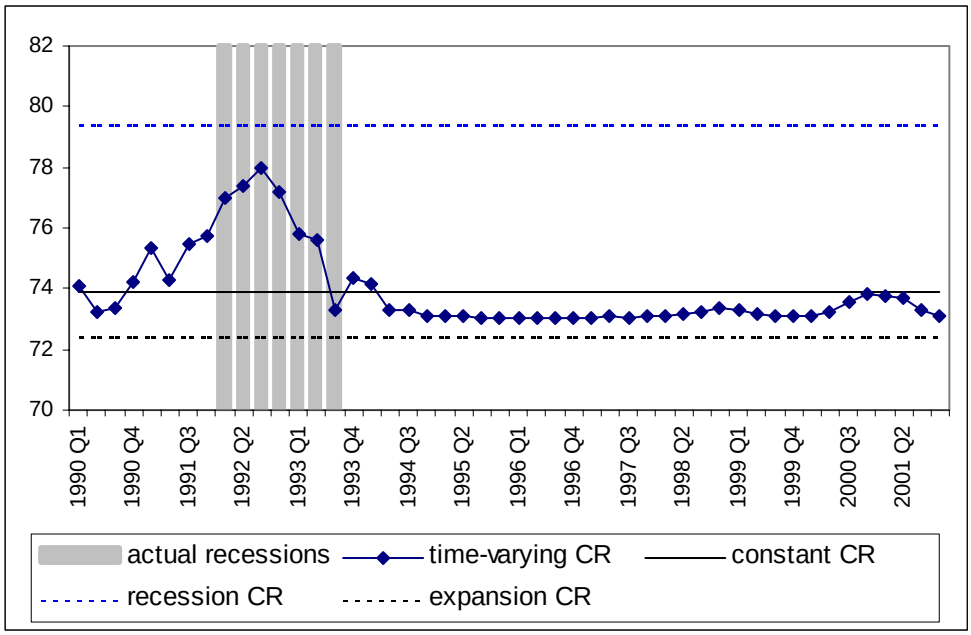
Fig. 4 Recession probability forecast – ECRI chronology



The black line is the recession probability fitted up to 1989 Q4 and predicted four quarters ahead from 1990 Q1 onwards. The grey bars represent the actual recessions as from the ECRI chronology.

By inspection of Figure 2 and 4, the prediction record based on the ECRI chronology appears much better. Accordingly, Figure 5 represents the capital requirements.

Fig.5 Basel II Capital Requirements (ECRI-based)



The actual recession are defined by the ECRI turning points. The model time-varying (quarterly revised) capital requirements (CR) is plotted against the constant CR based on long-run average PDs. The lower and upper bounds are defined by the expansion/recession CR based on expansion/recession average PDs. The CRs are drawn at the estimation time.

4. Conclusions

The present paper applies the model proposed in Pederzoli and Torricelli (2005) to the Italian case by exploiting default data provided by the Bank of Italy. To this end two main issues in the construction of a useful dataset are tackled: first the proxy for the ratings, second the different business cycle chronologies available for the Italian economy.

The model used is based on a binary representation of the business cycle and on the dependence of the default rates on the business cycle phases. In particular, the model estimates time-varying PDs by combining conditional (expansion and recession) PDs with a forecast of the recession probability over the credit horizon. The purpose of the model is that of defining capital requirements which anticipate the business cycle and can thus dampen procyclical effects.

The focus of the analysis is therefore on the relation between the default rates and the business cycle: based on the ISAE chronology, the default rates support the modelling of conditional expansion and recession PDs. Since the data set does not provide a distinction of borrowers by rating, in the present paper borrowers are classified by size and geographic area to approximate six 'rating classes'. The application of the model heavily relies on the business cycle forecast: consistently with the literature, the forecast is performed within a probit model with domestic and international financial variables as predictors. Even if the forecasting performance is not fully satisfactory, the results can be usefully exploited for the estimation of the PDs. During the 1992-93 recession, which is the most severe over the period analysed, capital requirements increase in anticipation of the recession and then decrease to a low level precisely at the bottom of the cycle. A less satisfactory forecasting performance hinders such a desirable outcome during the other recessions. However, the forecasting performance is improved if the alternative ECRI business cycle chronology is adopted. This finding suggests that the comparison between the alternative chronologies is an important issue that deserves further research.

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References

Altissimo F., Marchetti D. J., Oneto G. P., 2000. The Italian business cycle: coincident and leading indicators and some stylized facts, Temi di Discussione Banca d'Italia, 377.

Artis M., Birchenhall C., Osborn D., Sensier M., 2004. Domestic and international influences on business cycle regimes in Europe. International Journal of Forecasting, 20 (2), 343--357.

Ascenzo M. P., Viviani U., 2000. Nuove basi informative realizzate dalla Banca d'Italia. "Modelli per la gestione del rischio di credito". I ratings interni, Tematiche Istituzionali, Bank of Italy.

Banca d'Italia, 2003a. Base Informativa Pubblica.

Banca d'Italia, 2003b. Relazione Assemblea Generale Ordinaria dei Partecipanti, May 2003.

Bangia A., Diebold F., Kronimus A., Schagen C., Schuermann T., 2002. Ratings migration and the business cycle, with application to credit portfolio stress testing. Journal of Banking and Finance, 26, 445--474.

Bank of International Settlement (BIS), 2003. 73rd Annual Report.

Basel Committee on Banking Supervision (BCBS), 2003. The New Basel Capital Accord. Third Consultative Document, April.(CP3)

BCBS, 2004. International convergence of capital measurement and capital standards – A revised framework. June 2004.

Birchenhall C., Jessen H., Osborn D., Simpson P., 1999. Predicting U.S. business cycle regimes. Journal of Business & Economics Statistics, 17 (3), 313--323.

Borio C., Furfine C., Lowe P., 2001. Procyclicality of the financial system and Financial stability: issues and policy options. BIS Paper, 1.

Dullman K., Scheule H., 2003. Determinants of the asset correlations of German corporations and implications for regulatory capital. Paper presented at the Venice, 22-23th September 2003 convention "Dependence Modelling for Credit Portfolios".

Estrella A., Mishkin S., 1997. The predictive power of the term structure of interest rates in Europe and the United States: implications for the European Central Bank. European Economic Review, 41 (1), 1375--1401.

Estrella A., Mishkin S., 1998. Predicting U.S. recessions: financial variables as leading indicators. Review of Economics and Statistics, 80 (1), 45--61.

Gordy M., Howells B., 2004, Procyclicality in Basel II: can we treat the disease without killing the patient?. Paper presented at the Workshop "Accounting, transparency and bank stability", Basel, 17-18 May 2004.

Kavvathas D., 2001. Estimating credit rating transition probabilities for corporate bonds. Job Market paper, available at www.ssrn.com.

Nickell P., Perraudin W., Varotto S., 2000. Stability of rating transitions. Journal of Banking and Finance, 24, 203--227.

Pederzoli C., Torricelli C., 2005. Capital requirements and business cycle regimes: forward-looking modelling of default probabilities. Journal of Banking and Finance, in press.

PricewaterhouseCoopers, 2003. Can financial variables help to predict recessions?. European Economic Outlook, June 2003, 25.

Sironi A., Zazzara C., 2003. The Basel Committee proposals for a new capital accord: implications for Italian banks. Review of Financial Economics, 12, 99--126.

[1] The link between credit risk and macroeconomic components is recognised and tested in the literature (e.g. Nickell et al. (2000), Bangia et al. (2002), Kavvathas (2001)).

[2] The default data contained in the *Base Informativa Pubblica* starting from 2000 are fully described in Ascenzo and Viviani (2000).

[3] The default of a borrower is defined as the condition of '*sofferenza rettificata*', that refers to the position of the obligor towards the whole banking system (see Ascenzo and Viviani (2000)).

[4] Actually the borrowers are further divided by regions, but this detail, as well as the segmentation by sectors of economic activities are not exploited in this work in order to keep the number of categories tractable.

[5] The database used in Sironi and Zazzara (2003), that is the one published in February 2001, presents a different segmentation with respect to the more recently published databases, i.e. the thresholds are 500 millions and 5 billions lira respectively, which according to the authors are appropriate to characterise the three market segments. The segmentation adopted in the more recent quarterly database does not allow the same categorisation and therefore a different representation is adopted in this work.

[6] The averages are calculated over the period 1990 Q1-2000 Q4.

[7] The evidence that medium size firms are the riskiest is supported by similar evidence provided in Sironi and Zazzara (2003) for Italy and in Dullmann and Scheule (2003) for Germany.

[8] See Banca d'Italia (2003), Section E, "Rischi, redditività e patrimonio degli intermediari".

[9] This chronology is available at www.businesscycle.com.

[10] The conversion from the monthly chronology to a quarterly one is performed according to the following criterion: if the turning point occurs in the first (third) month of the quarter, then the quarter is classified according to the regime prevailing at the end (beginning) of the quarter; if the turning point occurs in the second month (i.e. in the middle) of the quarter, then the quarter is classified according to the regime prevailing at the end of the quarter.

[11] A two-sample test based on the Bernoulli representation of defaults is performed on the PD parameter: the null hypothesis of equality is rejected at the 1% level of significance.

[12] Artis et al. (2004) consider Italy, Germany, France and United Kingdom. Birchenhall et al. (1999) consider the US.

[13] The variables are fully available starting from 1969. The original data are monthly and they are converted in quarterly averages. The equity data are converted into growth rate series. The interest rate series present unit roots when tested with an Augmented Dickey-Fuller (4) test, with the exception of the short term German rate. Hence the unit root series are first differenced. The Comit Index is used instead of the MIB30 since available time series for the latter are not long enough for the estimation purposes. Only the term spread is considered among the US interest rate variables: Estrella and Mishkin (1998) show in fact that it is preferable to the separate use of short and long term interest rates in the US business cycle prediction.

[14] Different estimation samples and additional variables - German short term interest rate and equity index – change the results only negligibly .

[15] The capital requirement is calculated with LGD=45%, M=2.5. The correction for small and medium enterprises (SME) allowed in Basel II is neglected. The capital requirement represented in Figure 3 (as well as Figure 5 later on) reflects both the expected and unexpected losses, according to the so called CP3 (BCBS, 2003).