

# CREDIT RISK EVALUATION: THE ECONOMETRIC VS THE STRUCTURAL APPROACH



**RIDHA  
ELHADJ  
AHMED\***  
Ph. D in  
Finance  
(CEMAFI),  
Université  
de Nice  
Sophia-  
Antipolis



**INES  
GHAZOUANI  
BENAMEUR\*\***  
Ph. D in  
Finance  
(CEMAFI),  
TIME  
Université

Within the new Basel agreement (Basle II) and since the end of 1990s, the international banking supervision community's discussions have reinforced the need for a statistical evaluation of defaultable phenomena and analysis of credit risk. Indeed, after the international financial crisis of 1998, the international banking community and the relevant supervising authorities have undertaken significant measures meant to improve the comprehension and the prevention of credit risk. These measures, which complement the work already started in the middle of the 1990s on the monitoring and controlling of market risk, contributed to the reform of the banking solvency ratio (Basel II agreement). These models target the substitution of the ad hoc evaluation of the required risk-covering funds by an estimation which takes into consideration the diversity; level and quality of risks.

In order to evaluate credit risk, the Basel Committee retained a progressive approach based on two methods: a standard method (*Revised Standardised Approach – RSA*), which is based on external evaluations of credit risk, and a method which uses banks' internal ratings (*Internal Rating Based Approach – IRB*). Within the IRB approach, the internal evaluation of main risk parameters is processed by the banks themselves and includes the necessary elements to compute the required equities. Thus, banks adopting the IRB approach define default probabilities for each borrower. These probability measures are key parameters in fixing the minimum regulating capital necessary for covering potential losses.

The present paper focuses mainly on the IRB approach as applied to credit risk evaluation. Thus, by modulating its regulating power, the Basel Committee authorised banks to use internal models to evaluate credit risk. This step induced large banks to adopt market risk-oriented evaluation models in view of developing and marketing Value at Risk (VaR) for credit risk. For instance, the J. P. Morgan bank modified its *RiskMetrics* model, aimed

to evaluating market risk, and developed a new credit risk evaluation model called *CreditMetrics*, published in 1997. Based on the same assets evaluation model initially developed by Merton in 1974, KMV Corporation, specialised in credit risk analysis, developed a credit risk evaluation methodology slightly different from the *CreditMetrics* model. Likewise, the Credit Suisse Financial Products (CSFP) published at the end of 1997 a new approach called *CreditRisk+*. This initiative was followed by McKinsey Board by publishing their own model called *CreditPortfolioView*. All these models aim at providing for a given credit portfolio a thorough description of the distribution of possible profits and losses and a VaR estimation for credits.

Recently, the analysis of the performance and classification of these models has been the focus of several studies. A classification, inspired from the works of Nandi (1998) and Koyluoglu et al. (1998), allows us to distinguish between three approaches. The first approach, called Merton's structural approach, includes the *CreditMetrics* model and the *PortfolioManager* model of *KMV*<sup>1</sup>. The second approach is an actuary approach proposed by the *CreditRisk+* model. The third approach, qualified as an econometric approach, is illustrated by *CreditPortfolioView model*.

In this paper, we propose an application of these kinds of models in the French credit market. Our results show that credit risk evaluation by means of macroeconomic variables is an efficient evaluation method and might be interesting for banks with portfolios composed of lending targeted to unquoted firms. Likewise and since it allows the prediction of the sector-based credit risk's systematic component that has not been taken into consideration by the other models, the econometric approach might be a good complement for a structural approach.

Our analysis is threefold. In a first section, we present the econometric approach in terms of the *CreditPortfolioView* model, which would allow the evaluation of French firms' credit risk sensitivity to the evolution of macroeconomic variables and stock market prices. In a second section, we apply this model to analyse the relationship between

\* har\_ridha@hotmail.com

\*\* inesghazouani@hotmail.com

French firms sector-based default rates' variations and macroeconomic indicators and market prices during the period 1993-2005. Finally, the default rates obtained through this model will be transformed into default probabilities which will be compared in a third section with those issued from the application of the KMV model.

## ■ I. THE ECONOMETRIC APPROACH

The econometric approach to credit risk evaluation was developed by Wilson (1997a, 1997b) and proposed by McKinsey and Company in 1998 in their *CreditPortfolioView* model.

Based on the casual observation that credit cycle is linked to the economic cycle, the CreditPortfolioView is a multi-factor model which proposes a methodology based on the relationship between macroeconomic factors and default and/or transition probabilities. This methodology consists in defining a function allowing to estimate default probabilities using macroeconomic factors like unemployment rate, GDP growth rate, long-term interest rate, exchange rate, public expenses and global savings<sup>2</sup>.

The *CreditPortfolioView* model wants to be a reply to the following observations about the systematic (i.e. non-diversifiable) credit risk (Wilson, 1998):

- Other things being equal, diversification diminishes uncertainty over losses.
- Systematic risk exists even within the best diversified portfolios.
- This risk is strongly correlated to macroeconomic shocks.
- The sectors of a given economy react differently with macroeconomic shocks.
- The transition between credit-rating types is related to macroeconomic shocks.

This model does not focus on the borrowers as such nor on the returns on their assets, but rather on the industry (services, agriculture, financial institution, construction, etc) and the country which the borrowers belong to. The model defines a common rating and the same default probability for all borrowers belonging to the same sector-country couple.

Within the *CreditPortfolioView* approach, default probabilities are evaluated using a logit-model in which the independent variable is a speculative index specific to the sector (or industry). That is it self contingent upon on macroeconomic variables:

$$P_{j,t} = \frac{1}{1 + e^{-Y_{j,t}}} \quad (1)$$

In this equation,  $P_{j,t}$  represents the default probability during a period  $t$ , for a borrower  $j$ .  $Y_{j,t}$  represents the value of the macro-economic index which describes the situation of the industry-country couple at a date  $t$ . This index is approximated by a default rate for each sector and is estimated through a multifactor model described below.

The index  $Y_{j,t}$  is estimated by macro-economic factors which determine the economic situation of the country, using the following model:

$$Y_{j,t} = \beta_{j,0} + \beta_{j,1}X_{j,1,t} + \beta_{j,2}X_{j,2,t} + \dots + \beta_{j,m}X_{j,m,t} + v_{j,t} \quad (2)$$

Where:

$Y_{j,t}$  = the value of the index in a period  $t$  for a sector  $j$   
 $\beta_j = (\beta_{j,0}, \beta_{j,1}, \beta_{j,2}, \dots, \beta_{j,m})$  represents the to-be estimated parameters.

$X_{j,t} = (X_{j,1,t}, X_{j,2,t}, X_{j,3,t}, \dots, X_{j,m,t})$  the macro-economic variables corresponding to the  $j$ th country (or industry).

$v_{j,t}$  = error term

## ■ II. APPLICATION ON THE FRENCH MARKET

Since the beginning of the 1990s, economies and stock markets have witnessed highly unstable periods. Fluctuations of stock market prices and the unfavourable economic situations have transformed banks' behaviour concerning risk evaluation and management and consequently credits granting. Indeed, by adjusting their credit offer according to consumers' default risk evaluation, banks might seem restrictive in terms of lending during periods of recession and decrease in stock market prices. These latter contexts are characterized by a high exposure to credit risk.

Like other developed economies, the French economy has undergone such economic and stock market instabilities. Graph 1 shows that French firms' default risk seems to follow a reverse evolution compared to the evolution of the stock market prices.

This graph shows that there probably exists a relationship between deficiency rate evolution and the country's economic and financial situations. Indeed, at the beginning of 1993, the high default rates' values correspond to a period of economic recession and lower stock market prices for all sectors. The increase of stock market prices during the period 1994 to 2000 might have strongly increased the value of firms' equities and contributed in a continuous decrease of deficiency rates during this period. This period of credit risk decrease would be interrupted starting from 2001. The 2000 market crash and the deterioration of the economic situation starting from the mid 2000 led to an increase in default rates.

In order to econometrically attest for the existence of such relationship between evolution of activities cycle and the financial sphere on the one hand and fluctuations of French companies' default rates on the other hand across different sectors, we will consider a CreditPortfolioView-based model. Indeed, this model allows studying the effects of macroeconomic factors and stock market prices' fluctuations on French companies' credit risk. This model will allow banks to estimate the evolution of sector-bound credit risk in order to better diversify their credit portfolios.

Meant to measure credit risk using the evolution of the economic and financial situation across different sectors, the model that we propose takes the deficiency rate for each sector as endogenous variable. In order to be within the focus of this study, we take as exogenous variables, GDP by sector, long-term interest rate, unemployment rate and the Euro/Dollar exchange rate to measure the impact of the economic situation on the one hand, and the stock market index to measure the financial situation on the other hand.

In this model, variations of deficiency rates are assumed to depend not only on the fluctuations of the different economic indicators, but also on the evolution of the stock market prices. Indeed, in case of stock market shocks, the impact on equities valuation affects the companies' financial situation and influences the level of risk incurred by lenders.

$$TXDEF_{j,t} = C_{0,j} + C_{1,j} \cdot GDP_{j,t} + C_{2,j} \cdot ISBF_{j,t} + C_{3,j} \cdot TXINTER_{j,t} + C_{4,j} \cdot TXCHOM_{j,t} + C_{5,j} \cdot TXCHAN_{j,t} + \varepsilon_{j,t} \quad (3)$$

$TXDEF_{j,t}$ : companies' deficiency rate<sup>3</sup> within a sector  $j$  during a period  $t$ . It is computed as follows:

Deficiency rate = number of defaults during the period/ companies' stock present at the beginning of the period.

$GDP_{j,t}$ : Gross Domestic Product of sector  $j$  during the period  $t$ . For each sector, we take the level of the Added Value to set the GDP of this sector. Indeed, GDP might be defined by the sum of the different sectors' net added values or the different activities, increasing taxes minus the contributions on products (which are not granted to sectors and branches).

$TXINTER_t$ : average long-term interest rate of period  $t$ .

$TXCHAN_t$ : average Euro/Dollar exchange rate of period  $t$ .

$ISBF_t$ : average ISBF 250 stock market index of period  $t$ .

## II.1. THE DATA

We use quarterly data during the period stretching from the first quarter of 1993 to the fourth quarter of 2005 for ten sectors in France (see appendix A.1. for the definition of the sectors)<sup>4</sup>. The period and sectors have been chosen according to the availability of data on companies' deficiency.

Deficiency rates by sector are computed through quarterly data on the number of deficiencies and the demography of French companies by sector, taken from the INSEE's data base<sup>5</sup>. Likewise, GDP by sector and unemployment rate have been taken from data published by the INSEE.

For the GDP by sector, we took the series of quarterly added values in terms of current price volume, adjusted on season-based variations (CVS series). For the unemployment rate, we considered quarterly averages computed through the International Bureau of Labour-based unemployment figures, published by INSEE<sup>6</sup>.

The long-term interest rate used in the estimations is computed by the quarterly average of the ten-year Phare rate. The quarterly average Euro/Dollar exchange rate is computed by means of monthly data. This rate has been reconstituted through the exchange rate of the French Franc vs the Dollar for the period 1993-1999<sup>7</sup>.

Finally, we took the quarterly SBF stock market index average as an indicator of the stock market evolution. This choice is motivated by the fact that this index represents the broadest index of the Paris stock market and covers the whole of the economy<sup>8</sup>. Indeed, market authorities seek to distribute the 250 values making up this index over the large sectors and to systematically review its sample once a year, undertaking adjustments each quarter.

Thus, our database includes variables which vary across sectors and others which are the same for all sectors. Deficiency rate, interest rate and unemployment rate series are expressed in percentage.

## II.2. ANALYSIS AND INTERPRETATION OF RESULTS

### 1. Estimation of the Model by Sector

After studying the series' stability using the sequential strategy of Dickey and Fuller's unitary root test, model (3) is separately applied to each sector. This independent non-simultaneous estimation of equations did not create significant bias as attested by the retrospective simulation of the model (see Appendix A.2). This simulation shows that the observed and simulated deficiency rates' curves converge during the whole period.

The equations are estimated using the ordinary least square (OLS) method. Results are reported in Table 1.

The diagnosis undertaken on the residuals suggests that the model is well adapted to the data. Indeed, the Portmanteau tests, based on the Ljung-Box  $Q(m)$  and  $Q^2(m)$  statistics, which are applied to the residuals of the different estimations, show that no autocorrelation phenomenon exists for the lags between 1 and 24 since the  $Q(m)$  et  $Q^2(m)$  statistics are all non-significant. Besides, the Durbin-Watson's test statistics are close to 2 and show no first-order correlation for the different estimations' residuals. However, the LM test and effect-based ARCH test and the heterocedasticity test for the residuals confirm the validity of the used estimations.

### 2. The macroeconomic environment and deficiency Rate

In the following section, we focus on the relationships between the macroeconomic environment's indicators and credit risk. The results show that systematic credit risk is dependent in a great part on the country's macroeconomic context. Indeed, the macroeconomic factors explain a large proportion of the overall variation of deficiency rates, reflected in  $R^2$ .

In general, an evolution disfavoring the economic context is accompanied by an increase in deficiency rate and vice versa. Nevertheless, we should note that the link between cycle and deficiency intensity highly depends

on the considered sector. Indeed, some sectors undergo higher contextual variations than other sectors.

The results show that the evolution of the added value by sector (or GDP by sector) represents an important indicator of deficiency rate variation for all sectors. The coefficient relative to this variable is negative for all sectors and significant in most cases.

Moreover, we note that, except for equipments goods sector which incorporates a negative non-significant relationship between deficiency rate variation and interest rate variation, the coefficient associated with interest rate is positive for the remaining sectors. It is significant for Agricultural and food Industries sector, intermediate goods, transports, company-oriented and consumer-oriented services, though it is not significant for the other sectors (consumer goods, construction, trade, real estate). Nevertheless, this relationship remains significant for the whole of sectors. An increase in interest rate by one point increases deficiency rate by 0,02 points for the whole of sectors.

This relationship might be explained by the fact that during period of interest rate increase, companies having granted credits with variable rates witness an increase in the to-be paid interest and might find themselves in the incapacity of facing this interest excess. However, the effect of this mechanism remains low, which explains the non-significance of the coefficient relative to interest rate variations for some sectors.

Moreover, the effect of an increase in interest rate on credit risk remains limited and does not influence all sectors. Indeed, companies might diminish their credit demand and make recourse to financial markets during periods of interest rate increase.

Yet, the results show that the coefficients relative to unemployment rate variation are positive for all sectors and significant in most cases (for seven sectors of the ten studied). This relationship seems straightforward since several deficiency cases are cleared by stopping activities or by resuming activities that need cutting down jobs. This latter contributes to the increase in unemployment rate.

Finally, we note that exchange rate fluctuations are rarely significant within the estimated equations. Indeed, the relationship between exchange rate and that of deficiency rate is only significant for few sectors. It is positive and significant for the Agricultural and food Industries and real estate sectors and negative for transportation and company-oriented sectors. Besides, the relationship is negative and significant for all sectors.

### 3. The financial market evolution And deficiency rate

According to the results of the estimations, an increase in the SBF250 stock market index is negatively correlated to deficiency rate for the whole of sectors. Nevertheless, it seems that some sectors are found to be more sensitive to stock market shocks and cycle effects than others.

Comparing the coefficients associated with the stock market index across sectors, credit risk seems more sensitive to the financial context within consumer goods,

construction and real estate sectors. Moreover, the SBF 250 index variation has an impact on consumer goods sector's deficiency rate (- 0,056), twice as important as that of the trade sector, (- 0,02), and three times and a half as important as that of transportation or consumer-oriented sectors (- 0,016). However, the deficiency rate of the Agricultural and food Industries sector did not react to these stock market variations (non-significant coefficient). This point might be explained by the fact that the tertiary sector is mostly composed of unlisted mid-sized and small companies.

Thus, the strong stock market fluctuations, which took place during the mid 1990s and followed by some readjustments starting from the second quarter of 2003, led to mispricing (over and under values) and greater variability in firms' market values. This variability influenced the perception that economists might have of the companies' financial situations and, thus, of their capacity to pay off debts.

An increasing stock market shock puts into value the incurred shares and leads to over values which would increase listed companies' equities. These companies would see the weight of their borrowings in their liabilities diminish (indebtedness leverage) and their financial health improve, and consequently their credit risk diminish.

The increase in stock market prices during the second half of the 1990s would have increased the value of companies' equities and would have allowed them to improve their financial situation. The market crash starting from the third quarter of 2000 would have deteriorated companies' financial wellbeing and increased their credit risk.

However, the effects of the increase of stock market prices on companies' liabilities structure have progressively weakened between 2000 and 2003. The noted decrease in market prices during this period contributed to a decrease in deficiency rates for all sectors. Indeed, this deficiency rate recorded an increase from 0.43% in the first quarter to 0.62% in the third quarter of 2001, which is characterized by a substantial decline of stock market prices. This negative phase contributed to a devaluation of listed companies' equities and consequently increased their deficiency rates. This situation is translated by a decrease in new credits granted to companies. However, deficiency rates decreased again with the increase of market rates starting from the second quarter of 2003.

Finally, credit risk analysis across internal models cannot be limited to the study of deficiency rates evolution. Transforming these rates into deficiency probabilities is of an order.

### 4. Transformation of deficiency rates into default probabilities

The second phase of our study consists in expressing systematic credit risk in terms of default probabilities for each sector. Several authors<sup>9</sup> showed that default probabilities are much more reliable and robust than a simple deficiency (or default) rate, since probabilities take into account the structure of the target population and can be used in anticipations with efficiency.

To this effect, we use a logit model (1) to transform deficiency rates, estimated through macroeconomic factors, into default probabilities. Default probabilities provided by this transformation should be interpreted with precaution. Indeed, if, for a given sector and at a given date, we obtain a level of probability superior or equal to 50%, it can be concluded that this sector presents a default risk. And if this probability is inferior to 50%, we conclude that this sector is immune from default risk.

The results of these transformations for each sector are reported in appendix A 3. Figure 2 shows the evolution of mean default probabilities across the studied sectors.

We find that mean probability levels are superior to 50% for the whole period. This implies that there is a systematic credit risk for the whole period. A significant decrease in credit risk levels is identified between 1993 and 2001. From this period on, we have assisted to a dramatic risk rises and rebounding.

Firstly, the mean default probability level decreased quickly, moving from 50,20% during the third quarter of 1993 to 50,17% at the end of 1995. This decreasing trend was followed by a slackening during the period 1995-1997. Default probability is stabilised around 50,18% during these two years, before continuously decreasing again to reach its lowest level during the second quarter of 2001 (50,11%). However, starting from this date, systematic credit risk levels recorded an observable increase. This increasing phase is characterised by an increase in the mean default probability level which reached 50,13% during 2002 and continued to progress around this value during the period 2003 - 2005.

Generally speaking, the results of our study show that systematic credit risk of French companies recorded an important decreasing phase during the period 1993-2001 and an increasing phase between 2001 and 2005. These results are compatible with the hypothesis according to which a deterioration of the financial and economic situations tends to intensify risk levels.

### III. STRUCTURAL APPROACH APPLICATION AND COMPARATIVE STUDY OF DEFAULT PROBABILITIES

In order to finalise our credit risk analysis of the French market, we propose a comparison between the evolution of default probabilities issued from our application of the econometric approach (the CreditPortfolioView model) and those obtained through an application of the structural approach (the KMV's PortfolioManager).

#### III-1. DATA FOR THE APPLICATION OF THE KMV MODEL

In order to apply the KMV model, we considered the data of a sample of 590 Paris-listed French companies during the 1999-2005 period. These data, taken from the

Diane database<sup>10</sup>, included information on retained companies' stock market capitalisation and balance sheets. We should mention that the sample and the period are chosen according to data availability and that the stock market data are represented in frequencies per month and the balance sheets data are represented in terms of frequencies per quarter.

In order to estimate default probabilities, KMV Company uses the *Vasicek-Kealhofer (VK)* model which proceeds through three stages: the first consists in evaluating the company's assets and the volatility of their returns. The second consists in computing default distance<sup>11</sup>, and the third in deriving the EDFs<sup>12</sup> through the following preliminary calculations;

*Distance - to - default*

$$= \frac{[\text{assets market value}] - [\text{default point}]}{[\text{assets market values}] \cdot [\text{assets' volatility}]} \quad (4)$$

"Default point" is defined as  $DPT = DCT + \frac{1}{2} DLT$ , (5), in which DCT is the accounting value of short-term debts, DLT is the accounting value of long-term debts and DPT is the default point.

Thus, default distances are computed by the relationship (4) and we used the cumulative function of the normal distribution to deduce default probabilities.

#### III-2. INTERPRETATION AND COMPARISON OF RESULTS

The KMV model-based results tend to confirm the evolution of the obtained default probabilities through the application of the CreditPortfolioView model as is shown in Graph 3. The curve representing the KMV model's results describes accurately the evolution phases of French companies' credit risk. After the increase recorded during the 2000-2005 period, default probabilities started to be observed as from the end of 2003 in a continuously decreasing fashion (the 2003-2005 period). Indeed, the French economy witnessed a recovery during that period. This attractive period, along with a stock market awakening, embellished companies' activities and led to an improvement of their financial health and, thus, to a decrease in credit risk levels.

Moreover, the similarity in the evolution of the default probabilities obtained through the two different models signifies that credit risk is strongly linked to systematic factors. Indeed, default probabilities' curve computed through data, which is intrinsic to each company (the KMV model), replicates the evolution of those default probabilities estimated through macroeconomic factors.

Two main conclusions are of an order: the first is that credit risk estimation through macroeconomic variables represents an efficient evaluation method and might be interesting for banks with portfolios composed of credits granted to unquoted companies. The second is that this econometric approach represents a good complement for a structural approach. It allows the prediction of the systematic component of sector-bound credit risk and which is not taken into account by the other models.

Indeed, companies generally seek financing from several lenders whether by private treaty or market-induced agreements. Those loans are generally granted with different amounts, maturities and payment modalities. The sector's structure, thus, determines a general risk level which is preferable to be taken into account for the assessment of the whole evolution. Moreover, the Bank of France takes the type of sector into account within its granting criteria, but without making it a dominant element.

However, in order to study credit risk, banks should not limit themselves to the notion of default. They should supervise firms' indebtedness level and ensure that the granted credits do not disturb borrowers' balance sheets and do not lead to excessive debt leverage and, thus, to riskier situations. Indeed, the importance of inter-firms credits for financing companies dictates that taking into account payment incidents to evaluate credit risk is very appropriate. These payment incidents represent a prediction indicator since bill-related default often precedes credit-related default, which in itself precedes bonds-related default and bankruptcy.

In order to evaluate these payment incidents, the analyst may consult the Effects-based Payment Incidents' Central File, managed by the Bank of France<sup>13</sup>. The analyst may as well consult the Central File of Cheques, managed by the Bank of France to take into account declarations about unpaid cheques in order to have an idea about firms' default risk.

#### ■ IV. CONCLUSION

Applying these models to investigate French firms' credit risk, we reached some observations that credit professionals, operating within the French market, should take into consideration. First, the estimations and simulations of our systematic credit risk evaluation model show that this risk is mostly explained by the country's macroeconomic context. Credit risk has been shown to be very sensitive to both the economic environment and the financial context. Our results show the existence of a reverse statistical correlation between evolution of the macroeconomic and financial environment on the one hand and default rate on the other hand. Indeed, stock market revival, during the second half of the 1990s, contributed to companies' equities valuation and thus to improvement in their financial health and to diminishing their default risk levels. This decrease in credit risk levels is supported by activity cycle favouring an increase in added value within all sectors. However, decrease in market prices and slackening of activities between the third quarter 2000 and the first quarter 2003 contributed to increasing credit risk levels for all sectors and to increasing firms' deficiency rates and default probabilities.

Second, systematic credit risk exists even within the most diversified portfolios. This second observation is illustrated by the differences between real deficiency rates and those estimated by the model (see appendix A.2.).

The third observation is that sector membership constitutes an important criterion in credit risk evaluation. Indeed, effects due to activity cycle and to stock market evolution have been shown to differ from one sector to another.

Finally, the comparative analysis of the default rates issued from applying the structural approach through the KMV model reveals a similarity in the evolution of risk levels and confirms the above-mentioned observations. These mean default probabilities are conditioned by the economic context and incorporate sensitivities of the different industries.

These results allowed us to confirm the complementarity between the econometric approach and the structural approach. Thus, a credit risk evaluation following a structural approach might be more efficient if it is accompanied by an analysis of systematic risk based on the econometric approach.

- 1 The KMV model is the property of the KMV firm which was founded by S. Kealhofer, J. McQuown and O. Vasicek in 1989.
- 2 This model is better applied at a speculative level than to an investment level, since default probabilities are more sensitive to credit cycle (Kern. M and B. Rodolph (2001).
- 3 According to the definition of the Bank of France, "a company is considered in a deficiency or a clearing balance situation when it ceases payments and a judicial procedure is set against it" (Bank of France (2004). Page 4).
- 4 We follow the list of sectors which has been set by the INSEE.
- 5 For the companies' demography, we have at our disposal only figures over companies' population whose turnover is superior to 750 thousand Euros. We take this population as a reference measure of companies' stocks used in computing deficiency rate.
- 6 The IBL-based unemployment rate includes people who are simultaneously: without jobs, looking for a job (with or without salary), and available to work. This definition, normalised at the international level, makes comparisons easier than statistics on job seekers, who are subject to management and institutional rules (INSEE (ES362F, 2003)).
- 7 This reconstitution consists in taking the exchange rate of the Franc vs the Dollar and applying the conversion rate of the Euro into Franc (1 Euro = 6.55957 Francs).
- 8 The SBF 250 index includes values of the SBF 120 index and 130 others, indifferently taken at the First Market and Second Market, continuously or truly quoted. It is computed following the same ratio method between the current capitalisation of the 250 companies and that of December 31<sup>st</sup> 1990, where the threshold is 1000. This index is computed by means of two daily rates; the closing and opening rates.
- 9 Example : BARDOS (1998 b) and WILSON (1997).
- 10 The DIANE data base includes data on financial accounts and balance sheets of 950 000 French companies. It presents as well exhaustive information relative to transactions, shareholding, shares, administrators, some rules and a series of 50 pre-computed ratios.
- 11 This index is defined by the number of standard deviation from assets values distribution's mean and default point. It allows comparing the market's net accounting situation with the size of assets values' standard deviation.
- 12 EDFs : Expected Default Probabilities.
- 13 This file is held in virtue of the banking regulation committee's rule n° 86-08 dated February 27th 1986 and which keeps declarations about incidents made by credit institutions.

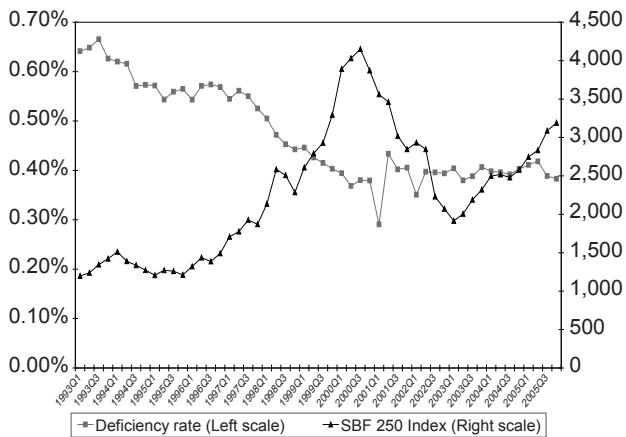
## References

- ALLEN L. AND SAUNDERS A. (2003), A survey of cyclical effects in credit risk measurement models. BIS Working Paper 126.
- ALTMAN E. (1968), Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, 23 (4), 589-609.
- ARTZNER P., DELBAEN F., EBER J. M. & HEALTH D. (1999), Coherent measures of risk. *Mathematical Finance*, Vol 9, N°3, pp. 203-228.
- BANGIA A., DIEBOLD F., KRONIMUS A., SCHAGEN C. AND SCHUERMAN T. (2002), Ratings migration and the business cycle, with an application to credit portfolio stress testing. *Journal of Banking and Finance*, 26, 445-474.
- BARDOS M. (1998a), Score BDFI, du diagnostic individuel à l'analyse de portefeuille. Banque de France, direction des entreprises, Les études de l'observatoire des entreprises, 1<sup>er</sup> trimestre 1998.
- BARDOS M. (1998b), Risque et taille des entreprises industrielles. Banque de France, direction des entreprises, Les études de l'observatoire des entreprises, 4<sup>e</sup> trimestre 1998.
- BARDOS M. (2001), Analyse discriminante, application au risque et scoring financier. Dunod, 2001.
- BASEL COMMITTEE ON BANKING SUPERVISION (2004), International convergence of capital measurement and capital standards: A revised framework. BIS report, June 2004.
- BERGER A. AND UDELL G. (2003), The institutional memory hypothesis and the procyclicality of bank lending behaviour. BIS Working Paper 125.
- BONFIRM D. (2008), Credit risk drivers: evaluating the contribution of firm level information and of macroeconomic dynamics. *Journal of Banking and Finance*, 33, 281-299.
- CARLING K., JACOBSON T., LINDE J. AND ROSZBACH K. (2002), Capital charges under Basel II: Corporate credit risk modelling and the macroeconomy. Sveriges Riksbank. Working Paper 142.
- CARLING K., JACOBSON T., LINDE J. AND ROSZBACH K. (2004), Corporate credit risk modelling and the macroeconomy. *Journal of Banking and Finance*, 31, 845-868.
- COUDERC F. AND RENAULT O. (2005), Times-to-default: Life cycle, global and industry cycle impacts. FAME Research Paper 142.
- CROUHY M., GALAI D. AND MARK, R. (2000), A comparative analysis of current credit risk models. *Journal of Banking and Finance*, 24, 59-117.
- DANIELSSON, J. (2002), The emperor has no clothes: limits of risk modelling. *Journal of Banking and Finance*, 26, 1273-1296.
- DUFFIE, D. AND SINGLETON, K. (2003), Credit risk: pricing, measurement and management. Princeton University Press.
- FABI F., LAVIOLA S. AND READTZ P.M. (2005), The new capital accord and banks' lending decisions. *Journal of Financial Stability*, 1, 501-521.
- GERSBACH H. AND LIPPONER A. (2003), Firm defaults and the correlation effect. *European Financial Management*, 9, 361-378.
- GORDY M.B. (2000), A comparative anatomy of credit risk models. *Journal of Banking and Finance*, 24, 119-149.
- GROSBIE P. AND BOHN J. (2003), Evaluating default risk. Online available at <http://www.Moodyskmv.com>.
- JARROW R. AND TURNBULL S. (1995), Pricing derivatives on financial securities subject to credit risk. *The Journal of Finance*, 50 (1), 53-85.
- JIMENEZ G. AND SAURINA J. (2004), Collateral, type of lender and relationship banking as determinants of credit risk. *Journal of Banking and Finance*, 28, 2191-2212.
- JIMENEZ G. AND SAURINA J. (2006), Credit cycles, credit risk and prudential regulation. *International Journal of Central Banking*, June, 65-98.
- KEALHOFER S. (2003), Quantifying credit risk I: default prediction. *Financial Analysts Journal*, 59, 30-44.
- KEALHOFER S. (2003), Quantifying credit risk II: debt valuation. *Financial Analysts Journal*, 59, 78-92.
- KENT C. AND D'ARCY P. (2001), Cyclical prudence – credit cycles in Australia. BIS Papers, 1, 58-90.
- KERN M. AND RODOLPH B. (2001), Comparative analysis of alternative credit risk models: an application on German meddle market. Centre of Financial Studies, working paper 2001/03, 1-27.
- KOOPMAN S.J. AND LUCAS A. (2005), Business and default cycles for credit risk. *Journal of Applied Econometrics*, 20, 311-323.
- KOYLUOGLU H.U. AND HICKMAN A. (1998), A generalized framework for credit risk portfolio models. Oliver, Wyman and Co and CSFP, pp1-18.
- LONGSTAFF F.A. AND SCHWARTZ E. (1995), A simple approach to valuing risky fixed and floating debt. *Journal of Finance*, 50, 789-819.
- LOPEZ J.A. AND SAIDENBERG M. R. (2000), Evaluating credit risk models. *Journal of Banking and Finance*, 24, 151-165.
- LOPEZ J. A. (1999), Regulatory evaluation of Value at Risk models. *Journal of Risk*, 1, 37-64.
- LOWE P. (2002), Credit risk measurement and procyclicality. BIS Working Paper 116.
- MCKINSEY AND COMPANY (1998), CreditPortfolioView: approach documentation and user's documentation. Zurich: McKinsey and Company.
- MERTON R. C. (1974), On the pricing of corporate debt: the risk structure of interest rates. *Journal of Finance*, 29, 449-70.
- MOODY'S KMV (2004), Measuring and managing credit risk: understanding the EDF credit measure for public firms. EDF\_methodologie, online available at <http://www.moodyskmv.com>.
- MULLER-GROELING A. AND NIETHEN S. (2000), Rating transition matrices conditional on the business cycle. Working Paper, 2000.
- NANDI S. (1998), Valuation models for default-risky securities: an overview. Federal Reserve Bank of Atlanta, *Economic Review*, 22-35.
- NICKELL P., PERRAUDIN W. AND VAROTTO S. (2000), Stability of rating transitions. *Journal of Banking and Finance*, 24, 203-227.
- PEDERZOLI C. AND TORRICELLI C. (2005), Capital requirements and business cycle regimes: Forward-

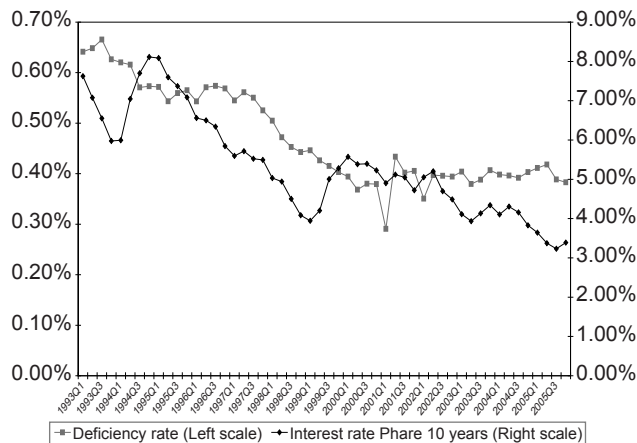
References (suite)

- looking modelling of default probabilities. *Journal of Banking and Finance*, 29, 3121-3140.
- SAUNDERS A. AND ALLEN L. (2002), *Credit risk measurement: new approaches to Value at Risk and other paradigms*. John Wiley and Sons, New York.
- SCHOONER H.M. AND TAYLOR M.W. (2010), *The new capital adequacy framework: Basel II and credit risk*. *Global Bank Regulation: Principles and Policies*, March 2010, pp. 147-164.
- SHUMWAY T. (2001), *Forecasting bankruptcy more accurately: a simple hazard model*. *The Journal of Business*, 74 (1), 101-124.
- SZEGO G. (2005), *Measures of risk*. *European Journal of Operational Research*, 163, 5-19.
- TUDELA M. AND YOUNG G. (2003), *Predicting default among UK companies: a Merton approach*. *Bank of England Financial Stability Review*, June 2003.
- WILSON T. (1997a), *Credit Portfolio Risk (I)*. *Risk Magazine*, Octobre 1997.
- WILSON T. (1997b), *Credit Portfolio Risk (II)*. *Risk Magazine*, Novembre 1997.
- WILSON T. (1998), *Portfolio credit risk*. *Federal Reserve Bank of New York Economic Policy Review*, October 1998, pp. 71-82.

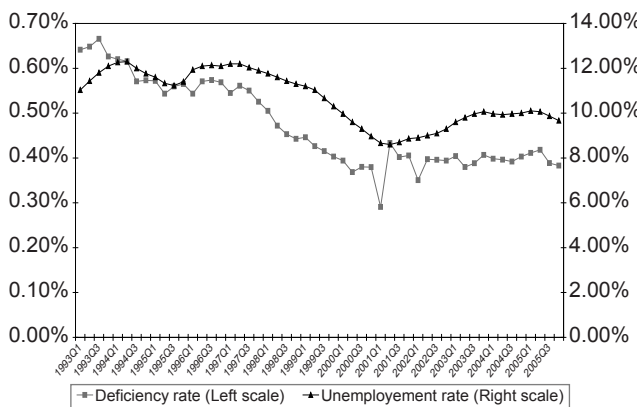
Graph 1. Deficiency rate and economic indicators evolutions



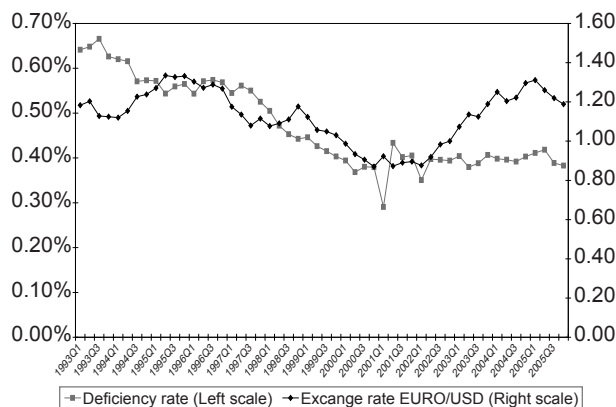
Graph.1.1: deficiency rate and SBF 250 index



Graph.1.2: deficiency rate and interest rate Phare 10 years

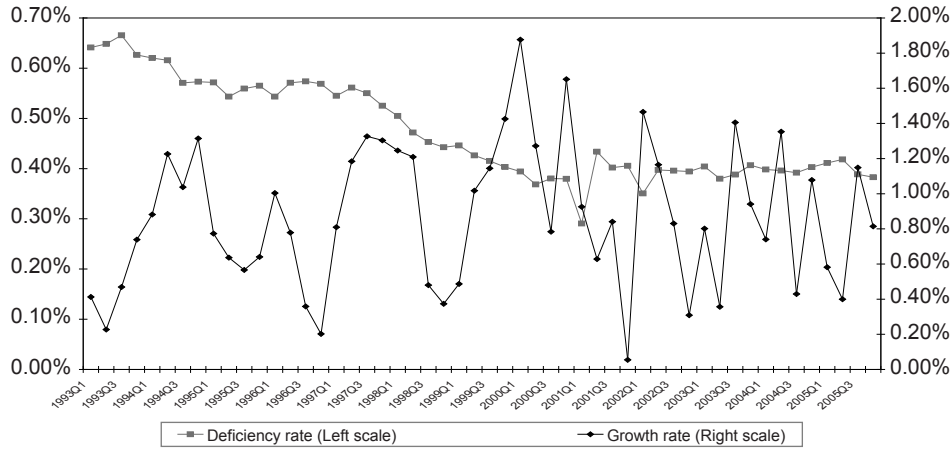


Graph.1.3: deficiency rate and unemployment rate



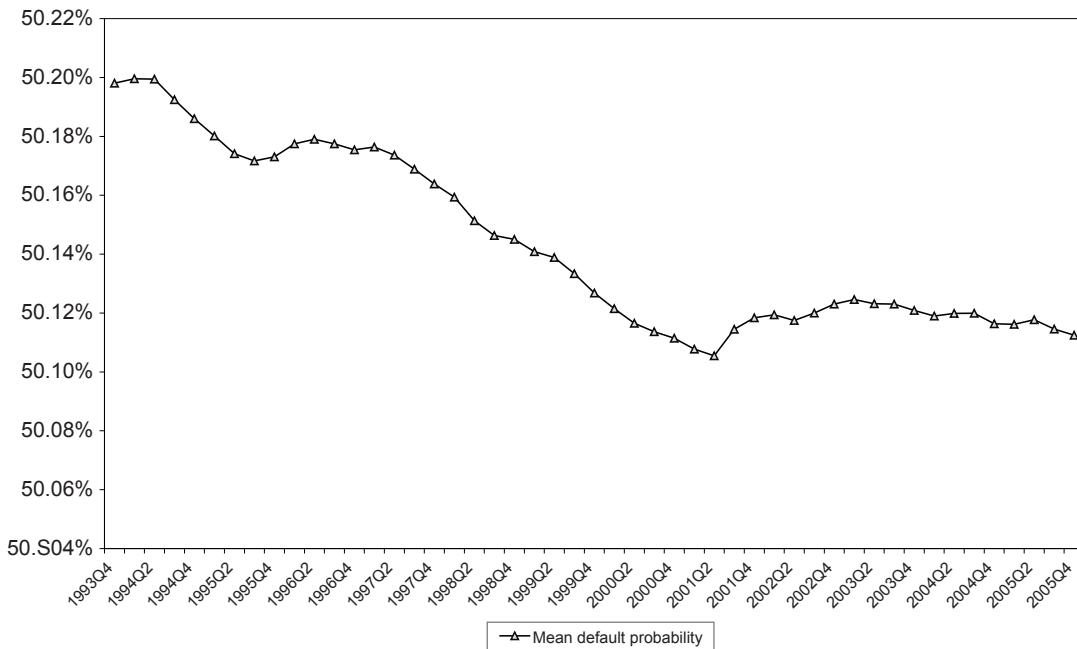
Graph.1.4: deficiency rate and exchange rate Euro/USD

**Graph 1. Deficiency rate and economic indicators evolutions (suite)**

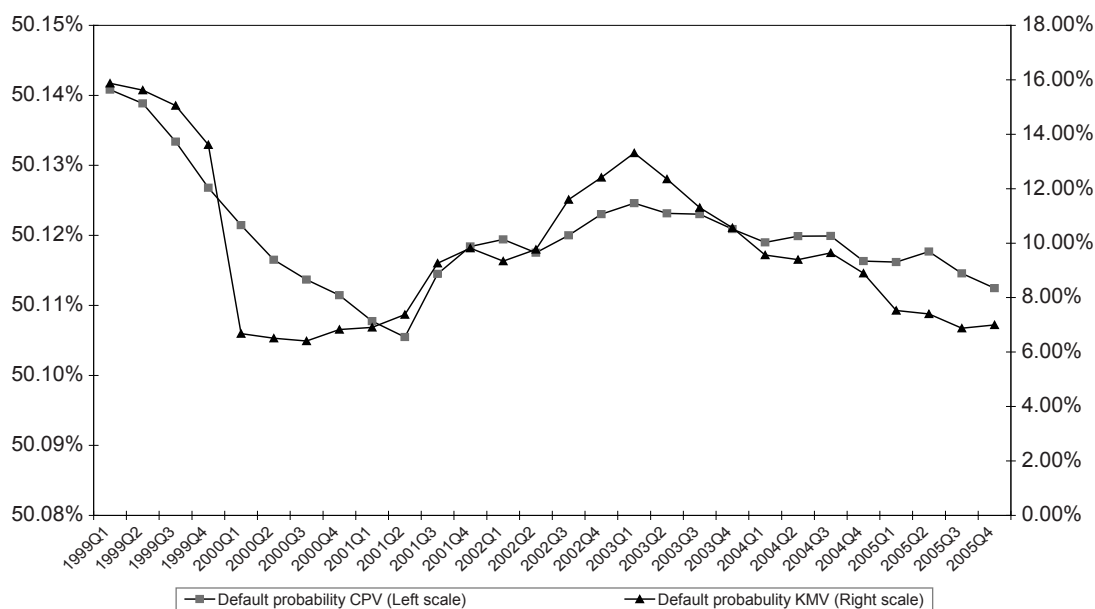


**Graph.1.5: deficiency rate and growth rate**

**Graph 2. Mean default probability evolution: CreditPortfolioView model**



**Graph 3. Comparison between the evolution of default probabilities: CreditPortfolioView Vs KMV's model.**



**Table 1. Results of model estimation by sector**

	C	DVA	DISBF	DTXINTER	DTXCHOM	DTXCHAN	R <sub>2</sub>	DW
Agricultural and Food Industries (AFI)	-0,002 * (-2,01)	-0,011 (-1,02)	0,019 (0,62)	0,019 *** (3,08)	0,009 (1,26)	0,168 *** (4,36)	0,66	2,017
Consumer Goods (CG)	-0,005 (-1,55)	-0,145 * (-1,78)	-0,056 *** (-2,97)	0,015 (0,89)	0,041 * (1,76)	0,023 (0,17)	0,59	1,971
Equipment Goods (EG)	-0,01 * (-1,83)	-0,317 * (-1,72)	-0,031 *** (-2,75)	-0,002 (-1,15)	0,026 * (1,87)	-0,027 (-1,66)	0,49	1,993
Intermediate Goods (IG)	0,005 *** (2,9)	-0,054 *** (-3,86)	-0,022 (-1,32)	0,021 * (1,87)	0,034 ** (2,42)	-0,012 (-0,13)	0,71	1,987
Construction (C)	0,008 * (1,72)	-0,063 ** (-2,31)	-0,043 *** (-2,97)	0,024 (0,93)	0,108 *** (3,23)	-0,02 (-0,18)	0,84	1,955
Trade (Tra)	0,002 (0,46)	-0,012 ** (-2,15)	-0,0201 (-1,21)	0,012 (1,17)	0,035 ** (2,31)	-0,078 (-1,05)	0,64	1,994
Transport (Transp)	0,002 (0,33)	-0,01 * (1,84)	-0,016 * (-1,87)	0,011 ** (1,98)	0,069 *** (2,7)	-0,25 * (-1,84)	0,47	1,967
Real Estate (RE)	-0,026 *** (-2,91)	-0,03 *** (-6,12)	-0,047 *** (-4,90)	0,019 (1,47)	0,017 (0,74)	0,24 *** (3,4)	0,7	1,943
Companies-Oriented Services (CompOS)	-0,004 (-0,65)	-0,002 (-1,67)	-0,046 *** (-2,36)	0,028 * (1,83)	0,007 (0,26)	-0,25 ** (-1,96)	0,58	1,973
Consumer-Oriented Services (ConsOS)	-0,00 (-0,77)	-0,002 (-0,13)	-0,016 (1,03)	0,017 * (1,83)	0,04 *** (2,75)	0,024 (0,27)	0,5	2,006
All sectors included	0,009 (1,42)	-0,005 ** (-2,43)	-0,029 *** (-4,04)	0,02 *** (3,14)	0,03 * (2,003)	-0,14 * (-1,77)	0,56	2,05

Student static's are between parentheses;

D means that series are in the first difference level;

Estimation period: 1993 [T1] – 2005 [T4].

\* Significance at 10%.

\*\* Significance at 5%.

\*\*\* Significance at 1%

### Appendix A.1. Industry-sector definition and NAF code.

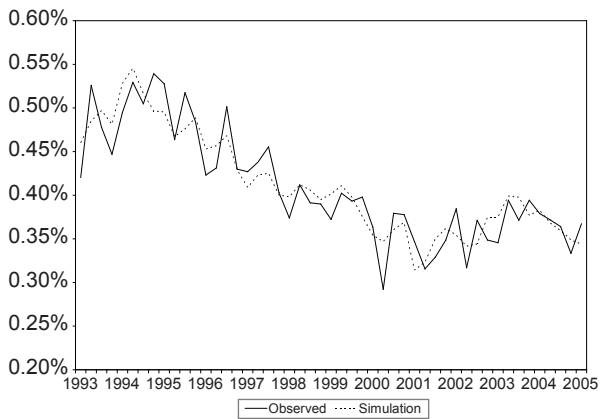
Industry-sector	NAF code
Agricultural and Food Industry	15 ET 16
Consumer Goods	18, 19, 22, 24.4, 24.5, 29.7, 32.3, 33.4, 33.5, 36
Equipment Goods	28.1, 28.2, 28.3, 29.1 à 29.6, 30, 31.1, 32.2, 33.1, 33.2, 33.3, 35
Intermediate Goods	13, 14, 17, 20, 21, 24.1, 24.2, 24.3, 24.6, 24.7, 25, 26, 27, 28.4, 28.5, 28.6, 28.7, 31.2 à 31.6, 32.1, 37
Construction	45
Trade*	50, 51, 52
Transport	60, 61, 62, 63
Real Estate	70
Companies-Oriented Services**	64, 65, 66, 67, 71, 72, 73, 74, 90
Consumer-Oriented Services ***	55, 92, 93, 95

\*This sector includes all the business kinds: Motor Vehicle Repair and Maintenance (or Motor Vehicle Dealers) (50), Food and Beverage Merchant Wholesalers (51.2, 51.3), Non-Food and Beverage Merchant Wholesalers (51.1, 51.4, 51.5, 51.6, 51.7), Non Specialized Retail Trade (52.1), Food and Beverage Retail Trade (52.2), and Miscellaneous Store Retailers (52.3, 52.4, 52.5, 52.6, 52.7) (Clothing, Leather, House Goods, Arts, Entertainment, and Recreation).

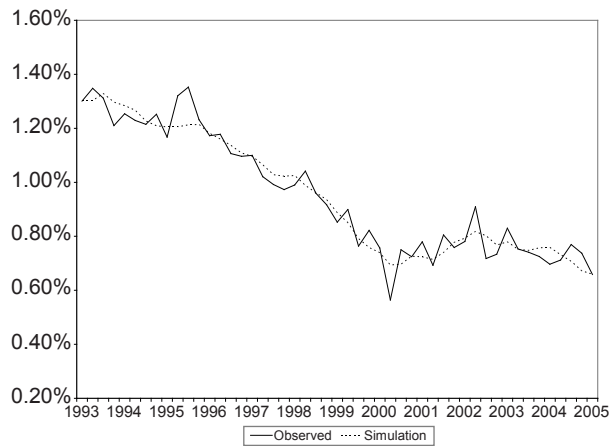
\*\* Companies-Oriented Services including financial activities and telecommunication

\*\*\* Consumer-Oriented Services including hotels, café shops and restaurants.

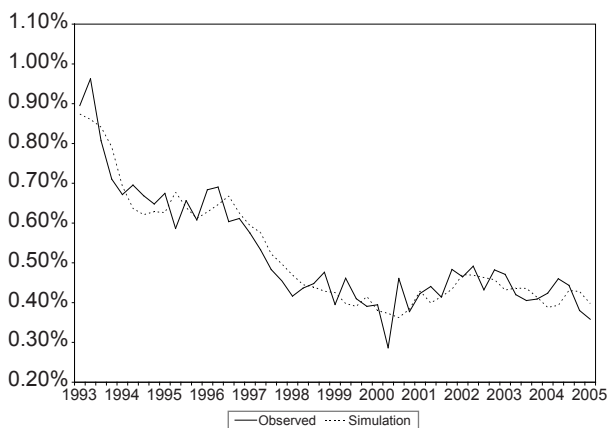
### Appendix A.2. Retrospective simulation of sector by sector deficiency rates



AFI sector



CG sector

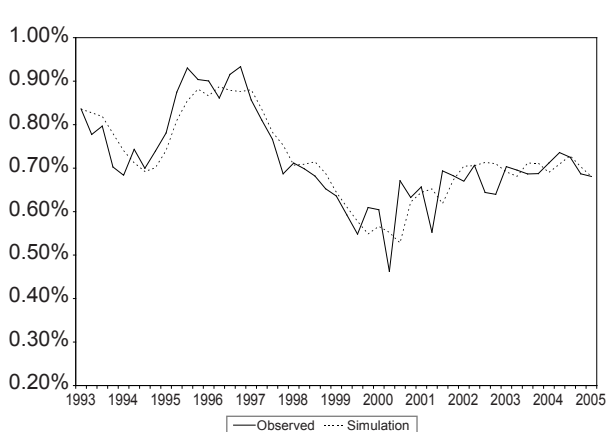


EG sector

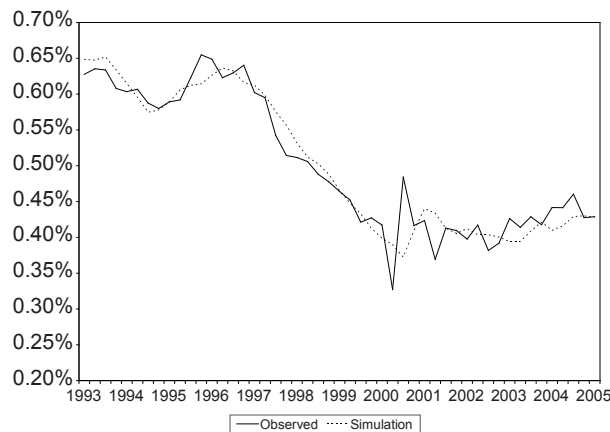


IG sector

Appendix A.2. Retrospective simulation of sector by sector deficiency rates (suite)



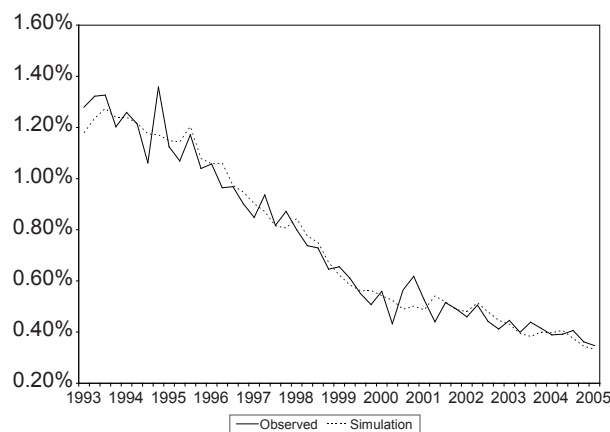
**C sector**



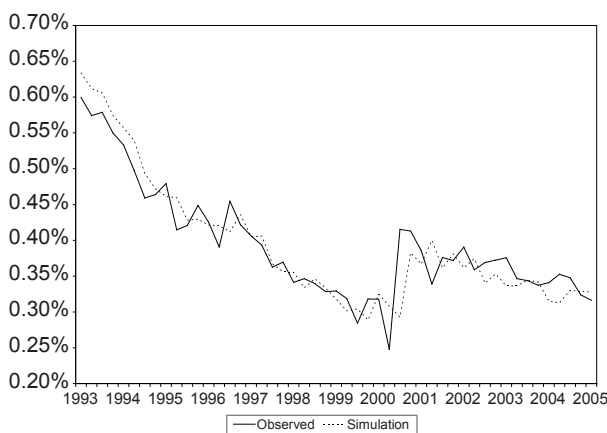
**TRA sector**



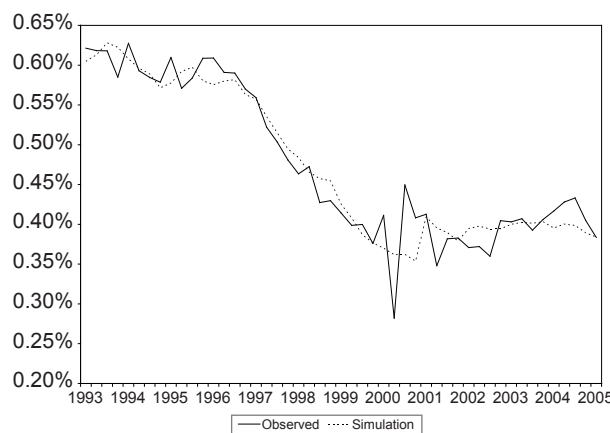
**Transp sector**



**RE sector**



**CompOS sector**



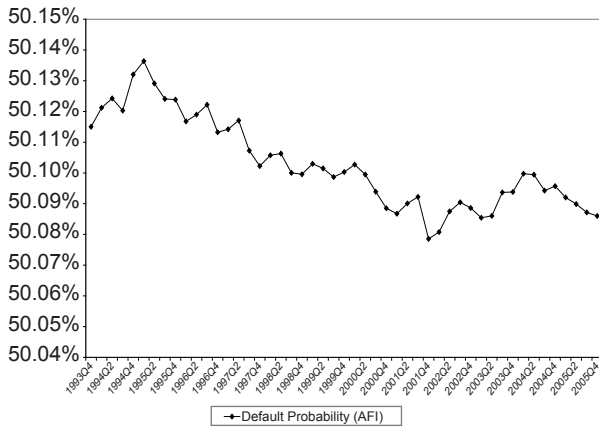
**ConsOS sector**

Appendix A.2. Retrospective simulation of sector by sector deficiency rates (suite)

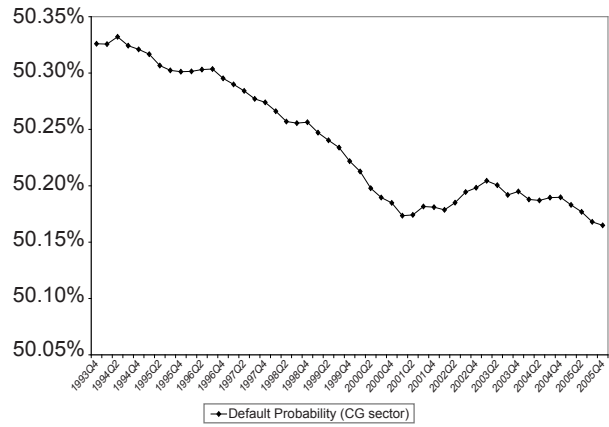


All sectors

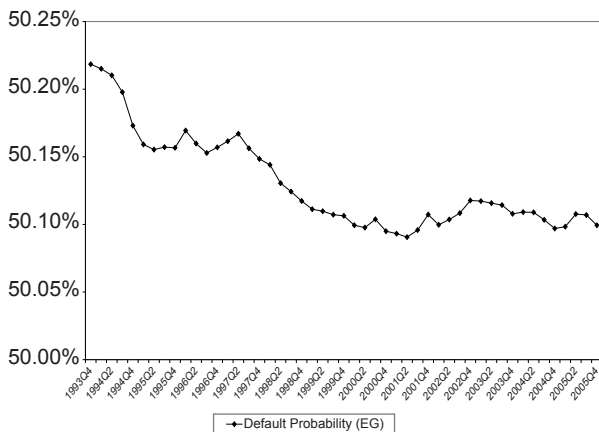
Appendix A.3. Default probability evolution : CreditPortfolioView Model



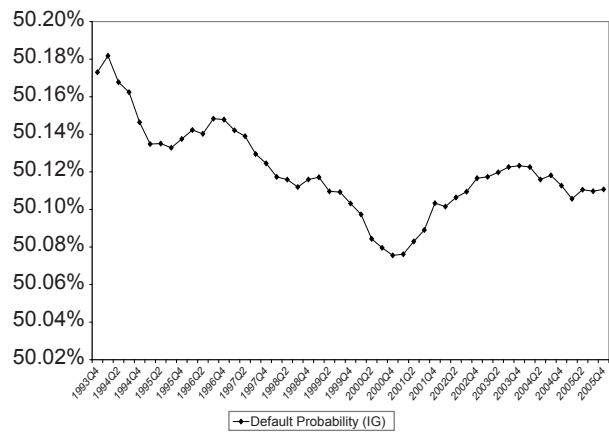
Graph.1 : Default probability : AFI Sector



Graph.2 : Default probability: CG sector

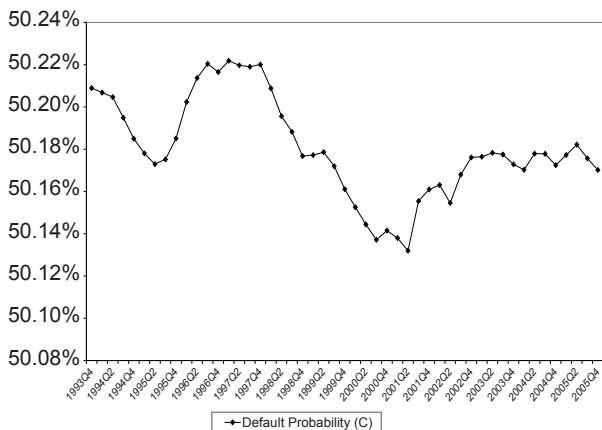


Graph.3 : Default probability: EG sector

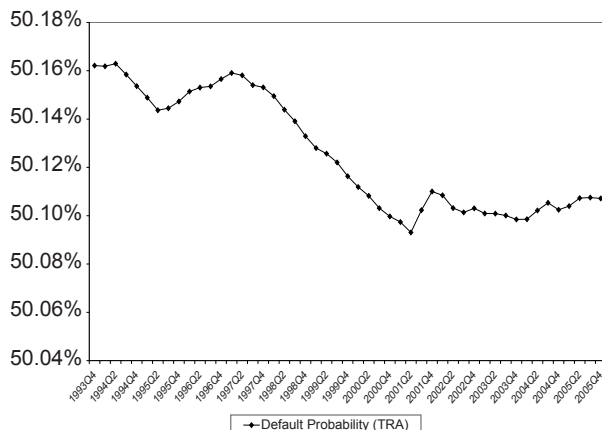


Graph.4 : Default probability: IG sector

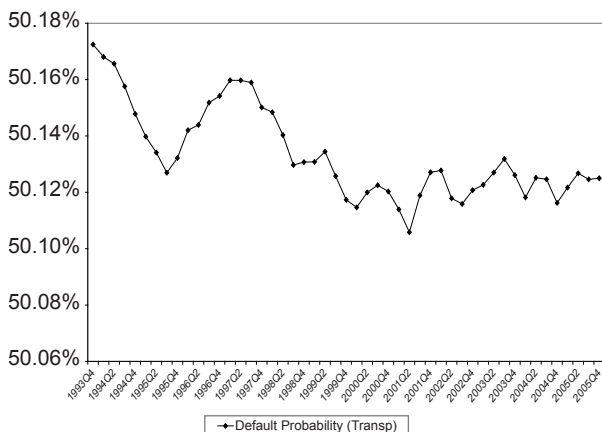
Appendix A.3. Default probability evolution : CreditPortfolioView Model (suite)



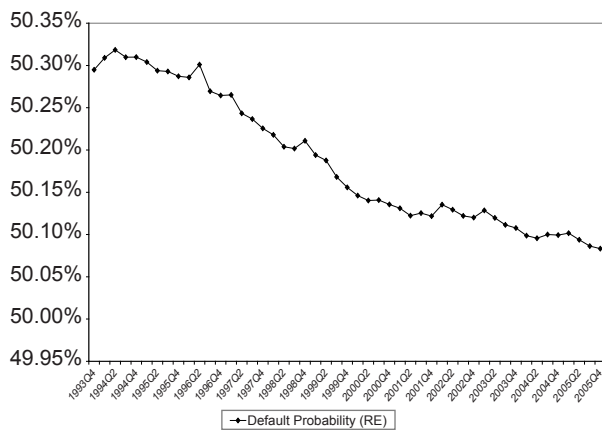
Graph.5 : Default probability: C sector



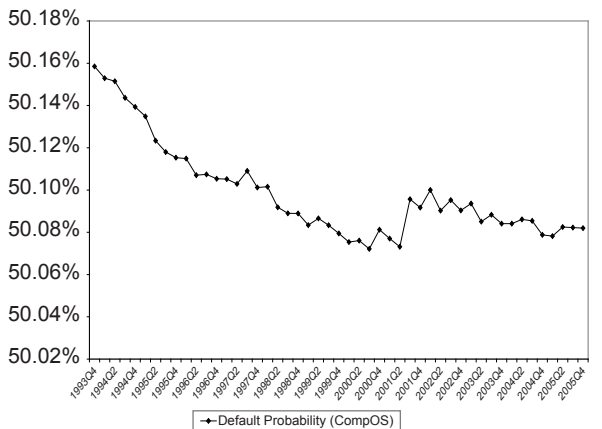
Graph.6 : Default probability: Tra sector



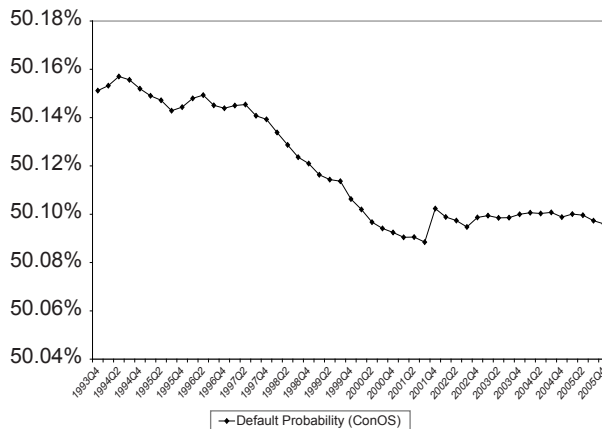
Graph.7 : Default probability: Transp sector



Graph.8 : Default probability: RE sector

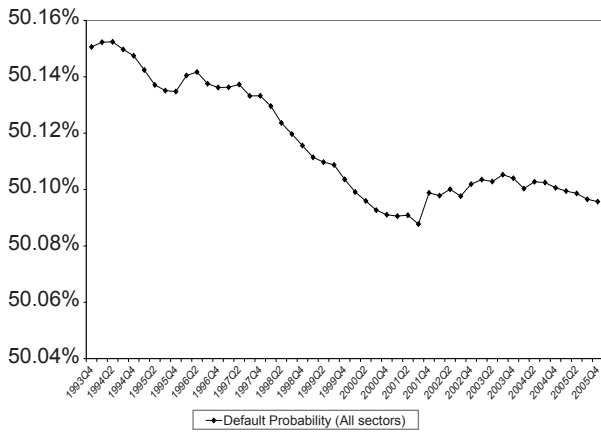


Graph.9 : Default probability: CompOS sector

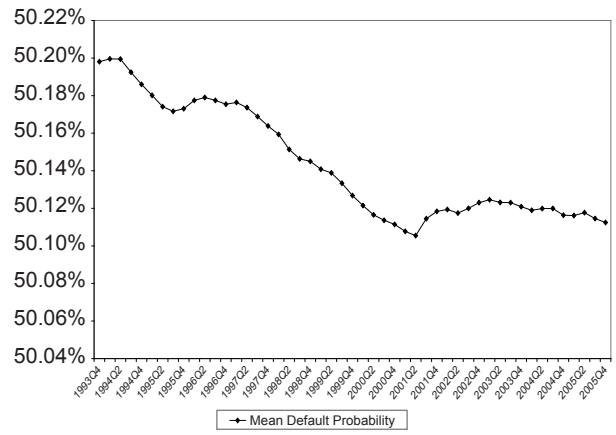


Graph.10 : Default probability: ConsOS sector

Appendix A.3. Default probability evolution : CreditPortfolioView Model (suite)



Graph.11 : Default probability: All sectors



Graph.12 : Mean default probability