Development of a financial health indicator based on companies' annual accounts

Working Paper Document

David Vivet

April 2011 No 213

National Bank OF BELGIUM
Eurosystem

Editorial Director
Jan Smets, Member of the Board of Directors of the National Bank of Belgium

Orders
For orders and information on subscriptions and reductions: National Bank of Belgium,
Documentation - Publications service, boulevard de Berlaimont 14, 1000 Brussels.

Tel +32 2 221 20 33 - Fax +32 2 21 30 42

The Working Papers are available on the website of the Bank: http://www.nbb.be.

ISSN: 1375-680X (print)
ISSN: 1784-2476 (online)

Abstract

This document describes the development of a financial health indicator based on companies' financial statements. This indicator is conceived as a weighted combination of variables, which is obtained through a model discriminating between failing firms and non-failing firms. The definition of failure is based on a legal criterion, namely that a company is considered to have failed if it has faced bankruptcy or judicial administration in the past. Based on the model results, companies are positioned in financial health classes, which are intended to be included in the "company files" designed by the Central Balance Sheet Office.

Key words: Corporate failure, logistic regression, micro-data, financial statements

JEL codes: C25, G30, G33

Corresponding author:

David Vivet, Microeconomic Information Department, NBB, e-mail: david.vivet@nbb.be

The author would like to thank Philippe Moës (Research Department) and Patrick Van Roy (Financial Stability Department) for their valuable comments on an earlier version of this paper. He also thanks colleagues from the Microeconomic Information Department, in particular François Coppens for stimulating conversations.

TABLE OF CONTENTS

INTRODUCTION

This document describes the development of a financial health indicator based on Belgian companies' annual accounts. This indicator is designed as a weighted combination of variables, created by means of a model constructed in the same way as a failure prediction model. The model takes the form of a logistic regression discriminating between failing and non-failing companies. The definition of failure is based on a legal criterion, namely that a company is considered to have failed if it has faced bankruptcy or judicial administration in the past.

The indicator summarises each company's situation in a single value which takes account simultaneously of the solvency, liquidity and profitability dimensions. Those dimensions are complementary in the establishment of a financial diagnosis, as a high debt level, for example, may be offset by a plentiful cash flow, and vice versa. The indicator also takes account of the companies' age and size, particularly through interaction variables.

The indicator constitutes a strictly financial assessment of the companies at a given moment. That assessment is based on data from the annual accounts, and therefore disregards any other fundamental elements, such as development prospects, competition, management calibre or shareholders' willingness to provide financial support. In that respect, it must be regarded as one of the factors enabling an overall appraisal of a firm's situation.

Initially, the Bank's aim was to have an indicator for all non-financial companies filing annual accounts with the Central Balance Sheet Office, i.e. around 300,000 observations for the 2008 financial year. However, preliminary analyses showed that some companies' data are difficult to interpret in the context of a large-scale statistical model. Much of the initial work therefore consisted in determining the contours of a population which was homogenous, in order to ensure that the results met a minimum standard of reliability.

That is why the indicator is calculated for companies satisfying a number of conditions, relating to such factors as size, length of the accounting period and content of the annual accounts. The population thus defined contains over 200,000 observations for recent financial years (225,000 in 2008). It is significantly larger than the populations examined in most comparable studies. The model nevertheless obtains very satisfactory and stable performances.

In view of the number of companies and items studied, the quantity of information processed proved to be particularly voluminous. The actual modelling was therefore preceded by laborious manipulation, cleaning and cross-checking of the source data in order to obtain coherent and analysable datasets.

The model presented in the third part replaces the previous model developed by the Bank. There are several improvements on the last version. First, the new model covers a population which is more than twice as large. This implies that the results are very widely appli-

cable. Second, in order to select the most relevant variables, particular attention was paid to data exploration. The new model thus includes logarithmic as well as dummy variables; it also takes account of interaction phenomena, which makes it possible to differentiate effects for some segments of the population. Analysis further showed that variables relating to overdue debts to the authorities have to be excluded, although they took a predominant role in the previous model. On the one hand, their predictive efficiency has been noticeably eroded over the last few years and, on the other hand, their reliability is seriously called into question. On the whole, when applied to recent years, the new model performs markedly better than the previous one.

The development of the financial health indicator falls within the scope of literature on bankruptcy prediction models. First models were developed by the end of the sixties (Beaver (1967) and Altman (1968)). Since then, interest paid to the topic has continuously grown, in particular for the purpose of credit risk assessment. Financial institutions thus developed in-house systems which are primarily intended to the estimation of individual probabilities of default. Unlike such systems, the model presented in this document is meant for external users and is aimed at summarising the situation of each company in one single value, i.e. the financial health indicator. In that respect, the group of companies in a bankruptcy or judicial administration situation is regarded as a benchmark for a weakened financial situation.

This document is intended for a broad public, including the end users, and therefore favours graphic analysis. It is divided into three parts. Part I presents the methodological aspects, namely the population studied, the variables and the technique of logistic regression. Part II describes the preliminary results used as the basis for constructing the model, including the individual regressions, distributions, correlations and interactions. Part III presents the final model, the indicator and the financial health classes derived from it. These are intended for incorporation in the company files prepared by the Central Balance Sheet Office in the form presented in section III.4.

PART I METHODOLOGY

I.1 POPULATION STUDIED

Initially, the Bank aimed to study all non-financial companies filing annual accounts with the Central Balance Sheet Office, i.e. the equivalent of 300,000 sets of accounts for the 2008 financial year[1]. However, it soon became apparent that this population needed to be limited to a more homogenous group, since some companies' data cannot really be interpreted in the context of a large-scale statistical model. This applies in particular to very small companies, "idle" companies and companies with a financial year different from 12 months.

Thus, following exploration, the population was confined to annual accounts satisfying the following conditions:
- passing the logical and arithmetical checks done by the Central Balance Sheet Office;
- balance sheet total of €50,000 or more;
- 12-month financial year;
- legal form: public limited company, private limited company or cooperative society;
- conditions regarding content: current assets, total debts and short-term debts larger than zero.

The condition relating to the balance sheet total is the most restrictive regarding the number of excluded annual accounts. That condition was necessary because the data from very small companies raise problems of interpretation. For one thing, their distributions are affected by numerous extreme values. Also, preliminary regressions showed that they are a significant source of errors, owing to their greater volatility.

The exclusion of financial years with a duration of less than 12 months is intended to ensure that the annual accounts are representative, and that the balance sheet amounts (stocks) are comparable with those in the profit and loss accounts (flows).

The population was then restricted to the main forms of commercial companies with limited liability (which represent over 95% of the annual accounts filed). Thus, partnerships, social enterprises and companies governed by public law were excluded. Preliminary analyses showed that these forms of company have either high error rates or virtually zero failure rates. In many cases, they are also not directly concerned by the issue of bankruptcy (public/quasi-public corporations, housing associations, ...).

Finally, the annual accounts have to satisfy minimum content conditions concerning the existence of current assets and liabilities in excess of zero. These conditions are neces-

[1] The set of non-financial companies as defined by the Central Balance Sheet Office corresponds to all the annual accounts filed in the full or abbreviated format. That set excludes, in particular, a large part of the financial sector and insurance companies.

sary for calculating certain financial ratios, and make it possible to exclude some of the “idle” companies.

The population thus defined is presented in tables 1 and 2. It comprises over 200,000 sets of annual accounts for recent financial years, with a maximum of 225,000 for the year 2008. The number of observations reported in the tables relates not to companies but to annual accounts. The same company may in fact be absent from the population for one financial year but present for another, depending on whether its annual accounts satisfy the conditions specified above. In the rest of this document, the terms “annual accounts” and "observations" will be used indiscriminately, both referring to the model’s analysis unit.

TABLE 1 POPULATION STUDIED, BY FINANCIAL YEAR

Financial year	Number of observations
1995	136,357
1996	138,399
1997	147,359
1998	155,330
1999	163,736
2000	170,722
2001	173,557
2002	179,784
2003	191,733
2004	200,830
2005	206,165
2006	213,468
2007	221,209
2008	225,389

Source: NBB.

Even after exclusion of companies with a balance sheet total of less than €50,000, the population still includes numerous small companies (table 2): 40% of the observations concern a balance sheet total of less than €250,000, and almost half the companies do not report any workers. Private limited companies represent 62% of the companies studied, against 35% for public limited companies and 3% for cooperatives. Over a third of the observations do not report any debts to credit institutions. Finally, the very great majority (92.9%) of the annual accounts are filed in the abbreviated format, which considerably reduces the range of available financial variables (cf. section I.3.1).

TABLE 2 CHARACTERISTICS OF THE POPULATION
(2008 financial year)

	Number of observations	Percentage
Legal forms		
Public limited companies	79,559	35.3
Private limited companies	139,353	61.8
Cooperative societies with limited liability	6,477	2.9
Total	225,389	100.0
Formats		
Full format	15,895	7.1
Abbreviated format	209,494	92.9
Total	225,389	100.0
Balance sheet total		
Balance sheet total < €250,000	90,001	39.9
€250,000 ≤ balance sheet total < €5,000,000	122,960	54.6
Balance sheet total ≥ €5,000,000	12,428	5.5
Total	225,389	100.0
Debts to credit institutions		
Yes	145,558	64.6
No	79,831	35.4
Total	225,389	100.0

Source: NBB.

I.2 DEPENDENT VARIABLE

In a model, the dependent variable is the variable to be explained. This study aims to explain corporate failure, which is why it defines a dependent variable representing that concept. The definition of failure is based on a legal criterion, namely that a company is considered to have failed if it has faced bankruptcy or judicial administration in the past.

I.2.1 Concept of failure

There is no single definition of a business in difficulties. However, the concepts of bankruptcy and judicial administration can be regarded as good approximations, in view of their legal basis. Bankruptcy assumes that a company has ceased payments and is uncreditworthy[2]. The status of judicial administration, which was replaced by new procedures in 2009, was intended for businesses which were temporarily unable to repay their debts[3]. By that token, and given the period covered by this study (financial years 1995 to 2008),

[2] Law of 8 August 1997 on bankruptcies, amended by the Law of 4 September 2002. Article 2: a tradesman who has persistently suspended his payments and is unable to raise credit is in a bankruptcy situation.

[3] Law of 17 July 1997 on judicial administration. Article 9 §1: judicial administration may be granted to any debtor who is temporarily unable to pay his debts or if the continuity of his enterprise is threatened by difficulties which could sooner or later lead to cessation of payments.
The Law of 31 January 2009 on the continuity of enterprises puts more emphasis on prevention and introduces new procedures replacing judicial administration. That law came into force on 1 April 2009, and at the time of conducting this study the Crossroads Bank for Enterprises did not identify enterprises embarking on these procedures. It was therefore not possible to take account of the law's implications. Regarding the new law, see Windey J. (2009), for example.

past judicial administration procedures are regarded as equivalent to failure events. Bankruptcies represent the very great majority of those events (over 95%).

The model described in Part III is constructed in the same way as a failure prediction model. However, it is called a "financial health model" because its primary aim is to establish an objective concept of financial health. In that respect, the group of companies facing bankruptcy or judicial administration is regarded as a benchmark for a weakened financial situation. The univariate analysis will verify that the situation of these companies is seriously weakened. Companies which the model considers to be “at risk” will also prove to be significantly less solvent, profitable or liquid than companies considered to be healthy.

I.2.2 Variables

The model focuses on failure prediction at a three-year horizon: a company is considered to have failed if it has been involved in bankruptcy or judicial administration proceedings within 1,095 days (i.e. 3 x 365 days) following the closing date of its annual accounts. Other companies are considered as non-failing. The failure date used is the date upon which the company's legal status changed (to one of bankruptcy or judicial administration) at the Crossroads Bank for Enterprises[4].

The dependent variable DEF identifies each set of annual accounts on the basis of that definition:
- DEF = 1 if the company has failed within 1,095 days following the closing date;
- DEF = 0 if it has not.

Table 3 details the population according to the variable DEF (situation as at 1 June 2010). Over the period studied, the failure rate at 3 years fluctuates between 2 and 3%. There is a link between the rate of observations DEF=1 and the economic cycle: the highest rate over the past ten years was observed in 2001, which was a low point in the cycle. The failure rate then began falling in line with a more favourable economic environment before starting to rise again in 2006, under the influence of the rise in bankruptcies from 2008. Since the table describes the situation as at 1 June 2010, the number of observations DEF=1 is incomplete for the years 2007 and 2008. As a consequence, the rate of failing observations is not significant for these two years.

Table 4 shows that bankruptcies and judicial administrations result in very similar financial positions, seriously weakened compared to non-failing companies. That finding justifies the decision to treat judicial administration procedures in the same way as failures. The financial ratios are defined in detail in Annex 1.

[4] The Crossroads Bank for Enterprises is the National Bank’s source for data identifying legal entities.

TABLE 3 POPULATION STUDIED ACCORDING TO THE VARIABLE DEF
(situation as at 1 June 2010, number of observations, unless otherwise stated)

Financial year	DEF = 1	DEF = 0	TOTAL	Rate of observations DEF=1
1995	3,911	132,446	136,357	2.87
1996	3,419	134,980	138,399	2.47
1997	3,485	143,874	147,359	2.36
1998	3,719	151,611	155,330	2.39
1999	4,136	159,600	163,736	2.53
2000	4,434	166,288	170,722	2.60
2001	4,623	168,934	173,557	2.66
2002	4,415	175,369	179,784	2.46
2003	4,416	187,317	191,733	2.30
2004	4,343	196,487	200,830	2.16
2005	4,152	202,013	206,165	2.01
2006	4,819	208,649	213,468	2.26
2007	4,274	216,935	221,209	n.s.
2008	1,928	223,461	225,389	n.s.

Source: NBB.

TABLE 4 MEDIAN FINANCIAL SITUATION ACCORDING TO THE LEGAL STATUS (2006)

	DEF =1		DEF = 0
	Bankruptcies	Judicial administration	
Financial independence	0.08	0.07	0.32
Liquidity in the broad sense	0.97	0.91	1.29
Net return on total assets before taxes and interest charges	0.02	0.02	0.06
Cash flow to debt coverage ratio	0.04	0.04	0.15

Source: NBB.

In order to analyse the financial dynamics of failure, the variable DEFDETAIL was defined. It details the temporal proximity of failures in tranches of 365 days:

- DEFDETAIL = DEF01 if time to failure[5] ≤ 365 days;
- DEFDETAIL = DEF02 if 365 days < time to failure ≤ 730 days;
- DEFDETAIL = DEF03 if 730 days < time to failure ≤ 1095 days;
- DEFDETAIL = DEF04 if 1095 days < time to failure ≤ 1460 days;
- DEFDETAIL = DEF05 if 1460 days < time to failure ≤ 1825 days;
- DEFDETAIL = DEF06 if 1825 days < time to failure ≤ 2190 days;
- DEFDETAIL = DEF07 if 2190 days < time to failure ≤ 2555 days;
- DEFDETAIL = DEF08 if 2555 days < time to failure ≤ 2920 days;
- DEFDETAIL = DEF09 if 2920 days < time to failure ≤ 3285 days;
- DEFDETAIL = DEF10 if 3285 days < time to failure ≤ 3650 days;
- DEFDETAIL = NODEF in other cases.

[5] I.e. the difference between the failure date and the closing date of the annual accounts.

TABLE 5 BREAKDOWN OF THE OBSERVATIONS ACCORDING TO DEFDETAIL
(number of observations per financial year, situation as at 1 June 2010)

Financial year	DEF01	DEF02	DEF03	DEF04	DEF05	DEF06	DEF07	DEF08	DEF09	DEF10	NODEF	TOTAL
1995	632	1,703	1,576	1,499	1,328	1,339	1,266	1,267	1,226	1,064	123,457	136,357
1996	559	1,395	1,465	1,339	1,412	1,337	1,328	1,270	1,152	1,008	126,134	138,399
1997	523	1,507	1,455	1,543	1,534	1,524	1,436	1,298	1,115	980	134,444	147,359
1998	549	1,432	1,738	1,724	1,677	1,627	1,465	1,235	1,063	1,067	141,753	155,330
1999	556	1,721	1,859	1,943	1,838	1,652	1,376	1,204	1,171	1,267	149,149	163,736
2000	640	1,753	2,041	2,035	1,768	1,539	1,348	1,315	1,414	659	156,210	170,722
2001	698	1,908	2,017	1,812	1,612	1,410	1,361	1,484	727	8	160,520	173,557
2002	715	1,842	1,858	1,736	1,498	1,441	1,599	796	12		168,287	179,784
2003	729	1,812	1,875	1,659	1,654	1,773	881	17			181,333	191,733
2004	749	1,802	1,792	1,823	2,017	988	14				191,645	200,830
2005	692	1,622	1,838	2,202	1,089	18					198,704	206,165
2006	708	1,766	2,345	1,187	16						207,446	213,468
2007	790	2,232	1,252	15							216,920	221,209
2008	859	1,053	16								223,461	225,389

Source: NBB.

The observations considered to be failing in this study therefore correspond to modalities DEF01, DEF02 and DEF03 of the variable DEFDETAIL. The breakdown of the observations according to that variable is presented in table 5. Leaving aside accounts for which the financial year does not correspond to the calendar year, the boxes on the same diagonal relate to failures occurring during one and the same year: for example, observations DEF10 in 1999, observations DEF09 in 2000, up to observations DEF01 in 2008, concern failures which occurred in 2009.

Table 5 shows in particular that many observations DEF01 are missing: for example, there are 859 observations DEF01 in 2008, compared to 2,232 observations DEF02 in 2007. The main reason is that, for many observations DEF01, the date of failure precedes the statutory deadline for filing the annual accounts, i.e. no later than seven months after the end of the financial year. Once bankruptcy has been declared, there is no longer any incentive to file the annual accounts. This non-availability of the observations DEF01 was the reason for choosing a three-year horizon for defining failure, in order to have a sufficiently representative number of observations DEF=1. It is also necessary to point out that the model results concern companies in order of filing, and that failure to respect this statutory obligation acts as a warning prior to any financial diagnosis.

I.3 INDEPENDENT VARIABLES

The independent variables are the variables destined to predict failure in the model. They are constructed on the basis of the information available at the Central Balance Sheet Office and the Crossroads Bank for Enterprises. They include financial variables, size variables and age variables. The contextual variables (linked to the macroeconomy or the branch of activity) were analysed, but in the end they were not taken into account in the modelling (cf. section I.3.4).

I.3.1 Financial variables

Financial variables are divided into two groups: financial ratios and additional variables.

I.3.1.1 Financial ratios

Around fifty financial ratios were tested in the data exploration phase. For conciseness, this document describes the results for the ratios below (see annex 1 for full definition). These ratios are based on the international literature on failure prediction (cf. bibliography) and cover the main dimensions of the financial analysis, namely solvency, liquidity and profitability. These dimensions are interdependent and their boundaries are clearly not water-tight.

Solvency

EQUITY	Equity in proportion to total liabilities
SELFIN	Degree of self-financing

DEBT1	Debt level
DEBT2	Short-term debt level
DEBT3	Long-term debt level
DEBT4	Financial debts in proportion to total liabilities
DEBT5	Debts to credit institutions in proportion to total liabilities
CHARGES	Debt interest charges in proportion to total liabilities
COVERAGE1	Cash flow to debt coverage ratio
COVERAGE2	Cash flow to short-term debt coverage ratio

Liquidity

LIQ1	Liquidity in the broad sense
LIQ2	Liquidity in the strict sense
LIQ3	Net cash position in proportion to total assets
LIQ4	Cash and current investment in proportion to total assets
LIQ5	Cash and current investment in proportion to current assets
OVERDUE	Overdue debts to tax authority and/or NSSO in proportion to total liabilities

Profitability

RETURN1	Gross return on total assets before taxes and interest charges
RETURN2	Net return on total assets before taxes and interest charges
RETURN3	Gross operating profitability
RETURN4	Net operating profitability
RETURN5	Value added in proportion to total assets

The solvency ratios reflect the companies' ability to honour their short- and long-term financial commitments. First, they comprise ratios relating to the balance sheet structure which measure financial independence and debt levels (EQUITY, SELFIN, DEBT1, DEBT2, DEBT3, etc.). If the debt level is low, the company is independent of borrowings, and that has two positive implications: first, financial charges are low and therefore have little adverse impact on profits; also, if necessary, new borrowings can be contracted easily and on good terms. The balance sheet structure ratios are vital to the solvency diagnosis. However, they are not sufficient since they do not enable assessment of the firms' ability to repay their debts, or the associated level of charges.

These other dimensions therefore have to be incorporated in the financial assessment, especially the variables relating to cash flow (COVERAGE1 and COVERAGE2). Cash flow is the net flow of cash generated by a firm, i.e. the difference between income received and expenses paid out. The degree to which the cash flow covers borrowings, measuring the proportion of the debts that the firm could repay by allocating its entire available cash flow to that purpose, is a measure of the repayment capability. The information supplied by this ratio supplements that obtained from the structure ratios, as a high debt level may be viewed differently in the light of a high repayment capability, and vice versa.

The liquidity ratios reflect the ability of companies to meet their short-term commitments. Liquidity provides a safety margin to absorb any cash shocks. It is measured via the con-

ventional ratios relating to liquidity in the broad sense and in the strict sense (LIQ1 and LIQ2), and the ratios directly relating to the cash position (LIQ3, LIQ4 and LIQ5). Overdue debts to the tax authority and the NSSO are also examined via the variable OVERDUE.

Finally, the profitability ratios reflect the ability of firms to generate profits. Profitability is one of the main determinants of solvency and liquidity: in the long term, the firm has to generate sufficient income to guarantee its viability; in the short term, negative profitability is a threat to liquidity. The ratios examined concern the operating result and the final result in their gross and net forms.

The diversity of the population studied considerably reduces the range of financial variables which can be used: for example, ratios with a denominator which may be negative (return on capital, value added ratios, etc.) or equal to zero (investment ratios) are excluded, as well as dynamic variables (i.e. variables implying successive annual accounts). Such variables would indeed lead to the exclusion of numerous observations, particularly those close to failure. Ratios which can only be calculated for full-format accounts are also excluded, since over 90% of the observations concern abbreviated accounts.

Finally, it is assumed that the annual accounts provide a true picture of the financial situation of each company. On that subject, while a minimum level of reliability is guaranteed if the data pass the arithmetical and logical checks conducted by the Central Balance Sheet Office, the possibility of creative accounting cannot be ruled out. It must also be said that the majority of the companies studied are not required to appoint an auditor to check their annual accounts.

I.3.1.2 Additional variables

The financial ratios are supplemented by a set of dummy and logarithmic variables. The dummy variables are equal to 1 or 0, depending on the company's situation. In contrast to the ratios (continuous variables), they make it possible to divide the population into different segments. The following dummy variables were defined:

EQNEG = 1 if the equity capital is negative, otherwise 0;
CASHNEG = 1 if the cash flow is negative, otherwise 0;
RESNEG = 1 if the net result is negative, otherwise 0;
OVERPOS = 1 if OVERDUE is positive, otherwise 0;
CREDPOS = 1 if the annual accounts indicate debts to credit institutions, otherwise 0;
DISTRIB = 1 if profits are distributed, otherwise 0;
REMCAP = 1 if the capital is remunerated, otherwise 0;
ALARM1 = 1 if the net assets equal less than half the authorised capital, otherwise 0;
ALARM2 = 1 if the net assets equal less than a quarter of the authorised capital, otherwise 0.

The variables EQNEG, CASHNEG, RESNEG, OVERPOS and CREDPOS are derived from the financial ratios defined in the preceding section. The other binary variables are based on additional information available in the annual accounts. The variables DISTRIB and REMCAP take account of the way in which companies allocate their profits. The

variables ALARM1 and ALARM2 identify the companies according to whether or not they meet the conditions for the “alarm bell” procedure laid down in Articles 332, 431 and 633 of the Company Code: when the management body finds that the company’s net assets have fallen below half or below a quarter of the authorised capital, it has to prepare a special report and convene the general meeting of shareholders within two months in order to decide on the continuation of the company and any recovery measures[6].

Certain ratios were also tested in logarithmic form, in order to compress the upper extremity and stretch the lower extremity of their distribution. For the variables with a lower limit and widespread upper values, such as DEBT1, DEBT2, LIQ1 and LIQ2, the logarithmic transformation reduces the dispersion[7]. A constant of 0.05 is added to each variable because the logarithm of zero does not exist.

LOGDEBT1 = ln(DEBT1+0.05)
LOGDEBT2 = ln(DEBT2+0.05)
LOGLIQ1 = ln(LIQ1+0.05)
LOGLIQ2 = ln(LIQ2+0.05)
LOGLIQ4 = ln(LIQ4+0.05)
LOGLIQ5 = ln(LIQ5+0.05)

I.3.2 Size

There is a clear size effect in regard to financial health which can already be observed between full-format and abbreviated accounts. The dummy variable FORMAT was defined in order to distinguish the observations on that basis[8]. However, in view of the size of the population studied, that distinction is too simple. An in-depth analysis was conducted in order to define more appropriate variables. This led to a decision in favour of the balance sheet total as the size criterion.

The balance sheet total corresponds to all the resources at a company’s disposal. That is a criterion which is easily applicable, in contrast to turnover, value added or employment. Turnover is not reported in most annual accounts, since it is an optional item in the abbreviated format[9]. Value added is a net figure which need not necessarily represent the volume of activity; moreover, it is negative in around 10% of cases. Employment also has its limitations (due to temporary workers, secondment, etc.) and almost half of companies do not record any employees in their annual accounts.

The distribution of the annual accounts according to the balance sheet total is decidedly asymmetric (chart 1): for the 2006 financial year, over a quarter of the companies studied have a balance sheet total of less than €150,000, and over half have a balance sheet total of less than €350,000. Above €1,000,000, the distribution is very spread out.

---

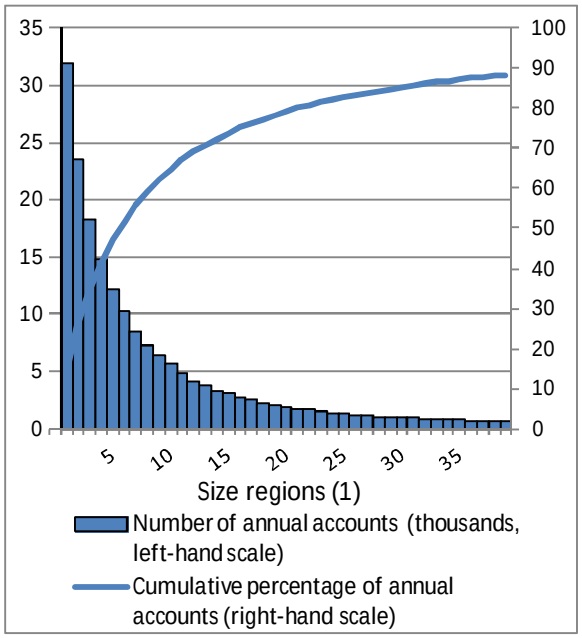
[6] In regard to the alarm bell procedure, see for example Soens P. and K. Cusse (2010).

[7] For instance, when LIQ1 rises from 20 to 100, LOGLIQ1 rises from 3 to 4.6, i.e. a much smaller factor of increase.

[8] FORMAT = 1 if the annual account is filed in the abbreviated format, otherwise 0.

[9] The "turnover" item is completed in around 20% of the annual accounts filed in the abbreviated format.

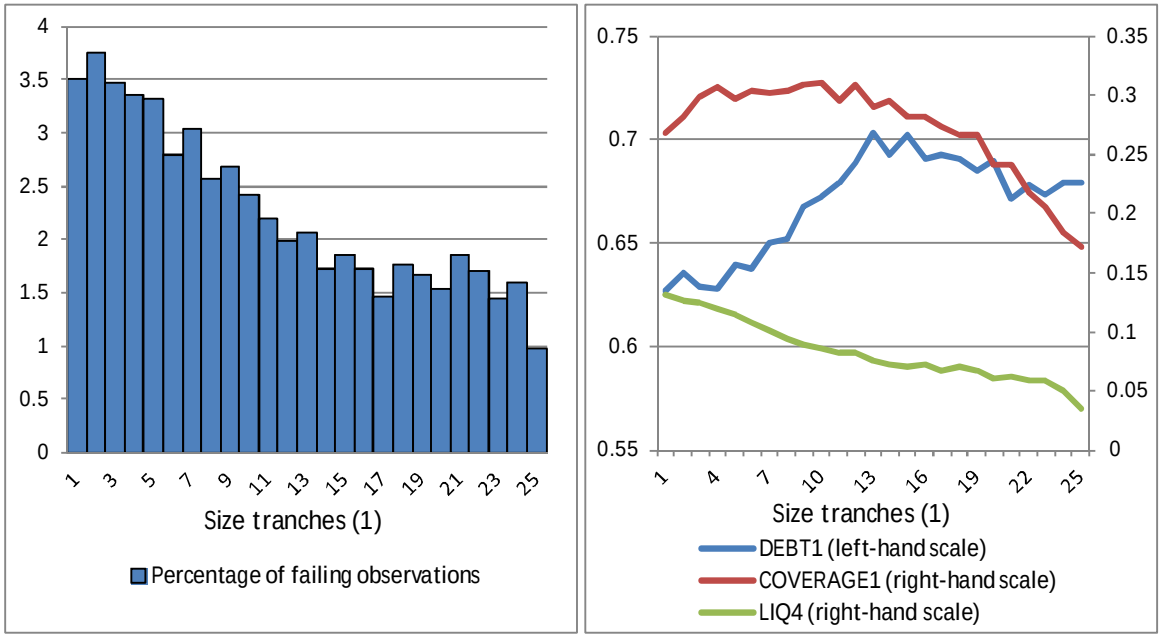
CHART 1 DISTRIBUTION OF THE OBSERVATIONS BY SIZE REGION (2006)



Source: NBB. (1) Regions corresponding to intervals of €50,000 in the balance sheet total: region 1 = [50,000;100,000[; region 2 = [100,000;150,000[; ... ; region 39 = [1,950,000;2,000,000[.

The first part of chart 2 shows that there is an overall negative link between size and failure rate: as size increases, the failure rate declines. However, the relationship is not linear and flattens out between tranches 14 and 24. The second part of chart 2 indicates that the value of the financial ratios fluctuates with the balance sheet total and that, in most cases, they become less favourable as size increases.

CHART 2 FAILURE FREQUENCY AND MEDIANS BY SIZE TRANCHE (2006)



Source: NBB. (1) Tranches corresponding to intervals of four percentiles of the balance sheet total: tranche 1 = [min;p4[; tranche 2 = [p4;p8[; ... ; tranche 25 = [p96;max].

A number of variables were defined to take account of the size factor: SIZE (balance sheet total), LOGSIZE (natural logarithm of the balance sheet total) and FORMAT (cf.

above). Apart from these variables, the SIZECLASS variable was defined in order to segment the population. The number of classes and their limits were determined following detailed analysis of the failure rates for a large number of balance sheet total tranches. These classes arrange the companies in homogenous groups from the point of view of the rate of failing observations: class 1 comprises 3.05% of failing observations, compared to 1.76% in class 2 and 1.07% in class 3 (table 6).

SIZECLASS

- SIZECLASS =1 if balance sheet total < €250,000;
- SIZECLASS =2 if €250,000 ≤ balance sheet total < €5,000,000;
- SIZECLASS =3 if balance sheet total ≥ €5,000,000;

TABLE 6 SIZE CLASSES AND FAILURE (2006)
(number of observations, unless otherwise stated)

SIZECLASS	DEF=1	DEF=0	TOTAL	Percentage of observations DEF=1
1	2,696	85,716	88,412	3.05
2	2,009	112,366	114,375	1.76
3	114	10,567	10,681	1.07
TOTAL	4,819	208,649	213,468	2.26

Source: NBB.

Inclusion of the variable SIZECLASS in a model amounts to assuming that the size effect is linear and varies by a factor of 1 to 3, which is not very plausible. In order to test the effect specific to each size class, three dummy variables were therefore created, each corresponding to one SIZECLASS modality:

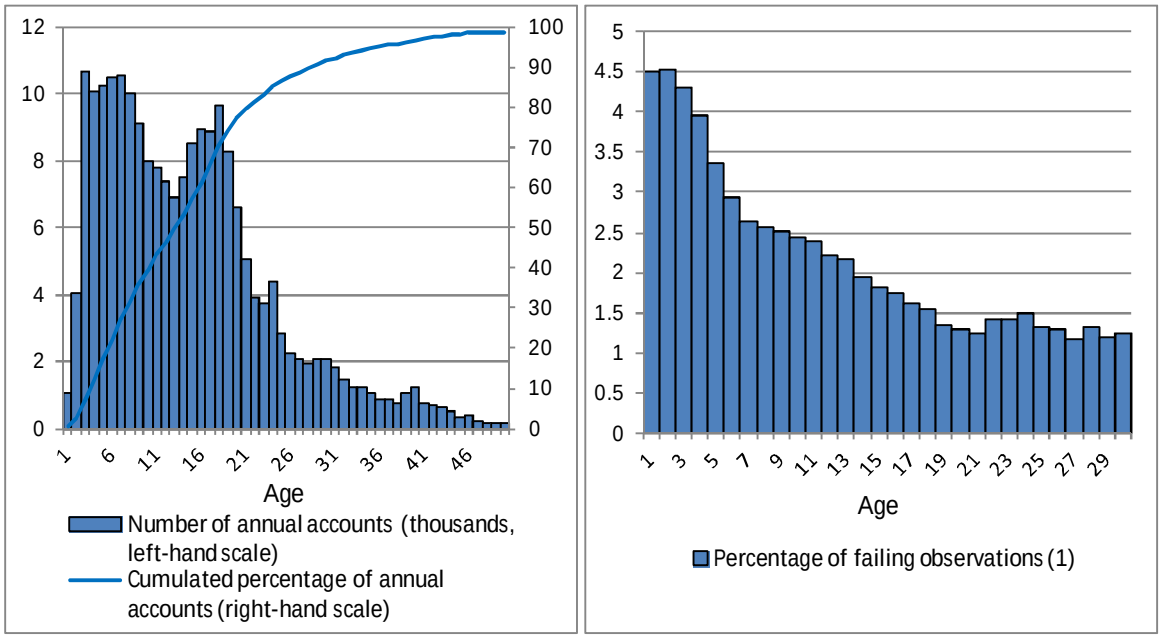
SIZE1 = 1 if SIZECLASS=1, otherwise SIZE1 = 0.
SIZE2 = 1 if SIZECLASS=2, otherwise SIZE2 = 0.
SIZE3 = 1 if SIZECLASS=3, otherwise SIZE3 = 0.

I.3.3 Age

For a given set of annual accounts, the company's age is defined as the difference between the closing date and the date on which the company was formed. That difference, expressed as a number of years, is rounded up to the next unit. Under this definition, the distribution of the observations according to age is also clearly asymmetric: 43% of the companies studied are less than 10 years old, and 81% are under 20 years old (first part of chart 3).

Age also has an impact on the vulnerability of companies. Almost two-thirds of the bankruptcies recorded in 2010 thus concern firms under ten years old, and 40% concern firms under 5 years old. The second part of chart 3 presents the negative relationship between age and failure rate: as age increases, the failure rate declines, and vice versa. The rate thus declines from 4.5% for the newest companies to under 1.5% for companies which have been running for more than 20 years. Beyond 20 years, the failure rate remains stable.

CHART 3 DISTRIBUTION OF OBSERVATIONS AND FAILURE RATE ACCORDING TO AGE (2006)



Source: NBB.
(1) Centered moving average on three age zones.

Just as in regard to size, a number of age variables were tested: the age itself (AGE), its logarithmic version (LOGAGE), a class variable (AGECLASS) and the corresponding binary variables (AGE1, AGE2 and AGE3). Full definitions can be found in annex 1.

I.3.4 Contextual variables

The model is designed as a multivariate financial analysis which takes account simultaneously of solvency, liquidity and profitability. It therefore focuses on the characteristics specific to each company and does not include contextual variables such as macroeconomic or sectoral variables. However, future studies could analyse these dimensions in greater depth.

The use of macroeconomic variables (GDP growth, exchange rate, etc.) raises methodological questions which are beyond the scope of this study. Since the model has a prediction horizon of three years, the use of variables reflecting the economic situation in the year to which the annual accounts relate, i.e. the approach adopted by other studies, is not sufficient. Moreover, the link with the economic context is blurred by the temporal characteristics of the accounting data: on the one hand, they are produced annually and not quarterly; on the other hand, one-fifth of the annual accounts have a financial year which does not coincide with the calendar year.

Branches of activity were also studied. Annex 2 shows that they are not equally exposed to the risk of failure. However, the model does not contain any sectoral variable because, even at the already high level of detail in annex 2, many branches are not homogenous in terms of activity and economic conditions. For example, in the "Hotels and restaurants" group, the failure rate at 3 years is 2.0% for hotel businesses compared to 4.8% for restaurants and bars. Company size also influences failure rates within a branch. Thus, the high rate in telecommunications is due to companies in the first size class (balance

sheet total < €250,000): the rate is 9.7% for these companies, against 1.8% for companies in size class 3 (balance sheet total ≥ €5,000,000).

I.4 WINSORISATION

Despite the exclusion of companies with a balance sheet total of less than €50,000, the distributions are still affected by a number of extreme values ("outliers"). For example, though the net return on assets (RETURN2) does not exceed 65% in 99% of cases, it peaks at 8.884% for one observation (annex 3, RETURN2 maximum = 88.84). Exceptional values of this type are generally due to the low level of the denominator, which may imply high volatility of the ratio.

In the vast majority of cases, extreme values are caused by the smallest companies, and although they have hardly any significance, they influence noticeably the model estimation. That is why, in order to attenuate that impact, the financial ratios are winsorised at the 1st and 99th percentile: for each financial year, values below the 1st percentile are equalised at the 1st percentile, while values above the 99th percentile are equalised at the 99th percentile. For example, in the case of RETURN2, that means that values below -0.43 are equalised at -0.43, and values above 0.65 are equalised at 0.65. Annex 3 presents the data distribution before and after winsorisation for the year 2006. This treatment amounts to considering that the ratios have no further effect beyond the values selected as the limits.

Winsorisation was preferred to the simple exclusion of extreme values, as that solution would have entailed rejecting very large numbers of failing observations, since the latter are heavily concentrated at the lower extremities (in terms of financial analysis) of the distributions.

I.5 SIMPLIFIED PRESENTATION OF THE LOGISTIC REGRESSION

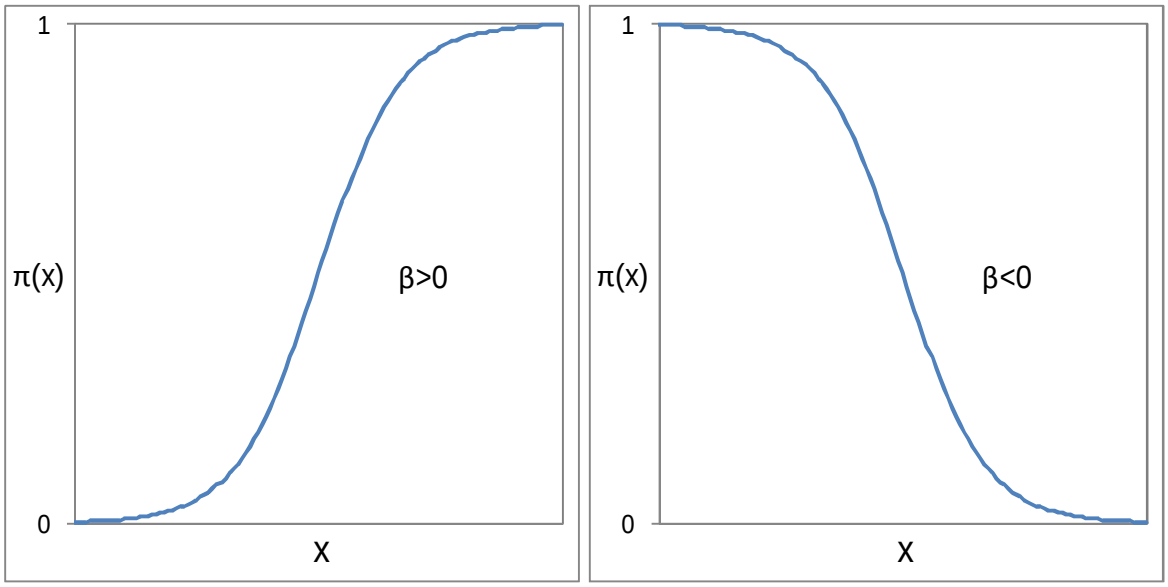
In view of its relatively unrestrictive assumptions, the logistic regression is a technique commonly used nowadays in the case of discrimination problems. This section presents the method in simplified terms in the case of a univariate model, i.e. a model including only one independent variable. Multivariate models (including multiple independent variables) are a generalisation of the univariate model presented here.

In the case of a binary dependent variable Y and an independent variable X, $\pi(x)$ represents the probability of occurrence of event Y (i.e. Y=1) when X equals x. The logistic regression takes the following functional form:

$$\pi(x) = \frac{e^{\alpha+\beta x}}{1 + e^{\alpha+\beta x}}$$

The relationship between $\pi(x)$ and x follows an S-curve: the rate of change of $\pi(x)$ as a function of x is not constant (chart 4).

CHART 4 LOGISTIC REGRESSION FUNCTIONS



For modelling purposes, $\pi(x)$ undergoes a transformation, called the logit transformation:

$$\text{logit}[\pi(x)] = \log\left(\frac{\pi(x)}{1-\pi(x)}\right) = \alpha + \beta x$$

Unlike the relationship between $\pi(x)$ and x, the relationship between $\text{logit}[\pi(x)]$ and x is linear: the rate of change of $\text{logit}[\pi(x)]$ as a function of x is constant. The expression $\pi(x)/[1-\pi(x)]$ is called "odds". It is the ratio between the probability of an event's occurrence and the probability of non-occurrence of that same event. Consequently, $\text{logit}[\pi(x)]$ is commonly called "log-odds". In practical applications, the term "score" denotes the log-odds of the model.

$$\text{Score} = \text{Log} - \text{odds} = \log\left(\frac{\pi(x)}{1-\pi(x)}\right)$$

The coefficients α and β are estimated by the maximum likelihood method. In very general terms, that method generates coefficient values which maximise the probability of obtaining the observed data.

In the financial health model, DEF takes the role of the variable Y: for each set of annual accounts, DEF is either equal to 1 or 0[10]. For example, if the debt level DEBT1 takes the role of X, a logistic regression estimated on a sample gives the following equation:

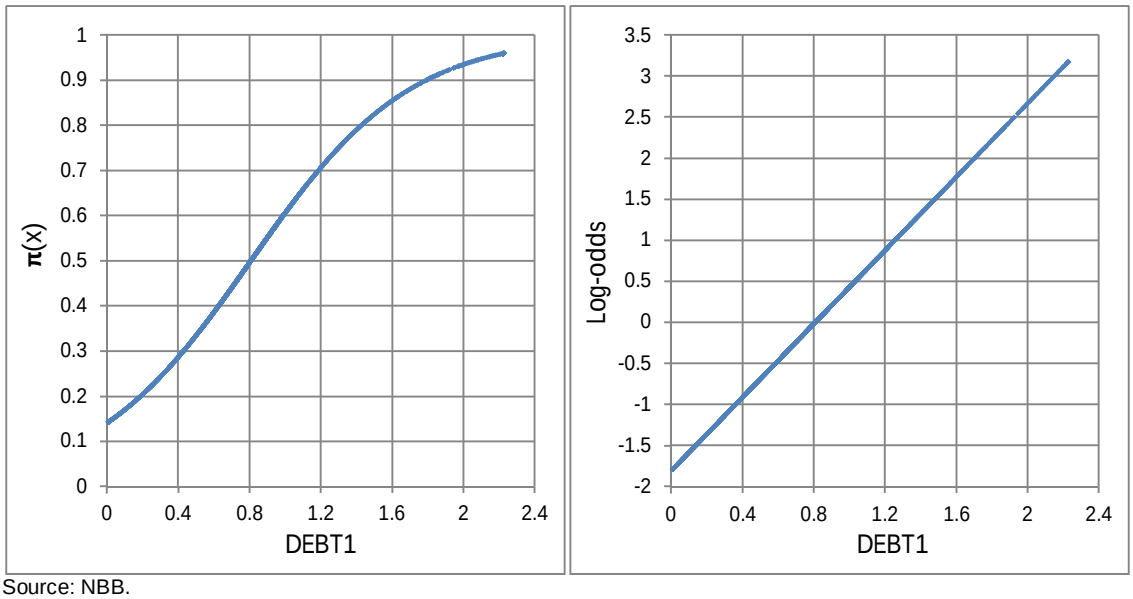
$$\text{Log} - \text{odds} = -1{,}7979 + 2{,}2358\ \text{DEBT1}$$

[10] DEF=1 if the company fails within 1,095 days following the closing date of its annual accounts; DEF=0 if the company does not fail within 1,095 days following the closing date of its annual accounts.

The coefficient associated with DEBT1 represents the change in the log-odds corresponding to a one unit change in DEBT1. In this example, if DEBT1 increases (declines) by one unit, the log-odds increases (declines) by 2.2358. The positive sign of the coefficient corresponds to intuition: if the debt level increases (declines), the probability of failure increases (declines).

The first part of chart 5 presents the relationship thus estimated between DEBT1 and $\pi(x)$, i.e. the S-curve described above. The second part of the chart presents the linear relationship between DEBT1 and the log-odds. The slope of this straight line is 2.2358, or the coefficient associated with DEBT1. One can also see that if the debt level is equal to zero, the log-odds is equal to the value of the constant, or -1.7979.

CHART 5 EXAMPLE - DEBT1, π(x) and LOG-ODDS



Source: NBB.

I.6 ASSESSMENT CRITERIA

The performance of a logistic regression can be assessed by means of numerous criteria. This section briefly describes the concepts on which this study focuses. Predictive efficiency (section I.6.2) is the central assessment criterion for minimising error rates. However, the general statistical tests (section I.6.1) as well as the statistical significance of the coefficients (sections I.6.3) were also investigated, because they shed additional light on a model's quality.

I.6.1 General statistical tests

All the statistical tests provided by the SAS software were observed, among which the likelihood ratio test, the global nullity test and the Hosmer and Lemeshow test. However, in the context of this analysis, practice showed that these tests are not very demanding and tend to reject the null hypothesis more or less systematically. They nevertheless proved useful in the variables selection process, when comparing competing models.

I.6.2 Predictive efficiency

A model's predictive efficiency concerns its ability to correctly predict the status of an observation, i.e. to discriminate between the two modalities of the dependent variable (in this case, DEF=1 and DEF=0). Among the existing measures, the study concentrates on the correct classification rate, the area under the ROC curve. R^2 measures were also observed because they give supplementary information on a model's quality. They are nevertheless not published due to interpretation problems[11].

I.6.2.1 Correct classification rate

The correct classification rates are based on classification tables. On the basis of a specified score threshold, observations are classified in one of the two modalities of the dependent variable. For each observation, that classification is then compared to the real status of the dependent variable.

In the failure prediction model, if the estimated score of a given observation exceeds the score chosen as the threshold, then the observation is regarded as failing and is classified in the modality DEF=1. If the score is lower than the score chosen as the threshold, the observation is regarded as not failing and is classified in the modality DEF=0. That classification is then compared with the DEF values actually observed. The threshold is chosen as the score which gives equal correct classification rates for both categories of observations.

Table 7 is the classification table for the example presented in the previous section. The threshold which equalises the two correct classification rates is 0.0087. At that threshold, the correct classification rate for the observations DEF=1 is equal to 68% (or 2,726/4,000), and the correct classification rate for the observations DEF=0 is also equal to 68% (or 2,725/4,000). The correct classification rate for observations DEF=1 is called sensibility, the correct classification rate for observations DEF=0 is called specificity.

TABLE 7 EXAMPLE – CORRECT CLASSIFICATION TABLE (1)
(number of observations)

Estimated	Observed		Total
	DEF = 1	DEF = 0	
DEF = 1	2,726	1,275	4,000
DEF = 0	1,274	2,725	4,000
Total	4,000	4,000	8,000

Source: NBB.
(1) Sensibility = (2.726/4.000) = 0.68. Specificity = (2.725/4.000) = 0.68.

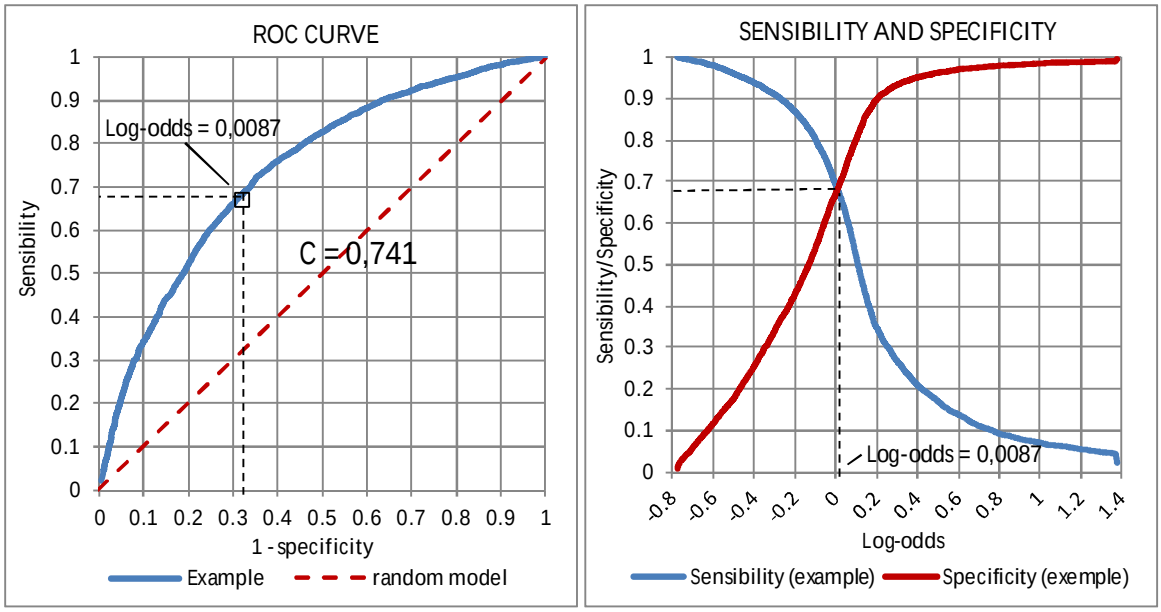
This type of table is a useful tool to summarise a model's results in a single quantity: the correct classification rate. However, that information is incomplete because it takes no account of the distribution of the estimated scores.

11 See for example Agresti (2002).

I.6.2.2 Area under the ROC curve

The ROC (Receiver Operating Characteristic) curves fill this gap by generalising the analysis of correct classification: we consider as many thresholds as there are estimated scores for the population studied. For each estimated score, the ROC curve associates the correct classification rate of observations DEF=1 (or the sensibility) and the incorrect classification rate of observations DEF=0 (or 1-specificity). Chart 6 shows the ROC curve for the example, and the corresponding sensibility and specificity curves.

CHART 6 EXAMPLE – ROC CURVE, SENSIBILITY AND SPECIFICITY



Source: NBB.

Each point on the ROC curve corresponds to a separate threshold score. The first point (in the lower left-hand corner) corresponds to the maximum score: at this threshold, all the observations studied are regarded as non-failing since the score of all observations is less than or equal to that score. Consequently, all the observations DEF=0 are classified correctly, whereas all observations DEF=1 are wrongly classified: specificity is equal to 1, sensibility is equal to zero. Conversely, the last point on the curve (in the upper right-hand corner) corresponds to the minimum score. At that threshold, all observations DEF=0 are wrongly classified, while all observations DEF=1 are correctly classified. The specificity is therefore equal to zero, while the sensibility is equal to 1. The other points on the curve correspond to intermediate thresholds. In particular, we identify the point corresponding to the score 0.0087, used in the correct classification table. At that threshold, the correct classification rates are the same as those in the table, i.e. a sensibility of 0.68 and a specificity of 0.68 (or 1-specificity=0.32). Incidentally, the diagonal in the chart corresponds to the ROC curve of a random model. Such a model would be equivalent to flipping a coin for each observation, in order to determine whether it belongs to modality DEF=0 or DEF=1.

The area below the ROC curve measures the model's ability to discriminate between failing observations and non-failing observations. That area ranges between 0 and 1 and is equivalent to the probability that a randomly chosen failing observation will have an

estimated score higher than that of a similarly randomly chosen non-failing observation. The higher the discriminatory power of the model, the closer the curve to the upper left-hand corner, and therefore the bigger the area under the curve. That area is called C in the rest of the document. In the example, it is equal to 0.741. For the random model (diagonal), it is equal to 0.5.

I.6.3 Individual coefficients

On the one hand, the statistical significance of each coefficient is watched. On the other hand, we check that the sign of the coefficients corresponds to intuition. In a model containing several independent variables, it can happen that the sign of some coefficients does not meet that criterion. For example, we make sure that the sign of the coefficient associated with the debt level is positive (as in the example), or that the one associated with profitability is negative.

PART II PRELIMINARY ANALYSES

This part describes the preliminary results which formed the basis for constructing the model presented in Part III, including univariate regressions, distributions and correlations. Examples of interaction and stepwise regression are also presented. For the reader's convenience, chart analysis is preferred. Most of the results relate to the combination of the annual accounts for 2005 and 2006, namely 206,165 + 213,468 = 419,633 sets of accounts (table 8). That population, called the reference population in the rest of this document, was also used to estimate the final model presented in Part III. It enables a study of the failures which occurred in 2006, 2007, 2008 and 2009.

TABLE 8 REFERENCE POPULATION ACCORDING TO SIZE CLASSES AND DEF
(number of observations)

SIZE CLASS	DEF=1 (failing observations)	DEF=0 (non-failing observations)	TOTAL
1	5,007	170,385	175,392
2	3,763	219,793	223,556
3	201	20,484	20,685
TOTAL	8,971	410,662	419,633

Source: NBB.

II.1 ANALYSIS OF DEFDETAIL

The variable DEFDETAIL is defined in section I.2.2. It details the temporal proximity of failures per 365-day tranche and enables us to verify that the financial situation of the companies deteriorates as failure approaches. Annex 4 describes the distribution elements of the 25 ratios studied according to DEFDETAIL. Chart 7 illustrates the data for certain ratios in the form of box plots, to be interpreted as follows:

- the extremity of the upper whisker corresponds to the ninth decile;
- the upper limit of the box corresponds to the third quartile;
- the line inside the box corresponds to the median;
- the lower limit of the box corresponds to the first quartile;
- the extremity of the lower whisker corresponds to the first decile;
- the grey point corresponds to the winsorised average.

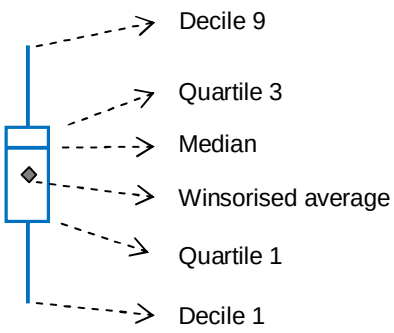
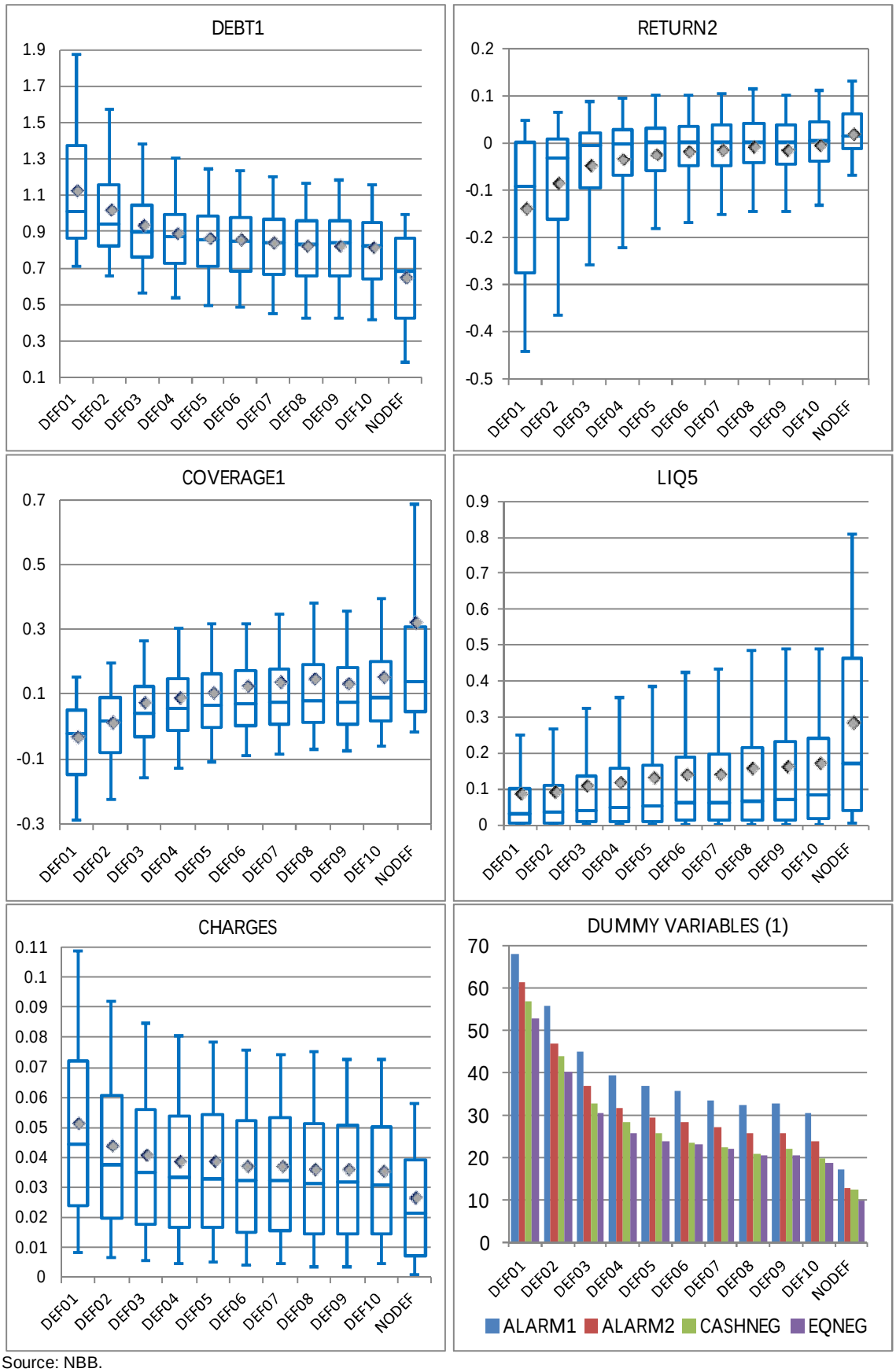


CHART 7 BOX PLOTS ACCORDING TO DEFDETAIL
(financial years 1997, 1998 and 1999)



Source: NBB.
(1) Percentage of observations for which the variable is equal to 1.

Chart 7 shows regular trajectories as we move from the group NODEF (non-failing observations at a ten-year horizon) to the group DEF01 (failing observations at a one-year horizon). The closer to failure, the more the financial situation deteriorates and, in the great majority of cases, that deterioration affects the entire distribution. That finding is borne out in particular in the last years preceding failure, i.e. for observations DEF01, DEF02 and DEF03.

In a number of cases, the distribution of observations DEF01 and NODEF tends to be more dispersed, towards lower and higher values respectively. That dispersion causes a visual compression of the differences between the various modalities of DEFDETAIL, but the differences nevertheless remain significant. For example, regarding the debt level (DEBT1), the first decile of the group DEF01 (0.71) is above the median of the group NODEF (0.69). In regard to the net return on total assets (RETURN2), the third quartile of the group DEF01 (0.0) is below the median of the group NODEF (0.02).

The final part of the chart shows the pattern of several dummy variables as a function of DEFDETAIL. Among other things, it shows that the closer the companies are to failure, the more they come under the alarm bell procedure laid down in the Company Code. Thus, the percentage of observations for which ALARM1 is equal to 1 (i.e. the percentage of observations showing net assets below half of the authorised capital) rises steadily from 17% for NODEF companies to 68% for DEF01 companies. This finding indicates the balance between business life and the preventive goal of the law.

The dependent variable DEF was defined following examination of the variable DEF-DETAIL. Ideally, only observations DEF01 should have been considered as failing, since those observations stand out more clearly from the other observations and would thus have implied better discrimination in the model. However, as pointed out in section I.2.2, observations DEF01 are not available in many cases. So, in order to obtain a sufficiently large set of failing observations, it was decided to consider observations DEF01, DEF02 and DEF03 as failing. A company is therefore regarded as failing if it gets into a bankruptcy or judicial administration situation within 1,095 days following the closing date of its annual accounts. Other companies are regarded as non-failing.

II.2 UNIVARIATE LOGISTIC REGRESSIONS

Univariate logistic regressions were estimated in order to test the statistical significance and the predictive efficiency of each variable. Table 9 presents the results of these regressions for the financial ratios. The great majority of the coefficients have signs which conform to intuition: the probability of failure increases with debt levels and declines with solvency, liquidity and profitability. The values of p indicate that all the variables are statistically significant at the individual level.

For each estimated model, table 9 also shows the value of C, i.e. the area under the ROC curve. At the univariate level, the solvency variables have the most marked predictive efficiency; that corresponds to intuition since solvency is central to the issue of bankruptcy. DEBT2, EQUITY, DEBT1, SELFIN and COVERAGE2 thus generate C values larger than 0.70. The variable which performs best is short-term debt (DEBT2), reflecting the fact that, from the point of view of failure prediction, the balance of the short-term obligations prevails. Analysis also showed that all the tested variables concerning debts to credit institutions (e.g. DEBT5) perform relatively poorly. That is due to the ambivalence of those variables: on the one hand, debts to credit institutions are synonymous with debt; but on the other hand, they presuppose that the companies have met the loan criteria imposed by the lending institutions.

In regard to liquidity, the traditional ratios for liquidity in the broad sense and in the strict sense (LIQ1 and LIQ2) perform less well than the ratios directly linked to the cash position (LIQ3, LIQ4 and LIQ5), probably because the latter are less dispersed (cf. annex 3).

The variables linked to overdue debts to the tax authority and the NSSO (OVERDUE and OVERPOS) have a lower predictive efficiency than expected. These variables based on the accounts annex had in fact proved interesting in previous studies; moreover, delays in the payment of social security contributions and taxes serve as “warning lights” in the inquiries of the commercial courts. In recent years, the percentage (and the number) of sets of accounts reporting overdue debts to the tax authority and/or the NSSO (i.e. OVERPOS=1) has declined considerably; it is the abbreviated formats that have exerted the most downward pressure (cf. annex 5). Such a reduction is hard to explain and raises the question of the quality of the information given in the annual accounts annex. Omitting to complete the items concerned may enable a company to avoid attracting attention, all the more since the amounts indicated cannot be verified by logical checks. Publication of a number of models incorporating these items may have encouraged that type of omission. It must also be pointed out that, in some cases, the overdue debts are caused by a dispute with the authorities, and that obviously does not have the same significance as if they are due to poor liquidity[12]. Finally, regressions estimated per financial year show that, in contrast to most other variables, the predictive efficacy of OVERDUE and OVERPOS declines considerably over time: between 1997 and 2006, the C associated with OVERPOS thus drops gradually from 0.602 to 0.549. All these considerations led us to exercise the greatest caution in the use of these variables.

In regard to profitability, the performance of the ratios studied is similar. The net ratios generate C values slightly higher than those of the gross ratios.

[12] On the question of overdue debts to the tax authority and the NSSO in the annual accounts, see in particular Mercken R. (2010).

TABLE 9 UNIVARIATE LOGISTIC REGRESSIONS – FINANCIAL VARIABLES
(reference population)

Variable	Coefficient	Standard error	p	C
EQUITY	-1.6403	0.0202	<0.001	0.734
SELFIN	-1.0962	0.0154	<0.001	0.718
DEBT1	1.6466	0.0204	<0.001	0.732
DEBT2	2.0274	0.0226	<0.001	0.753
DEBT3	-0.1956	0.0434	<0.001	0.514
DEBT4	0.4694	0.0364	<0.001	0.532
DEBT5	0.5171	0.0392	<0.001	0.538
CHARGES	18.8525	0.3465	<0.001	0.626
COVERAGE1	-1.3383	0.0366	<0.001	0.694
COVERAGE2	-0.8004	0.0200	<0.001	0.716
LIQ1	-0.0784	0.0046	<0.001	0.614
LIQ2	-0.0645	0.0041	<0.001	0.605
LIQ3	-2.5708	0.0481	<0.001	0.678
LIQ4	-3.8189	0.0964	<0.001	0.653
LIQ5	-3.2509	0.0601	<0.001	0.708
OVERDUE	22.5702	0.4028	<0.001	0.556
RETURN1	-3.4195	0.0723	<0.001	0.634
RETURN2	-3.6440	0.0681	<0.001	0.638
RETURN3	-3.6117	0.0731	<0.001	0.634
RETURN4	-3.8240	0.0688	<0.001	0.637
RETURN5	0.3680	0.0289	<0.001	0.518
LOGDEBT1	1, 6584	0.0251	<0.001	0.732
LOGDEBT2	1.5065	0.0199	<0.001	0.753
LOGLIQ1	-0.2744	0.0088	<0.001	0.627
LOGLIQ2	-0.3047	0.0083	<0.001	0.628
LOGLIQ4	-0.7365	0.0156	<0.001	0.654
LOGLIQ5	-0.7913	0.0123	<0.001	0.708
CASHNEG	1.3543	0.222	<0.001	0.621
EQNEG	1.5408	0.0225	<0.001	0.628
RESNEG	1.0247	0.0215	<0.001	0.622
OVERPOS	1.2918	0.0299	<0.001	0.554
CREDPOS	0.4293	0.0245	<0.001	0.545
DISTRIB	-1.5049	0.0609	<0.001	0.548
REMCAP	-1.8565	0.0928	<0.001	0.533
ALARM1	1.4556	0.0215	<0.001	0.652
ALARM2	1.5185	0.0218	<0.001	0.642

Source: NBB.

The long-term debt level (DEBT3) and the value added ratio (RETURN5) are the only variables for which the estimated coefficient does not conform to intuition. These variables also have a low univariate predictive efficiency, with a C only just above 0.5. That means that, taken individually, these ratios provide little more information than flipping a coin to determine whether or not a company is failing.

The logarithmic variables give results which are generally better than those of the non-transformed variables. So, the estimation responds favourably to the logarithmic transformation. In the case of LIQ1 (liquidity in the broad sense) for example, the transformation implies that the effect of a given increase in liquidity declines as liquidity increases.

The coefficients associated with the dummy variables also conform to intuition. For example, the presence of a negative cash flow (CASHNEG=1) implies an increase in the probability of failure, while the distribution of profits (DISTRIB=1) implies a reduced probability.

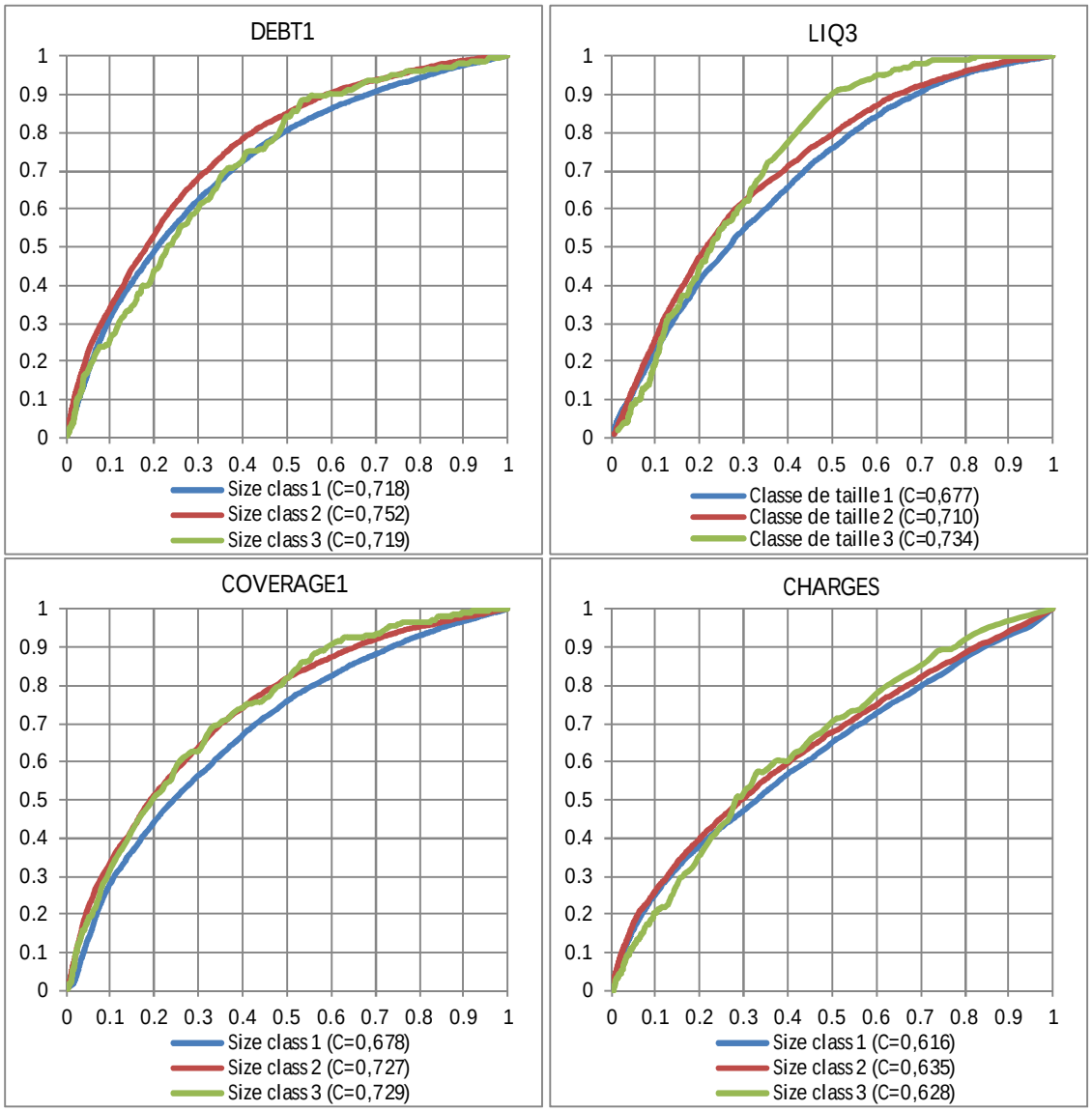
Annex 6 presents the estimated univariate regressions for the size and age variables. The signs of the coefficients also tally with intuition: when size and age increase, the probability of failure declines, and vice versa. As in the case of the financial variables, the logarithmic transformations (LOGSIZE and LOGAGE) result in improved performance.

Finally, regressions were estimated separately for each of the 3 size classes. Chart 8 presents the resulting ROC curves for the level of debt (DEBT1), net cash position in proportion to the assets (LIQ3), cash flow coverage ratio (COVERAGE1) and debt charges in proportion to total liabilities (CHARGES). Each ROC curve corresponds to a separate model estimated by size class.

The chart shows that, to a greater or lesser extent, predictive efficiency is markedly higher for size 2 and size 3 companies: overall, the variables are more significant for large companies, owing to their more recurrent activity and more stable structure[13]. For example, in regard to LIQ3, the value of the area C is 0.677 for size class 1, 0.710 for class 2 and 0.734 for class 3. In the data exploration phase, the same kind of analysis showed much lower C values for companies with a balance sheet total of less than €50,000. It was that type of finding that led to the exclusion of those companies.

[13] Tests for the equality of the surfaces carried out in STATA showed that in the great majority of cases, surfaces for class 1 are significantly lower than surfaces for classes 2 and 3.

CHART 8 ROC CURVES FOR SEPARATE UNIVARIATE MODELS BY SIZE CLASS
(reference population)



Source: NBB.

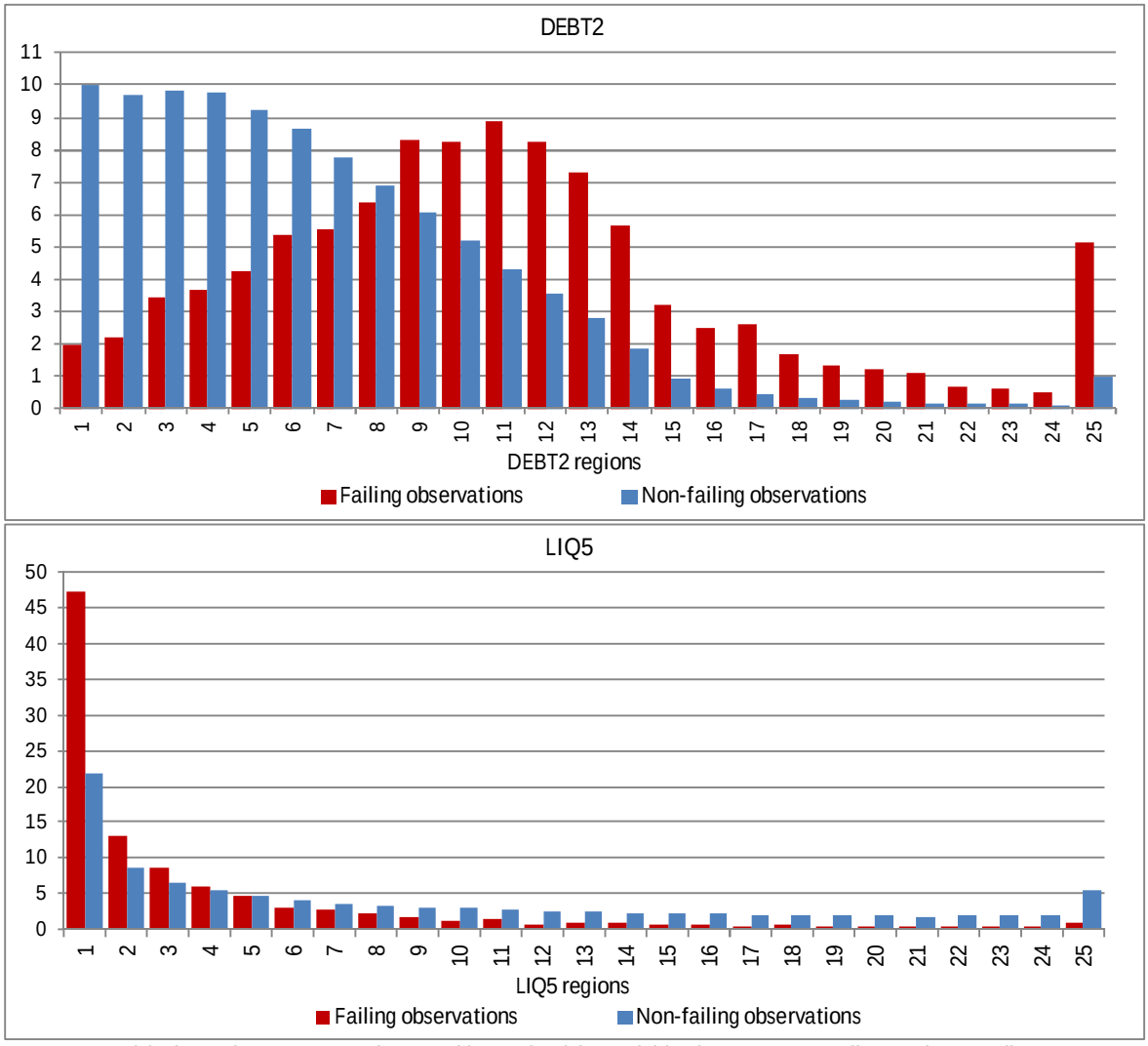
II.3 DISTRIBUTION ELEMENTS

Charting the distributions enables detailed observation of the link between the financial position and the risk of failure. This observation permits among other things to detect potential non linear relationships. The distributions presented below are based on a regional breakdown of the financial ratios. The regions correspond to equal intervals of the variables between percentile 1 and percentile 99, i.e. the limits used for the winsorisation.

Chart 9 presents the distribution of the failing and non-failing observations for 25 regions of the short-term debt ratio DEBT2 and the cash position ratio LIQ5. In the case of DEBT2 for example, the first region corresponds to values below 0.076 (or a short-term debt ratio of 7.6%). The next regions correspond to intervals of 0.072 of the variable, up to region 25 which corresponds to values higher than 1.73 (or a short-term debt ratio of 173%).

Chart 9 shows that non-failing companies are concentrated in the low-debt regions: almost half of those companies are found in regions 1 to 5, i.e. they have a short-term debt ratio of less than 36.4%. Conversely, the failing companies are concentrated in the high-debt regions: almost half of those companies are found beyond region 11, i.e. they have a short-term debt ratio of over 72.3%. The greater concentration of observations in region 25 is due to the dispersion of the ratio towards higher values.

CHART 9 DISTRIBUTION OF FAILING AND NON-FAILING OBSERVATIONS BY FINANCIAL VARIABLE REGION (1)
(2006, percentages)



Source: NBB. (1) The regions correspond to equal intervals of the variables between percentile 1 and percentile 99.

LIQ5 measures the percentage of cash and current investment in proportion to current assets. The ratio has a value between 0 and 1. Chart 9 shows that failing companies are concentrated in the five first regions; in particular, 47% of these companies are found in the first region, which means that their cash holdings represent less than 4% of the current assets. While 22% of the non-failing observations also belong to the first region, their distribution concentrates much more on the higher values: over a quarter of these companies are found beyond region 13, which means that their cash holdings represent over 56% of the current assets.

Chart 10 presents the distributions from a different angle. It shows failure rates per variable region, and the cumulative frequency curve for all the observations. For example, looking at the 33rd region of EQUITY, the chart shows (a) that this region contains 2.2% of failing observations (histogram, left-hand scale) and (b) that 40% of all the observations are found in regions 1 to 33 (cumulative frequency curve, right-hand scale), i.e. they have a financial independence of less than 23%.

Chart 10 demonstrates the diversity of the links between the financial variables and the failure rate. For most of the ratios presented, the link corresponds to intuition and is positive (DEBT2, CHARGES) or negative (EQUITY, SELFIN, LIQ5, RETURN3) overall.

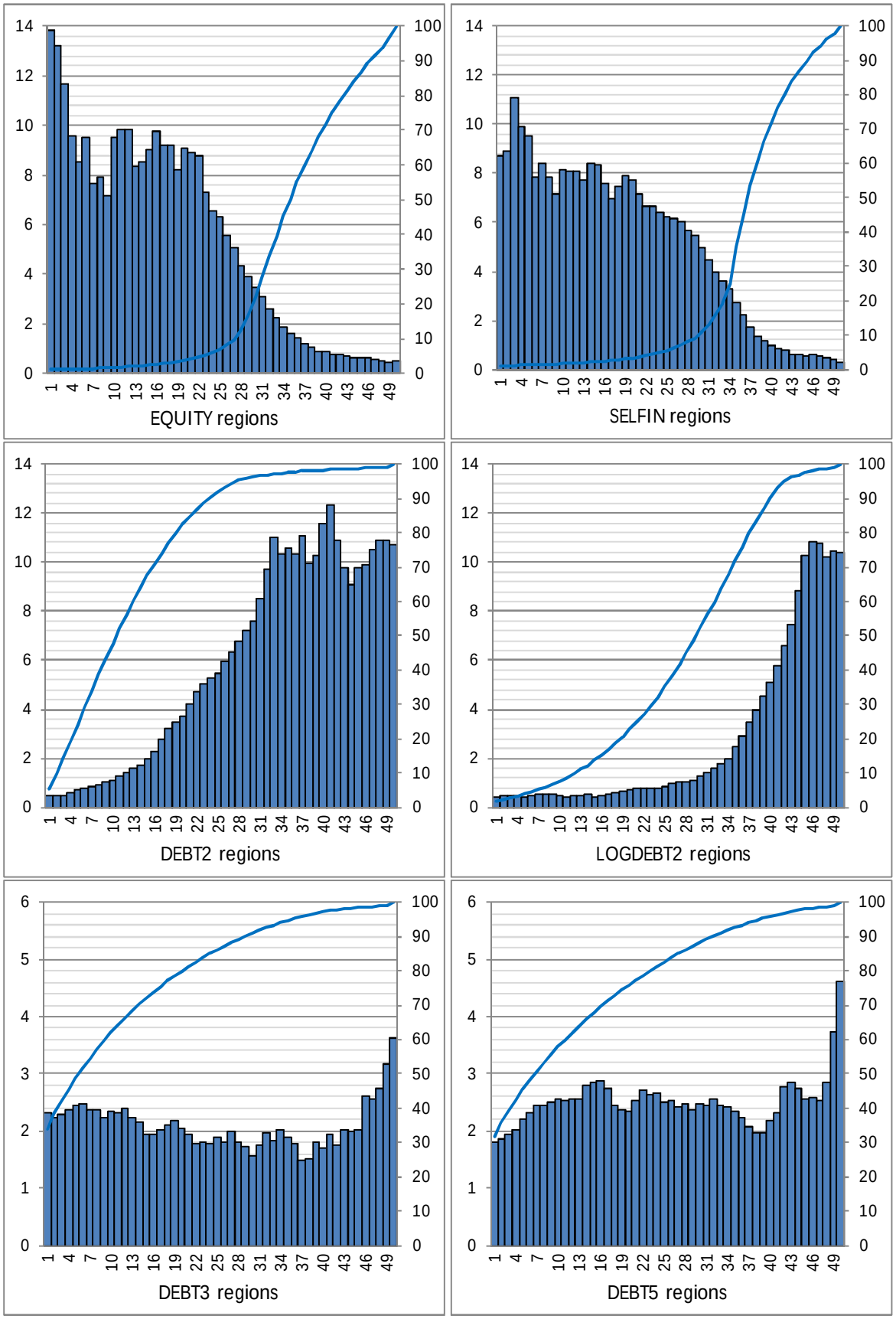
For example, there is a clearly negative link between financial independence (EQUITY) and the risk of failure: the failure rate drops from almost 14% for companies in the first region (i.e. the least solvent companies) to below 0.5% for companies in the 50th region (i.e. the most solvent companies). The correlation is not linear and flattens out between regions 4 and 22. But in general, the higher (lower) the degree of financial independence, the lower (higher) the risk of failure. The chart also shows that the distribution of the ratio is decidedly asymmetric, as a minority of companies are concentrated in the regions with low level of equity: for example, the cumulative frequency curve shows that the first 20 regions (i.e. the regions with very negative equity) contain less than 4% of the companies.

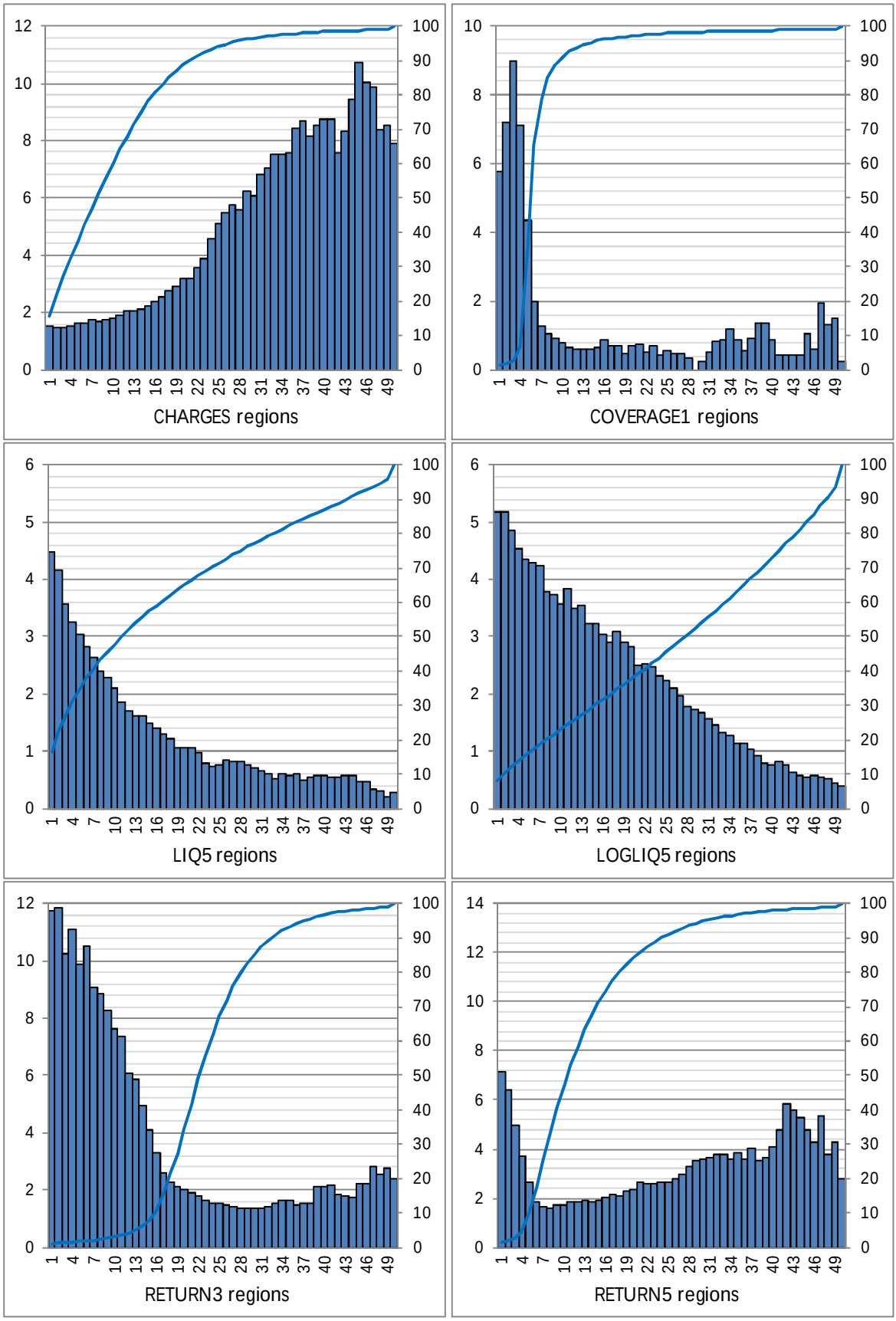
The chart relating to the short-term debt level (DEBT2) illustrates the case of a positive relationship: when debt rises (falls), the risk of failure rises (falls). That correlation also conforms to intuition, as companies with heavy debts are logically more vulnerable. As in the case of EQUITY, the relationship is not linear and features a plateau beyond region 33 (i.e. when short-term debt goes over 119.2%). That plateau indicates that, beyond a certain level, debt no longer affects the risk of failure, which suggests that the logarithmic version of the variable may be useful.

For other variables, the connection is less obvious. In the case of the long-term debt level (DEBT3) and debts to credit institutions in proportion to total liabilities (DEBT5), the failure rate varies little, except for the last regions. In the case of the value added ratio (RETURN5), while the rate declines sharply in the initial regions, it then increases steadily, this counter-intuitive pattern being due to a minority of observations (cf. cumulative frequency curve). The chart relating to the cash flow to debt coverage ratio (COVERAGE1) suggests that the binary variable CASHNEG should be interesting: failure rates are high in the negative-cash-flow regions (i.e. regions 1 to 5) but relatively stable and low in the positive-cash-flow regions (i.e. the next 45 regions). Finally, the charts relating to LOGDEBT2 and LOGLIQ5 show the impact which the logarithmic transformation may have on the relationship between the financial situation and the failure rate. In the case of LIQ5 for example, the switch to LOGLIQ5 produces a linear relationship.

CHART 10 FAILURE RATE AND CUMULATIVE FREQUENCY OF THE POPULATION BY VARIABLE REGION (1)

(2006) (the histogram indicates the percentage of failing observations by variable region (centered moving average of three regions, left-hand scale), the curve indicates the cumulative frequency of all the observations (right-hand scale))



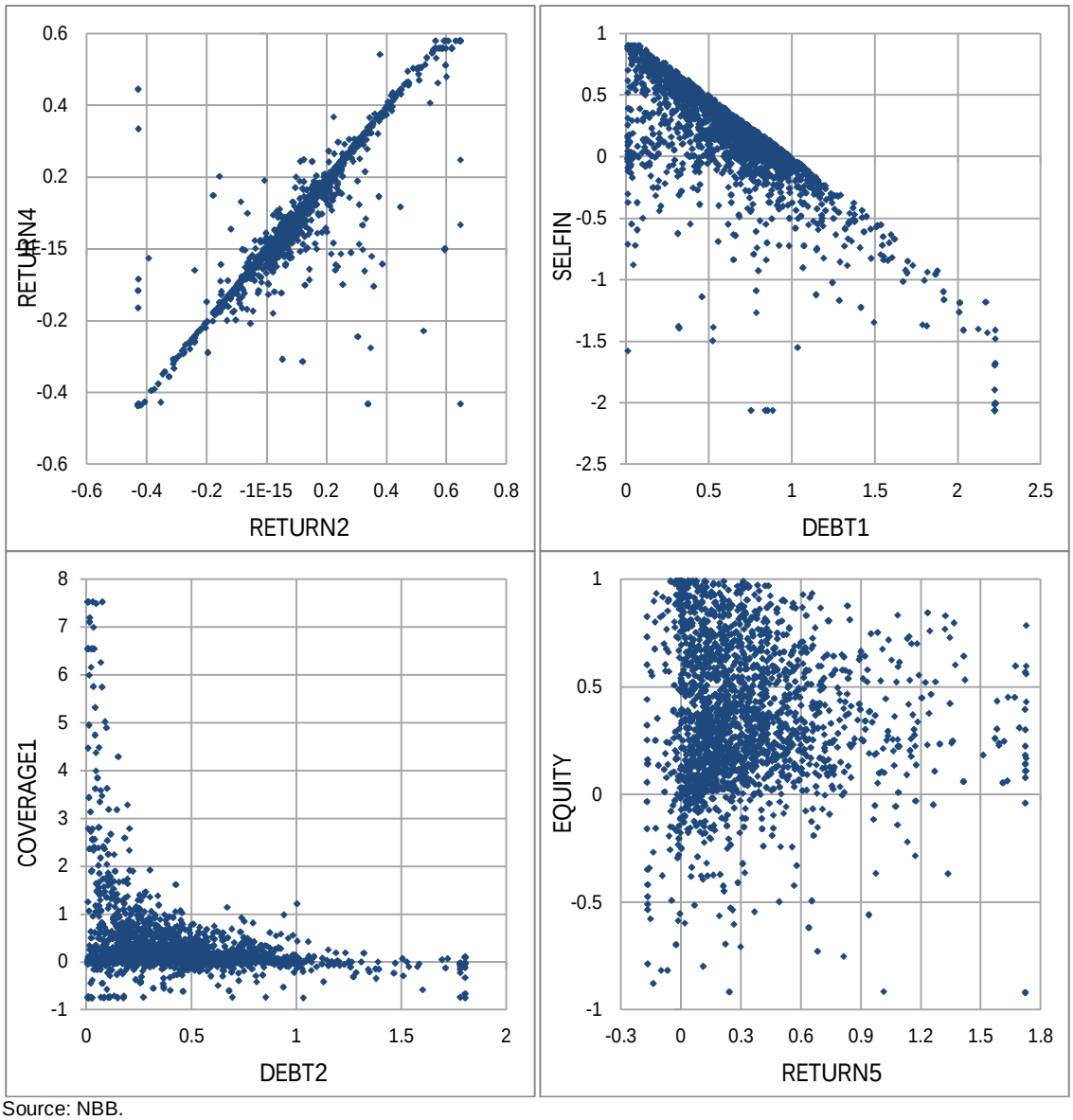


Source: NBB. (1) The regions correspond to equal intervals of the variables between percentile 1 and percentile 99.

II.4 CORRELATIONS

The correlation coefficient measures the degree of linear association between two variables. It takes a value between -1 (if the cloud of points between the two variables forms a straight line with a negative slope) and 1 (if the cloud of points between the two variables forms a straight line with a positive slope). Annex 7 presents the correlation matrix for the financial ratios. Examination of this matrix is intended to avoid multicollinearity problems in the model, which may arise for instance if two highly correlated variables are included[14]. Multicollinearity implies a lack of accuracy in the estimation of the individual coefficients. Chart 11 illustrates four cases of correlation.

CHART 11 CLOUDS OF POINTS BETWEEN PAIRS OF VARIABLES
(reference population – random sample of 2000 observations)



Source: NBB.

[14] Multicollinearity means the existence of a linear relationship between multiple independent variables included in a regression.

The correlation between the net return on assets before taxes and interest (RETURN2) and the net operating profitability (RETURN4) is high (0.89), because the two variables are similar concepts. That is reflected in a cloud of points close to a straight line. For the great majority of observations, RETURN2 is higher than RETURN4, the other cases being due to financial or exceptional losses. The correlation between the debt level (DEBT1) and the degree of self-financing (SELFIN) is also high, but negative (-0.78): *ceteris paribus*, when the reserves and profits carried forward increase, the debt level falls. The correlation between short-term debt (DEBT2) and the cash flow to debt coverage ratio (COVERAGE1) is an intermediate case (correlation = -0.30). The sign is negative because, if cash flow is constant, an increase in debts implies a decline in COVERAGE1 (via an increase in its denominator). Finally, the cloud of points between the value added ratio (RETURN5) and the equity ratio (EQUITY) is an example of the absence of any linear correlation between two variables (correlation = -0.03). As a matter of interest, the edges of the clouds of points show the impact of winsorisation on the data.

II.5 INTERACTIONS

The final model presented in Part III includes interaction variables. This section introduces the concept by means of simple models. An interaction is said to exist when the effect of an independent variable on the dependent variable differs depending on the value of a third variable, called a "moderator variable". In the examples below, the independent variables are financial ratios and the moderator variables are dummy variables. All estimated coefficients are statistically significant at the 99% threshold. Interaction variables are useful because they make it possible to differentiate the effect of the independent variables for certain segments of the population.

II.5.1 Interactions between DEBT1 and CASHNEG

In this example, the aim is to determine the effect of debt on the risk of failure, as a function of the cash flow position. DEF is the dependent variable, DEBT1 is the independent variable, and CASHNEG is the moderator variable. It should be remembered that CASHNEG is equal to 1 if the cash flow is negative, 0 if the cash flow is positive. The estimated model contains the variables DEBT1 and CASHNEG plus the interaction variable (CASHNEG × DEBT1). It gives the following equation:

$$\text{Log} - \text{odds} = -5{,}3782 + 1{,}5308\ \text{CASHNEG} + 1{,}6782\ \text{DEBT1} - 0{,}6432\ (\text{CASHNEG} \times \text{DEBT1})\ (*)$$

This model corresponds to an equation per modality of CASHNEG. If the cash-flow is positive, then CASHNEG equals zero. When entering this value in equation (*), it becomes:

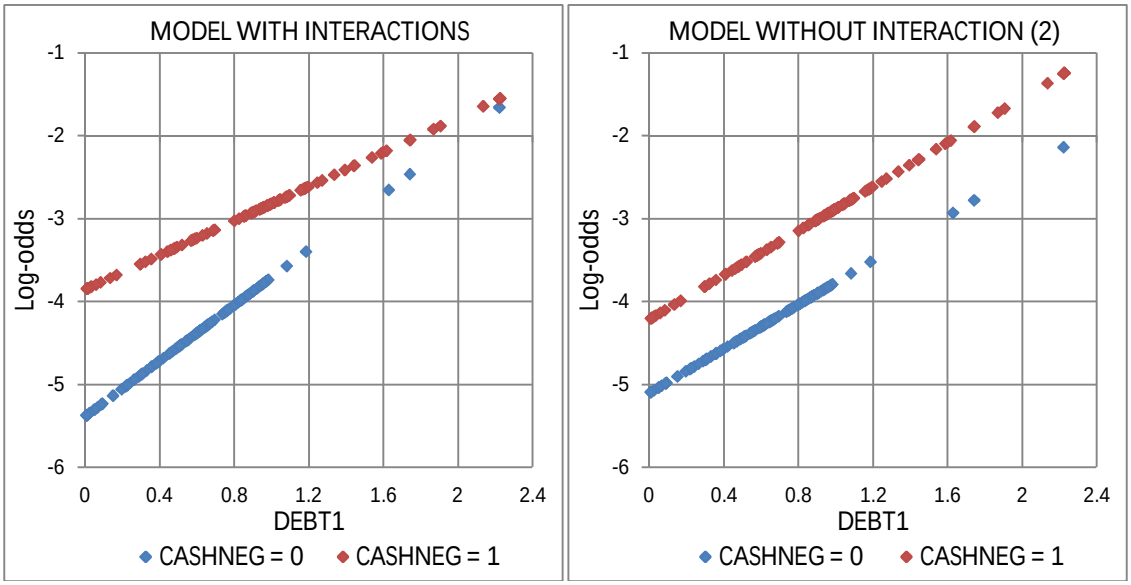
$$\text{Log} - \text{odds} = -5{,}3782 + 1{,}6782\ \text{DEBT1}$$

If the cash flow is negative, then CASHNEG equals 1. When entering this value in equation (*), it becomes:

$$\text{Log} - \text{odds} = -3{,}8474 + 1{,}0350\ \text{DEBT1}$$

The first part of chart 12 illustrates these two equations. Each modality of CASHNEG is represented by a random sample of 100 observations. For comparison, the second part of the chart illustrates the corresponding model with no interaction variable.

CHART 12 RELATIONSHIP BETWEEN DEBT1 AND THE LOG-ODDS (1)



Source: NBB.
(1) Each modality of CASHNEG is represented by a random sample of 100 observations.
(2) I.e. the model Log – odds = – 5,0958 + 0,8884 CASHNEG + 1,3346 DEBT1

The inclusion of the interaction term affects both the constant and the slope of the lines. In the model with interaction, the slope of the observations with positive cash flow is steeper, implying that the difference between the two groups declines as debt increases. At its highest point, the difference between the two groups is virtually zero. This simple model shows that the more the debt increases, the less the cash flow position influences the level of the estimated risk.

The chart also shows that instances of very high debt levels are uncommon in the positive cash flow group. In the sample of 100 observations representing that group, only three companies have a debt level of more than 160% (i.e. DEBT1 > 1.6). One of those companies is still in business, another is part of the failing group (DEF = 1) and the last one was wound up during the ensuing year. This last case shows that a deteriorating financial situation may have unfortunate consequences other than bankruptcy or judicial administration.

Inclusion of interactions between CASHNEG and DEBT1 improves the quality of the model in regard to all the assessment criteria defined in section I.6. In this simple model, the addition of the interaction term is therefore justified.

II.5.2 Interactions between RETURN3 and size classes

In this example, the aim is to determine the effect of gross operating profitability (RETURN3) on the risk of failure, as a function of size class. DEF is the dependent variable, RETURN3 is the independent variable, and the size classes are the moderator variables. The following model is estimated:

$$\begin{aligned}\text{Log} - \text{odds} = &- 4{,}2341 + 1{,}0121\ \text{SIZE1} + 0{,}6025\ \text{SIZE2} - 6{,}5854\ \text{RETURN3} \\ &+ 3{,}7461\ (\text{SIZE1} \times \text{RETURN3}) + 1{,}4510\ (\text{SIZE2} \times \text{RETURN3})\ (**)\end{aligned}$$

For the purpose of isolating the effect specific to each size class, it is not the SIZECLASS variable that is used, but the corresponding dummy variables defined in section I.3.2. Since SIZECLASS has three modalities, it is represented by means of two of the three dummy variables:
SIZE1 = 1 if SIZECLASS = 1, otherwise 0;
SIZE2 = 1 if SIZECLASS = 2, otherwise 0.

In this case, the size class 3 observations are considered as the reference group. The variable SIZE3 is not included in the equation because it would be redundant: the case where SIZE3 equals 1 corresponds to the case where SIZE1 and SIZE2 are simultaneously equal to zero.

The estimated model can be presented in the form of an equation by size class. In the case of size class 1 observations, SIZE1 is equal to 1 and SIZE2 is equal to 0. When entering these values in equation (**), it becomes:

$$\text{Log} - \text{odds} = -3{,}2220 - 2{,}8393\ \text{RETURN3}$$

In the case of size class 2 observations, SIZE1 is equal to 0 and SIZE2 is equal to 1. When entering these values in equation (**), it becomes:

$$\text{Log} - \text{odds} = -3{,}6316 - 5{,}1344\ \text{RETURN3}$$

Finally, for size class 3 observations, SIZE1 and SIZE2 are both equal to 0. The equation (**) then becomes:

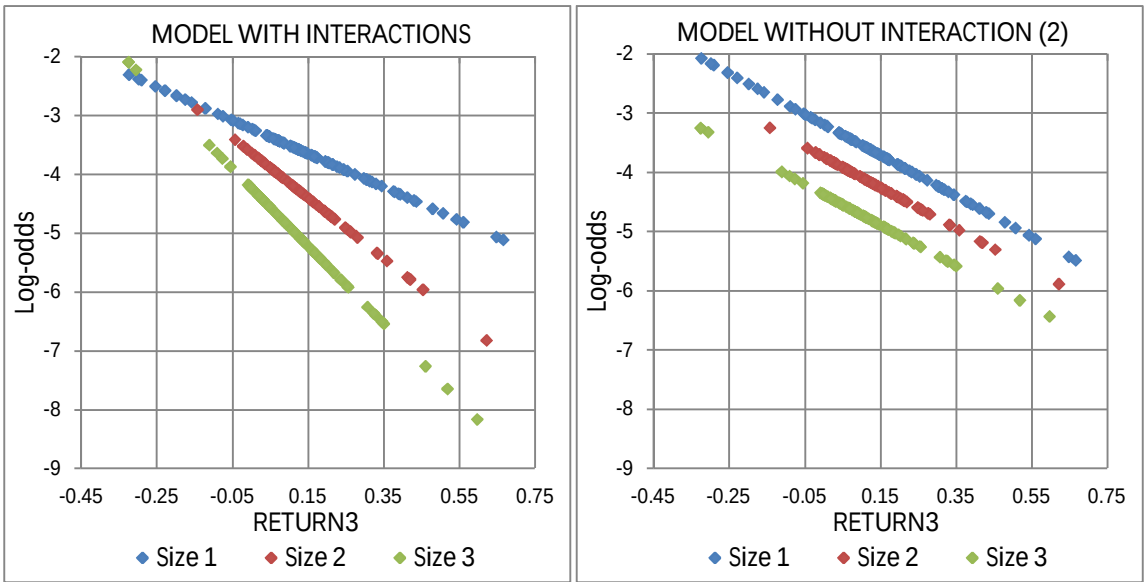
$$\text{Log} - \text{odds} = -4{,}2341 - 6{,}5854\ \text{RETURN3}$$

The first part of chart 13 illustrates these three equations. Each size class is represented by a random sample of 100 observations. The second part of the graph illustrates the corresponding model without the interaction variables. In the model with interactions, the slope of size class 1 is noticeably lower than that of the other classes, which means that for the smallest companies, a change in profitability has less impact on the log-odds. Since there is no lower limit to the ratio, the higher slopes for classes 2 and 3 imply a high log-odds for companies incurring heavy losses. However, as is evident from the chart,

instances of very negative values are very rare in classes 2 and 3. Among the 200 observations representing these two classes, there are only two cases where, for a given level of RETURN3, the estimated log-odds is higher than that estimated for the observations in class 1. This concerns two observations from class 3. One of these companies is still in business. The second went bankrupt, but more than three years after the closing date of the annual accounts. It is therefore not failing according to the specific definition used in this study, though it is a failing company in the broader sense.

Including the interactions between size and RETURN3 improves the quality of the model in regard to all the assessment criteria defined in section I.6. In this simple model, the addition of the interaction terms is therefore justified.

CHART 13 RELATIONSHIP BETWEEN RETURN3 AND LOG-ODDS (1)



Source: NBB.
(1) Each size class is represented by a random sample of 100 observations.
(2) I.e. the model Log – odds = – 4,3704 + 1,1829 SIZE1 + 0,6336 SIZE2 – 3,4499 RETURN3

II.5.3 Interactions between LIQ4 and size classes

In this example, the aim is to determine the effect of the level of liquidity on the risk of failure as a function of size class. DEF is the dependent variable, LIQ4 (cash and current investment in proportion to total assets) is the independent variable, and size classes are the moderator variables. According to a logic equivalent to that explained in the previous section, the following model is estimated:

$$\text{Log} - \text{odds} = -4{,}0930 + 1{,}0365\ \text{SIZE1} + 0{,}5186\ \text{SIZE2} - 10{,}3597\ \text{LIQ4} + 6{,}8943\ (\text{SIZE1} \times \text{LIQ4}) + 4{,}8006\ (\text{SIZE2} \times \text{LIQ4})\ (***)$$

This model can be presented in the form of an equation by size class. For the size class 1 observations, SIZE1 is equal to 1 and SIZE2 is equal to 0. When entering these values in equation (***), it becomes:

$$\text{Log} - \text{odds} = -3{,}0565 - 3{,}4654\ \text{LIQ4}$$

For the size class 2 observations, SIZE1 is equal to 0 and SIZE2 is equal to 1. When entering these values in equation (***), it becomes:

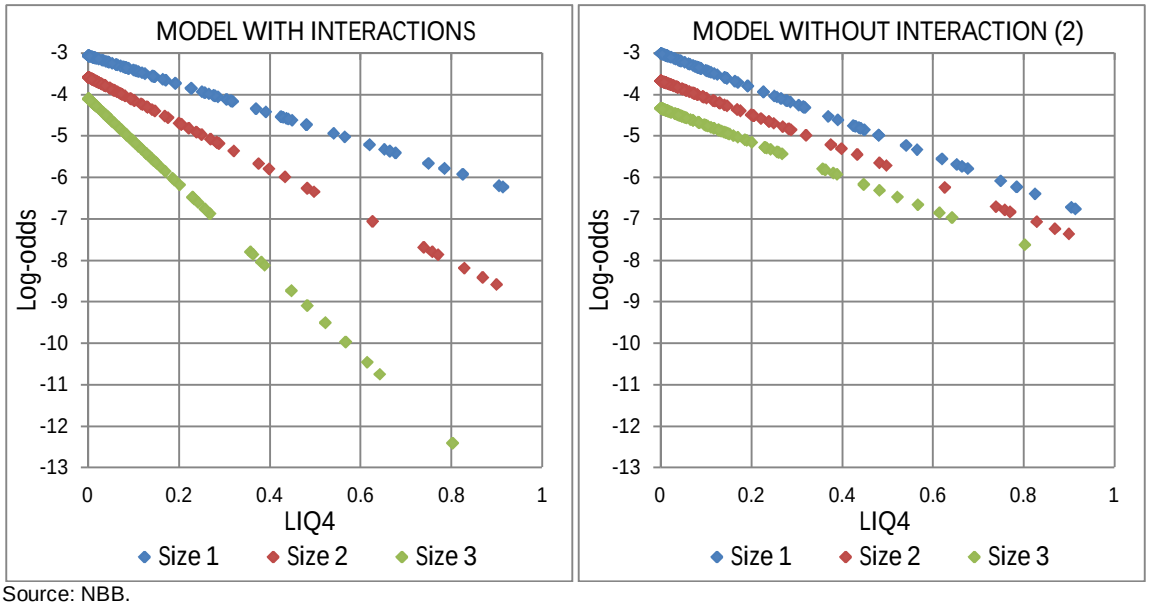
$$\text{Log} - \text{odds} = -3{,}5744 - 5{,}5591\ \text{LIQ4}$$

Finally, for the size class 3 observations, SIZE1 and SIZE2 are both equal to 0. Equation (***) therefore becomes:

$$\text{Log} - \text{odds} = -4{,}0930 - 10{,}3597\ \text{LIQ4}$$

The first part of chart 14 illustrates these three equations. Each size class is represented by a random sample of 100 observations. In the model with interactions, the slope rises with size. Consequently, the difference between the three classes increases as LIQ4 increases. As in the two previous examples, inclusion of the interactions improves the quality of the model in regard to all the assessment criteria. In this simple model, the addition of the interaction variables is therefore justified.

CHART 14 RELATIONSHIP BETWEEN LIQ4 AND LOG-ODDS (1)



Source: NBB.
(1) Each size class is represented by a random sample of 100 observations.
(2) I.e. the model Log – odds = – 4,3228 + 1,3227 SIZE1 + 0,6607 SIZE2 – 4,1072 LIQ4

II.6 STEPWISE LOGISTIC REGRESSIONS

The final phase of the preliminary analyses consisted in estimating stepwise logistic regressions. This type of procedure is based on an algorithm which calculates the importance of each variable, in terms of the statistical significance of the associated coefficient. At each stage in the procedure, a variable can be either included or excluded from the model, according to the chosen significance thresholds. Stepwise regressions are an exploratory tool used to detect the importance of certain variables and associations. Their results must be interpreted with caution, because they depend on the chosen parameters.

Several types of stepwise regressions were estimated, some with the obligatory inclusion of one or more variables, others taking account of the potential interactions. These regressions largely confirmed the univariate results.

Table 10 presents a model obtained on completion of a simple procedure limited to 20 steps. The variables are reported in the order of their inclusion. After the 20th step, the model contains 20 variables, none of the variables included being excluded subsequently in the procedure. In accordance with intuition, the first variables entered are solvency and liquidity variables, namely DEBT2 and LOGLIQ5. The variable OVERDUE comes third, thus indicating its importance in a multivariate context. However, it was not included in the final model owing to its temporal instability and the difficulties of interpretation mentioned in section II.2. The procedure confirms the significance of the logarithmic variables (LOGLIQ5, LOGAGE, LOGDEBT1, ...) and the dummy variables (CASHNEG, DISTRIB, FORMAT, ALARM1, ...). It can also be seen that a number of coefficients have a counter-intuitive sign (RETURN5, LOGLIQ2, COVERAGE1, ...), confirming the need for caution in analysing the results. On completion of the procedure, C is equal to 0.837 whereas it is already 0.831 after the tenth step; the inclusion of additional variables therefore yields only a marginal improvement in the model's performance.

TABLE 10 STEPWISE LOGISTIC REGRESSION COMPRISING 20 STEPS
(variables in order of inclusion, reference population)

	Coefficient	Standard error	p
Intercept	-5.5616	0.0972	< 0.0001
DEBT2	1.6584	0.0642	< 0.0001
LOGLIQ5	-0.4214	0.0229	< 0.0001
OVERDUE	12.6332	0.4474	< 0.0001
LOGAGE	-0.4465	0.0145	< 0.0001
CASHNEG	0.4759	0.0330	< 0.0001
CHARGES	6.5456	0.4431	< 0.0001
LIQ3	1.3956	0.0717	< 0.0001
DISTRIB	-0.8496	0.0629	< 0.0001
FORMAT	0.9668	0.0633	< 0.0001
RETURN5	0.4450	0.0300	< 0.0001
RETURN3	-1.3500	0.0951	< 0.0001
LOGDEBT1	0.3629	0.0442	< 0.0001
DEBT4	-1.3495	0.1142	< 0.0001
CREDPOS	0.2907	0.0317	< 0.0001
DEBT5	0.8420	0.1138	< 0.0001
LOGLIQ2	0.2233	0.0184	< 0.0001
LOGLIQ3	-0.3283	0.0315	< 0.0001
LIQ4	-1.1341	0.1502	< 0.0001
ALARM1	0.2101	0.0319	< 0.0001
COVERAGE1	0.1558	0.0269	< 0.0001

Source: NBB.

PART III MODEL AND FINANCIAL HEALTH INDICATOR

III.1 FINANCIAL HEALTH MODEL

III.1.1 Description

The financial health model was developed in the same way as a failure prediction model. It takes the form of a logistic regression discriminating between failing and non-failing companies. A company is considered to have failed if it has faced bankruptcy or judicial administration within three years following the closing date of its annual accounts[15]. The model is called a "financial health model" because its primary aim is to establish an objective concept of financial health. In this connection, the group of companies facing bankruptcy or judicial administration is considered as a benchmark for a deteriorated financial situation.

The model is constructed on the basis of the results presented in Part II of this document. Numerous competing models were tested and assessed according to the criteria defined in section I.6. In the last stage of the modelling process, each included variable was replaced by other conceptually close variables, in order to check its superiority in a multivariate context. The model finally adopted is described in table 11. It was estimated on the reference population which, it should be remembered, comprises a combination of the annual accounts relating to the years 2005 and 2006, and which therefore makes it possible to study the failures which occurred in 2006, 2007, 2008 and 2009. This population is much bigger than the populations examined in most comparable studies. Nonetheless, the model performs very satisfactorily, and the number of companies covered means that the results are very widely applicable. The use of interaction variables also permits differentiation of the effects for certain population segments.

In table 11, the score is equal to the log-odds presented previously, and is therefore a measure of the failure risk: when the score increases (decreases), the estimated probability of failure increases (decreases). This means that if a variable is associated with a positive coefficient, the probability of failure increases when the variable increases, whereas if a variable is associated with a negative coefficient, the probability of failure decreases when the variable increases. Each coefficient represents the change in the score corresponding to a one unit change in the variable with which it is associated. For example, when RETURN3 (gross operating profitability) increases by one unit, the score falls by 2.0465. All the coefficients are significant at the 99% level and have signs which conform to intuition. The variables are divided into three groups: continuous variables (LOGDEBT2, LOGLIQ5, CHARGES, RETURN3 and LOGAGE), dummy variables (SIZE1, SIZE2, DISTRIB and CASHNEG) and interaction variables.

[15] The concept of failure is discussed in section I.2.1. The implications of the new law on business continuity were not assessed because, when this study was conducted, the Crossroads Bank for Enterprises did not identify firms entering into the new procedures.

TABLE 11 FINANCIAL HEALTH MODEL
(model estimated on the reference population, i.e. 419,633 observations relating to financial years 2005 and 2006)

	Coefficient (1)	Variable	Description
SCORE =	- 4.1932		
	+ 1.4215	LOGDEBT2	Logarithm of short-term debt level
	- 0.6263	LOGLIQ5	Logarithm of cash and current investment in proportion to current assets
	- 2.0465	RETURN3	Gross operating profitability
	- 0.4098	LOGAGE	Logarithm of age
	+ 8.8396	CHARGES	Debt interest charges in proportion to total liabilities
	+ 1.3334	SIZE1	SIZE1=1 if balance sheet total < €250,000, otherwise 0
	+ 0.5963	SIZE2	SIZE2=1 if €250,000 ≤ balance sheet total < €5,000,000, otherwise 0
	- 0.7297	DISTRIB	DISTRIB=1 if profits are distributed, otherwise 0
	+ 0.2796	CASHNEG	CASHNEG =1 if the cash flow is negative, otherwise 0
	+ 0.2603	(SIZE1 × LOGLIQ5)	
	+ 1.1987	(SIZE1 × RETURN3)	
	- 0.4276	(CASHNEG × LOGDEBT2)	
	+ 0.1760	(LOGDEBT2 × LOGLIQ5)	

Source: NBB.
(1) All the coefficients are significant at the 99% threshold. In each group, variables are mentioned in the decreasing order of standardised coefficients.

The logarithmic variables were introduced by replacing the non-transformed variables. The logarithms implying a significant improvement in the model were retained, namely LOGDEBT2 (logarithm of short-term debt level), LOGLIQ5 (logarithm of the cash ratio) and LOGAGE (logarithm of age). The interaction variables were then introduced in order to distinguish the effect of the continuous variables for certain population segments. Only the interactions implying a significant improvement in the model were added, namely (SIZE1 × LOGLIQ5), (SIZE1 × RETURN3), (CASHNEG × LOGDEBT2) and (LOGDEBT2 × LOGLIQ5).

III.1.2 Interpretation

LOGDEBT2 (logarithm of short-term debt level): reflects the level of debts maturing during the year, i.e. the funds which the company cannot rely on in the long term. The associated positive coefficient means that the estimated probability of failure increases when LOGDEBT2 increases. The logarithmic transformation implies that the effect of a given increase in the debt declines as the debt level increases[16].

[16] For example, for a 20% increase in the debt level, the effect will be greater if the debt increases from 30% to 50% than if the debt increases from 70% to 90%.

LOGLIQ5 (logarithm of cash and current investment in proportion to current assets): measures the immediately available liquidity within the short-term assets. The associated negative coefficient means that the estimated probability of failure declines when LOGLIQ5 increases. The logarithmic transformation implies that the effect of a given increase in liquidity declines as liquidity increases.

RETURN3 (gross operating profitability): measures the gross operating profitability, i.e. the operating profitability before depreciation, write-downs and provisions. The associated negative coefficient indicates that the estimated probability of failure declines when RETURN3 increases.

LOGAGE (logarithm of age): measures the age of each company. The associated negative coefficient means that the estimated probability of failure declines when LOGAGE increases. The logarithmic transformation implies that the effect of a given increase in age declines as age increases.

CHARGES (debt interest charges in proportion to total liabilities): reflects the level of debt interest charges borne by the company in proportion to the total assets at its disposal. The associated positive coefficient indicates that the estimated probability of failure increases when CHARGES increases.

SIZE1: variable equal to 1 for size class 1 companies (balance sheet total less than €250,000), 0 for others. The associated positive coefficient means that belonging to this class increases the estimated probability of failure.

SIZE2: variable equal to 1 for size class 1 companies (balance sheet total between €250,000 and €5,000,000), 0 for others. The associated positive coefficient means that belonging to this class increases the estimated probability of failure. However, that increase is less marked than in the case of the size class 1 observations.

DISTRIB: variable equal to 1 for companies which distribute some or all of their profits, 0 for others. The associated negative coefficient indicates that the fact that profits are distributed reduces the estimated probability of failure. When DISTRIB is equal to 1, that means that the company has profits available for distribution, and that its net assets meet the requirements set out in the Company Code[17].

CASHNEG: variable equal to 1 for companies with a negative cash flow, 0 for others. The associated positive coefficient indicates that a negative cash flow situation increases the estimated probability of failure.

SIZE1*LOGLIQ5: variable taking account of the interactions between size and liquid resources which can be mobilised immediately. The associated positive coefficient indi-

[17] Articles 320, 429 and 617 of the Company Code.

cates that, for companies in size class 1, a given increase in LOGLIQ5 has less impact on the estimated probability of failure.

SIZE1*RETURN3: variable taking account of the interactions between size and gross operating profitability. The associated positive coefficient means that, for companies in size class 1, a given increase in RETURN3 has less impact on the estimated probability of failure.

CASHNEG*LOGDEBT2: variable taking account of the interactions between the debt level and the cash flow position. The associated negative coefficient indicates that, for companies with a negative cash flow, a given increase in LOGDEBT2 has less impact on the probability of failure. At the same time, such companies carry a risk premium via the variable CASHNEG (cf. above).

LOGDEBT2*LOGLIQ5: variable taking account of the interactions between short-term debt and liquidity.

III.1.3 Assessment

The performance of the final model and the alternative models was assessed on the basis of the criteria defined in section I.6, namely general statistical tests, predictive efficiency and statistical significance of the coefficients. The present section focuses on predictive efficiency, which is the central criterion from the point of view of minimising errors. However, the other criteria were examined and were particularly useful in the variable selection process.

The correct classification analysis aims to obtain the same correct classification rates for failing and non-failing observations. In the financial health model, the threshold score corresponding to that criterion is -3.64. At that threshold, the correct classification rate for failing observations (DEF=1) is 75% (i.e. 6.692/8.971), while the correct classification rate for non-failing observations (DEF=0) is also 75% (i.e. 306.639/410.662). As pointed out in section I.6.2.1, the correct classification rate summarizes the model's performance in a single quantity. However, this information is incomplete, since it takes no account of the distribution of the estimated scores.

TABLE 12 CORRECT CLASSIFICATION TABLE
(number of observations)

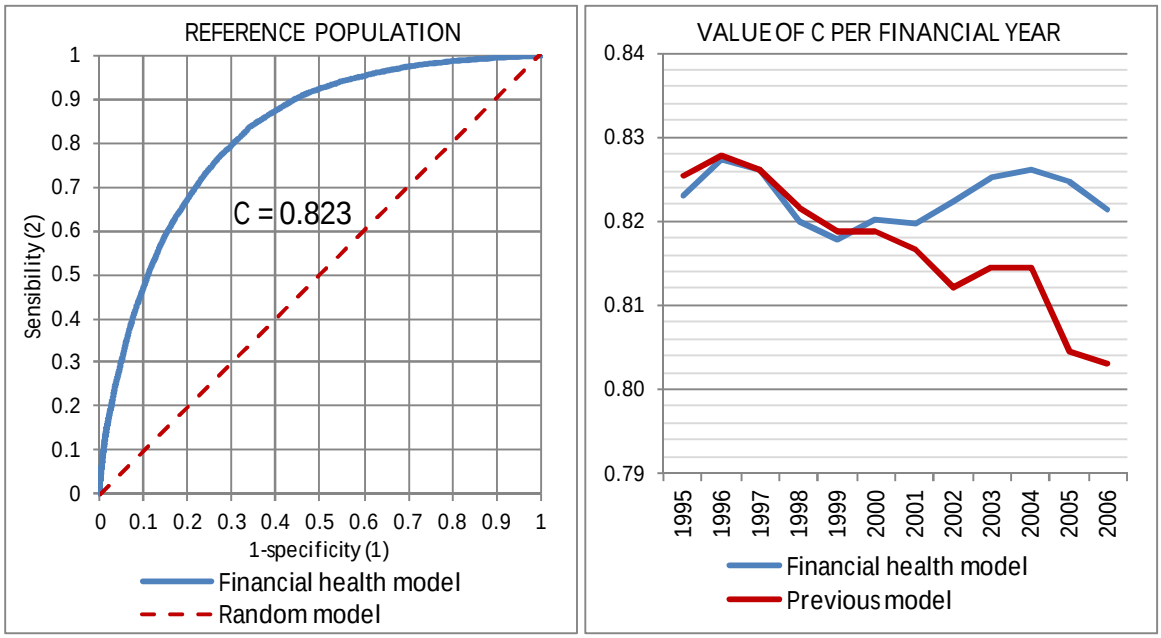
Estimated	Observed		Total
	DEF=1	DEF=0	
DEF=1	6,692	104,023	110,715
DEF=0	2,279	306,639	308,918
Total	8,971	410,662	419,633

Source: NBB.

ROC curves solve this problem by considering as many thresholds as there are estimated scores for the population studied. The financial health model obtains an area C under the

ROC curve equal to 0.823 (first part of chart 15). That value means that in 82.3% of cases, a randomly chosen failing observation will have an estimated score higher than that of a similarly randomly chosen non-failing observation. This means excellent predictive efficacy according to Hosmer and Lemeshow (2000). The prediction quality is all the more pleasing since the population is much larger (and therefore more heterogeneous) than the populations examined in most comparable studies. The second part of chart 15 describes the values of C obtained by validating the model for each financial year studied. The predictive efficacy proves to be particularly stable over time, since C fluctuates in a narrow range between 0.817 and 0.828.

CHART 15 ROC CURVE OF THE FINANCIAL HEALTH MODEL



Source: NBB.
(1) 1 - specificity = rate of incorrect classification of non-failing observations (DEF=0).
(2) Sensibility = rate of correct classification of failing observations (DEF=1).

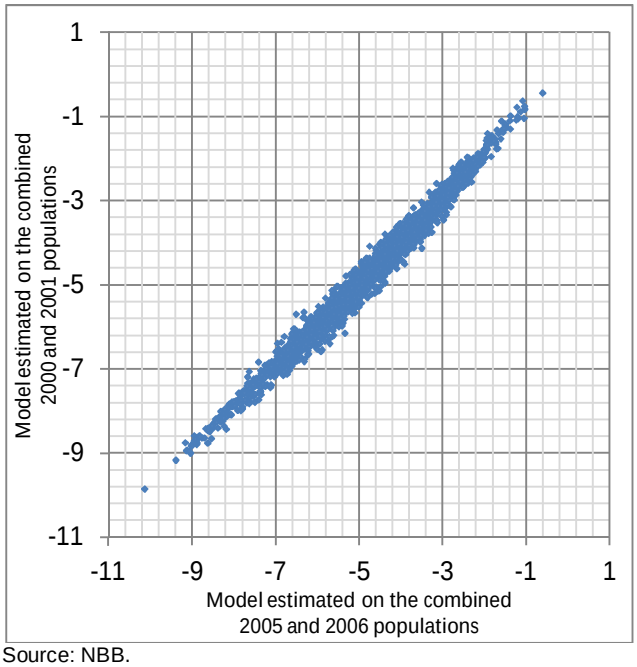
Comparison with the previous model shows that the two models perform similarly until 2000, after what the efficiency of the previous model noticeably falls. This fall is essentially due to the marked erosion of the predictive power of the variable "overdue debts to tax authorities and NSSO", which was included in the previous model. Over the last years, the replacement of this variable with more relevant variables stabilises the predictive efficiency. It should also be noted that Mitchell and Van Roy (2007) compared the previous version of the Bank's model (developed on the same basis as the present model) with the models of two commercial companies and Altman's Z-score. That analysis showed that the four models achieve a comparable performance in terms of predictive efficiency, although they do not use the same methodology and the same definition of the concept of failure[18]. In all likelihood, the new model thus favourably compares with models developed by other institutions.

Chart 16 depicts the estimation stability. The x-axis gives the scores obtained on the basis of the financial health model, i.e. the model estimated on the combined 2005 and 2006

[18] This result suggests that the definition of failure (payment default or bankruptcy) is of minor importance.

populations. The y-axis gives the scores obtained on the basis of a model containing the same variables, but estimated on the combined 2000 and 2001 populations. This chart indicates that the choice of the estimation population has hardly any effect on either the scores obtained or the classification of the observations.

CHART 16 ESTIMATION STABILITY
(estimated scores for the 2008 population – random sample of 2000 observations)

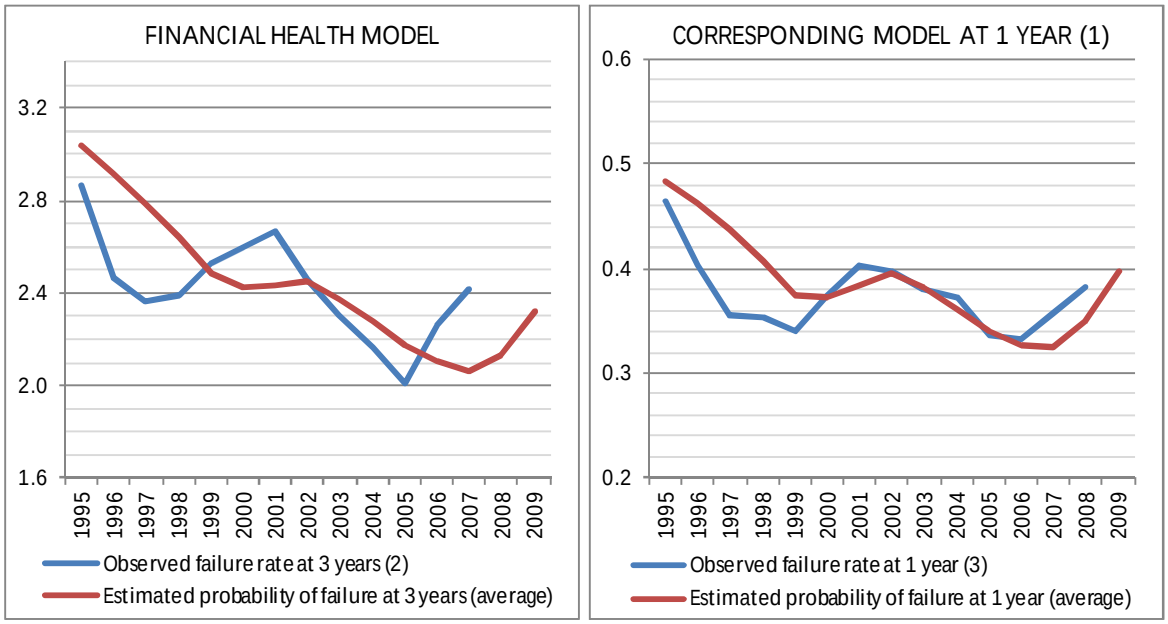


Source: NBB.

Finally, for each financial year, the first part of chart 17 describes the observed failure rate at 3 years and the average probability of failure estimated by the financial health model. The two values follow the same trend but with a time lag due to the 3-year horizon chosen to define failure. Over the recent period, for example, the failure rate at 3 years begins rising from the year 2006 (owing to the increased number of bankruptcies in 2008 and in 2009), whereas the estimated probability begins rising in 2008. In fact, it is only from 2008 onwards that the economic cycle affects the financial position of the companies. Over the whole of the period studied, the estimated probability tends to smooth out the fluctuations: in boom periods, it exceeds the observed failure rate whereas in periods of weak activity it is lower than that figure.

The second part of the chart shows the results obtained when the failure horizon is reduced to one year. It compares the observed failure rate at 1 year with the average probability derived from a model containing the same independent variables as the financial health model, but estimated for failure prediction at 1 year. The chart shows that this adjustment to the failure horizon largely reconciles the two values, at least for the past ten financial years.

CHART 17 OBSERVED FAILURE RATE AND ESTIMATED PROBABILITY OF FAILURE



Source: NBB.
(1) Model containing the same independent variables as the financial health model, but estimated for failure prediction at 1 year. The dependent variable is therefore equal to 1 if DEFDETAIL=DEF01, otherwise 0.
(2) I.e. rate of observations DEF=1.
(3) I.e. rate of observations DEFDETAIL=DEF01.

III.2 FINANCIAL HEALTH INDICATOR

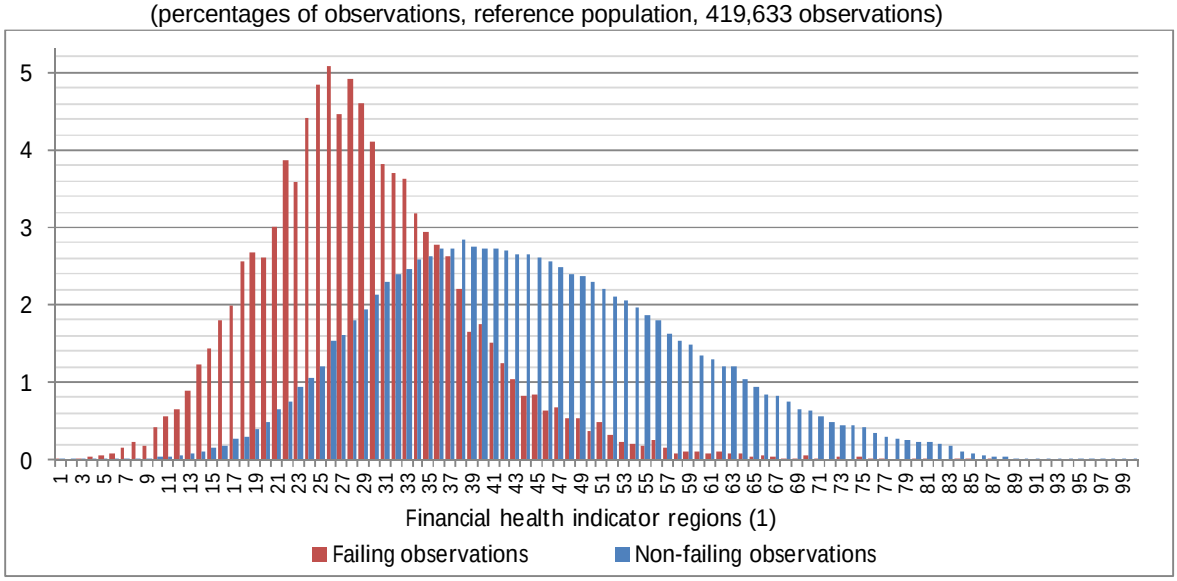
The score estimated by the model is a measure of the failure risk: the higher a company's score, the higher its estimated probability of failure and, implicitly, the worse its financial situation. Since the financial health indicator is intended to take account of the opposite concept, it is defined as follows:

Financial health indicator = - score

According to this definition, the higher a company's indicator, the lower its estimated probability of failure and, implicitly, the more satisfactory its financial situation. Charts 18 and 19 illustrate this relationship via a 100-region breakdown of the indicator. The regions correspond to equal intervals in the indicator between its minimum and maximum values.

Chart 18 presents the distribution of the failing and non-failing observations for the 100 regions thus defined. It shows that the failing companies are concentrated in the lower regions of the indicator, while the non-failing companies are concentrated in the higher regions. Thus, regions 1 to 28 contain over half of the failing companies, against just 12% of the non-failing companies. Conversely, the last fifty regions contain almost 40% of the non-failing companies, against 4% of the failing companies. The chart also shows the existence of a "grey zone" in which it is hard to discriminate between companies. This grey zone corresponds to the regions in which the proportions of failing and non-failing observations are similar.

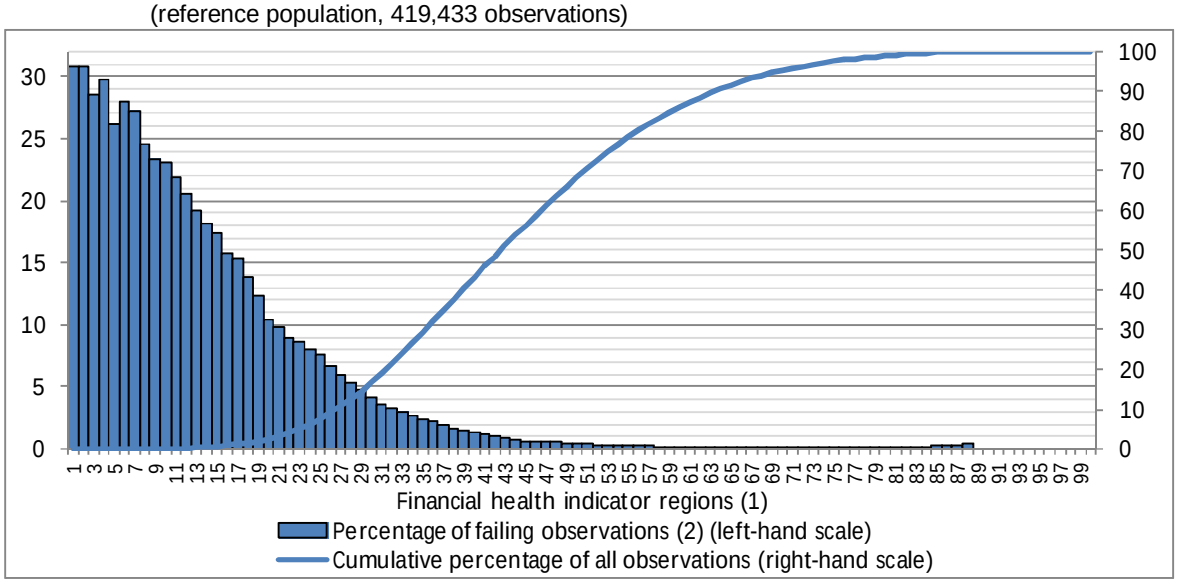
CHART 18 DISTRIBUTION OF FAILING AND NON-FAILING OBSERVATIONS, BY FINANCIAL HEALTH INDICATOR REGION
(percentages of observations, reference population, 419,633 observations)



Source: NBB. (1) Regions corresponding to equal intervals of the indicator between its minimum and maximum values; region 1 = [-0.10;0.01[; region 2 = [0.01;0.12[; region 3 = [0.12;0.13[; ... ; region 99 = [10.82;10.93[; region 100 = [10.93;11.04].

Chart 19 presents the distribution from a different angle: for each of the 100 regions, it describes the failure rate and the cumulative frequency curve of the observations. This chart reveals the very negative relationship between the indicator and the failure risk, as the failure rate at 3 years drops from over 30% in the first regions to 0% in the last regions. The relationship is not linear, and beyond the 60th region the failure rate is more or less stationary at a very low level. This means that, beyond a certain level, an additional increase in the indicator has no more meaning in terms of failure risk.

CHART 19 FAILURE RATE AND CUMULATIVE FREQUENCY FOR ALL OBSERVATIONS, BY FINANCIAL HEALTH INDICATOR REGION
(reference population, 419,433 observations)



Source: NBB.
(1) Regions corresponding to equal intervals of the indicator between its minimum and maximum values; region 1 = [-0.10;0.01[; region 2 = [0.01;0.12[; region 3 = [0.12;0.13[; ... ; region 99 = [10.82;10.93[; region 100 = [10.93;11.04].
(2) Centered moving average of three regions.

III.3 FINANCIAL HEALTH CLASSES

III.3.1 Definition

Once the indicator has been calculated, the observations are arranged in groups by merging bordering regions of the indicator until obtaining sets which are sufficiently homogenous and stable in terms of failure rate observed in the ensuing three years. Ten "financial health classes" were thus created[19].

Each class is associated with a different risk level defined by the failure rate at 3 years observed in the past (table 13). The rates presented in the table were calculated on the full set of annual accounts relating to the financial years 2000 to 2006, i.e. for failures occurring between 2001 and 2009. These rates are therefore independent of the economic cycle and consequently enjoy stability over time. In view of the number of observations on which the calculations were based (1,336,259 sets of accounts), they can be interpreted as reliable probabilities. Annex 8 gives the detailed rates by year and by class. One can see that they fluctuate little over time and that the confidence intervals for the mean do not overlap[20].

TABLE 13 DEFINITION OF THE FINANCIAL HEALTH CLASSES
(combination of accounts relating to financial years 2000 to 2006, i.e. 1,336,259 observations)

Classes de santé financière	Rate of failing observations at a 3-year horizon	Percentage of companies present in the class
Classe 1	0.09	8.12
Classe 2	0.22	16.54
Classe 3	0.46	15.90
Classe 4	0.94	16.01
Classe 5	2.35	24.93
Classe 6	5.58	11.87
Classe 7	10.20	4.71
Classe 8	15.32	1.24
Classe 9	20.01	0.47
Classe 10	26.25	0.21
TOTAL	**2.34**	**100.0**

Source: NBB.

[19] The previous model resulted in six classes. The increase in the number of classes was made possible by the larger population. The new classes correspond to the following intervals of the indicator:
- Class 1: indicator ≥ 6.99;
- Class 2: 6.99 > indicator ≥ 5.66;
- Class 3: 5.66 > indicator ≥ 4.88;
- Class 4: 4.88 > indicator ≥ 4.22;
- Class 5: 4.22 > indicator ≥ 3.22;
- Class 6: 3.22 > indicator ≥ 2.53;
- Class 7: 2.53 > indicator ≥ 1.93;
- Class 8: 1.93 > indicator ≥ 1.52;
- Class 9: 1.52 > indicator ≥ 1.12;
- Class 10: 1.12 > indicator.

[20] For information purposes, annex 9 also provides failure rates at 1, 2 and 3 years.

The failure rate comes to 0.09 in class 1, i.e. the class corresponding to the highest values of the financial health indicator. That rate means that, in the past, fewer than one in a thousand companies in that class failed at a 3-year horizon. The failure rate then increases steadily as we move from class 1 to class 10, what implicitly corresponds to a deterioration in the financial situation. The rate reaches 26.2% in class 10, i.e. the class corresponding to the lowest values of the indicator. This means that, in the past, over a quarter of class 10 companies failed at a 3-year horizon.

Classes 1, 2, 3 and 4 are associated with below-average failure rates, and therefore correspond to a favourable financial situation. However, the rates are not zero, which means that these classes are not totally risk free. Conversely, classes 6, 7, 8, 9 and 10 are associated with above-average failure rates, and therefore correspond to a situation of vulnerability. That is why belonging to one of these classes can be interpreted as a warning sign, which becomes stronger as we move from class 6 to class 10. Finally, class 5 is equivalent to the grey zone mentioned in the previous section. It corresponds to an average failure rate (2.3%) and is therefore neutral in terms of interpretation.

Half of the companies are found in the first four classes, namely the classes corresponding to a below-average failure rate. Conversely, the last three classes contain under 2% of companies.

It should be noted that the failure rates presented in table 13 concern companies in order of filing their annual accounts, and that failure to fulfil that statutory obligation is a warning signal prior to any financial diagnosis. Those rates also concern a specific definition of failure, namely bankruptcy or judicial administration situations at a 3-year horizon. If that horizon is extended to 5 or 10 years, the rates become markedly higher. Table 14 relating to the 1999 financial year shows that, in class 10 for example, the failure rate is 45.4% at 10 years, compared to 37.3% at 5 years and 27.8% at 3 years.

Moreover, apart from bankruptcy, companies belonging to the last classes could be exposed to other undesirable consequences, such as payment default, restructuring, dissolution or liquidation. At a 10-year horizon, if we add to the bankruptcies the cases of companies which have disappeared for any other reason, the business cessation rate exceeds 60% in class 10 and 50% in classes 8 and 9. The continuity of companies positioned in the last classes is therefore seriously compromised sooner or later. Most of the companies remaining in business subsequently obtain financial support from their shareholders in the form of loans, capital increases or soaking up of losses.

The financial health classes thus defined, like the indicator from which they are derived, represent a strictly financial assessment of the companies at a particular moment. The assessment is based on data from the annual accounts, and therefore disregards other fundamental aspects, such as development prospects, competition or management skills. By that token, it must be seen as one of the factors enabling an overall appraisal of a company's situation.

TABLE 14 FINANCIAL HEALTH CLASSES AND EXTENDED DEFINITION OF FAILURE
(financial year 1999)

Financial health classes	Failure rate at a 3-year horizon	Failure rate at a 5-year horizon	Failure rate at a 10-year horizon
Class 1	0.1	0.3	0.8
Class 2	0.2	0.6	1.8
Class 3	0.4	1.2	3.1
Class 4	0.9	2.3	5.3
Class 5	2.4	4.9	10.0
Class 6	5.3	10.4	18.2
Class 7	10.9	18.3	27.6
Class 8	15.2	23.5	34.1
Class 9	20.9	29.7	39.0
Class 10	27.8	37.3	45.4
TOTAL	**2.5**	**4.8**	**8.9**

Source: NBB.

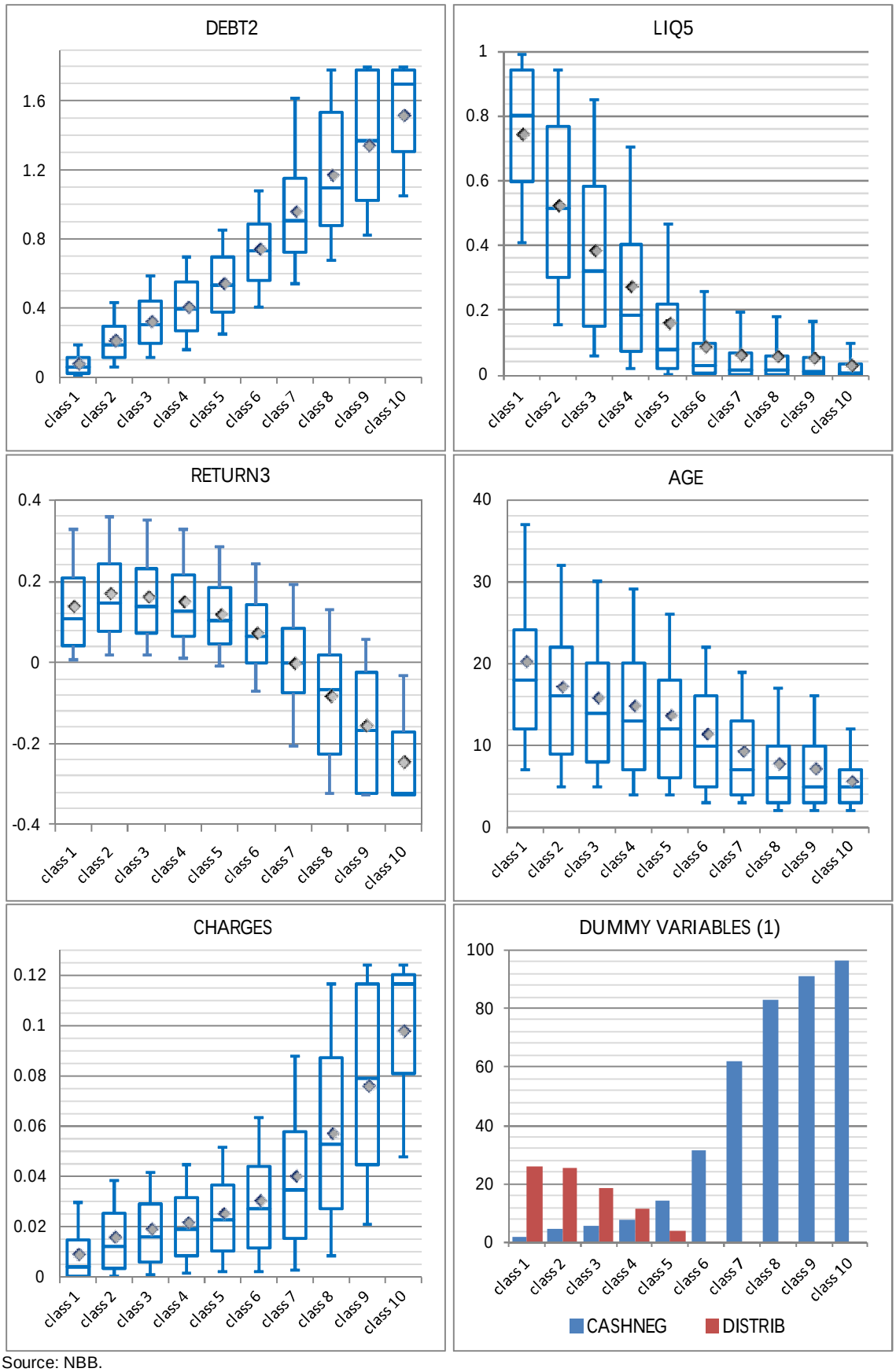
III.3.2 Financial characterisation

Chart 20 describes the financial situation of companies in each of the classes, in the form of box plots (cf. interpretation in section II.1). For each variable included in the model, it shows that the position of the companies deteriorates progressively from class 1 to class 10. In the great majority of cases, that deterioration affects the whole distribution, from the 10^{th} to the 90^{th} percentile. Companies in the first classes have significantly lower debt levels, and are more profitable and more liquid than companies in the last classes.

For example, one can see that short-term debt level (DEBT2) is below 0.2 for 90% of companies in class 1, whereas it exceeds 1.05 for 90% of companies in class 10. Similarly, gross operating profitability (RETURN3) is positive for 90% of companies in class 1, whereas it is negative for almost all companies in class 10. It also appears that half of class 1 companies are over 18 years old, whereas half of class 10 companies are under 5 years old. In most cases, the distributions are decidedly asymmetric for the last classes, owing to the concentration of companies in the lower regions of the variables. In the case of RETURN3 for example, the median of class 10 (-0.32) is the same as the first quartile and the first decile.

Regarding the binary variables, the proportion of companies with a negative cash flow (i.e. CASHNEG=1) rises steadily from 1.8% in class 1 to 96.1% in class 10. It also appears that, with occasional exceptions, companies in the last classes do not distribute any profits.

CHART 20 INDEPENDENT VARIABLES - BOX PLOTS BY FINANCIAL HEALTH CLASS
(reference population)



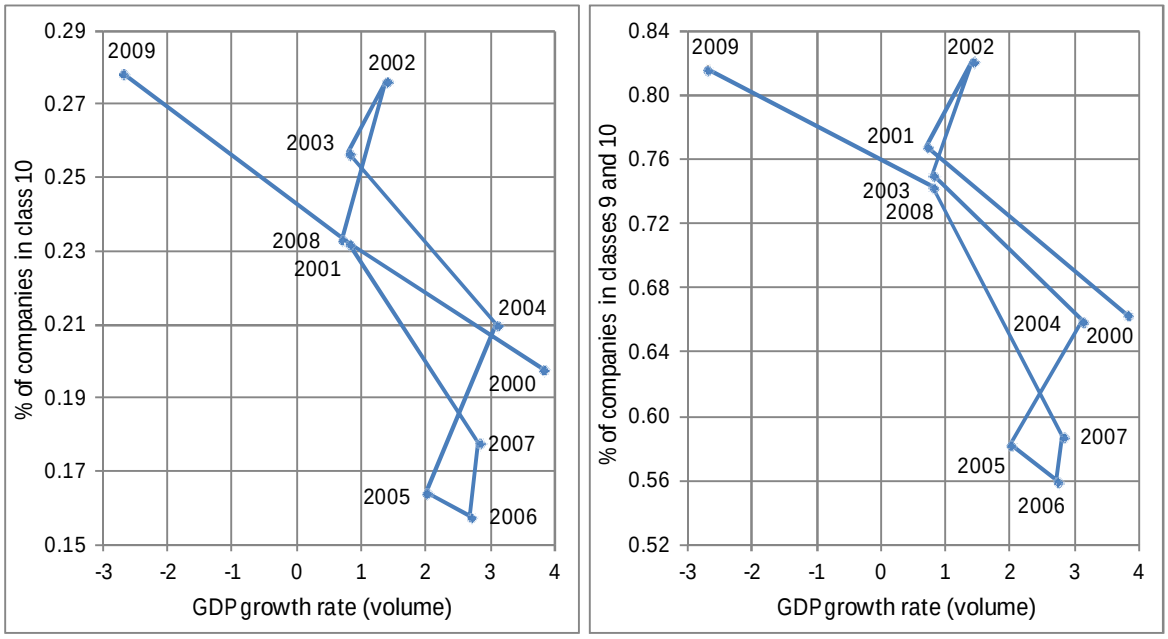
Source: NBB.
(1) Percentage of observations for which the variable is equal to 1.

III.3.3 Changes in the distribution of the companies

The distribution of the companies among the financial health classes fluctuates over time (cf. annex 10). In particular, periods of weak economic activity correspond to an increase in the percentage of companies in the last classes (i.e. the most vulnerable classes), whereas boom periods correspond to a reduction in that same percentage. This is especially true for the last two or three classes. Chart 21 thus shows that the years of weak GDP growth (namely 2002, 2003, 2008 and 2009) coincide with higher percentages of companies in classes 9 and 10.

The impact of the recession which began in late 2008 and persisted in 2009 is particularly marked: between 2007 and 2009, the proportion of companies in classes 9 and 10 increased from 0.59% to 0.82% All branches of the economy were affected by this heightened vulnerability, to a greater or a lesser extent (cf. annex 11). In 2009, the branches with the largest number of vulnerable companies were hotels, restaurants, trade, transport and construction.

CHART 21 PERCENTAGE OF COMPANIES IN THE LAST CLASSES AND GDP GROWTH RATE



Source: NBB.

III.4 USE IN THE CENTRAL BALANCE SHEET OFFICE'S ENTERPRISE FILES

The financial health classes are to be used in the enterprise files compiled by the Central Balance Sheet Office. These files are designed for the purpose of comparing the financial situation of a firm with that of firms in the same branch of activity. They contain a summary of the accounting and financial data obtained from the annual accounts of each firm over three successive years, to be selected from the last five years. This summary is supplemented by a comparison with the figures for firms operating in the same branch of activity[21].

[21] For more information, see www.centraledesbilans.be.

For companies which satisfy the conditions for calculating the indicator (cf. section I.1), the enterprise files include a table identical with table 15. Each company is positioned in one of the 10 classes for the last three financial years in order to take account of the trend over time. In the interpretation, that trend is just as important as the company's position at a particular moment. The table also provides information on the failure rate at a 3-year horizon observed in the past, and the distribution of companies among the classes for the last complete financial year.

TABLE 15 EXAMPLE – FINANCIAL HEALTH CLASSES IN THE ENTERPRISE FILE

Financial health classes	Year 2007	Year 2008	Year 2009	Percentage of failing companies at a 3-year horizon (1)	Percentage of companies in the class (2)
Class 1				0.09	10.70
Class 2				0.22	19.07
Class 3			X	0.46	16.43
Class 4				0.94	15.35
Class 5	X			2.35	21.84
Class 6		X		5.58	10.35
Class 7				10.20	4.31
Class 8				15.32	1.21
Class 9				20.01	0.51
Class 10				26.25	0.23

(1) Average for the years 2000 to 2006.
(2) 2008 financial year.

CONCLUSION

This document sums up the work on the development of a financial health indicator based on the companies' annual accounts. This indicator is designed as a weighted combination of variables, created by means of a model constructed in the same way as a failure prediction model. The model takes the form of a logistic regression discriminating between failing and non-failing companies. The definition of failure is based on a legal criterion, namely that a company is considered to have failed if it has faced bankruptcy or judicial administration in the past.

The indicator summarises each company's situation in a single value which takes account simultaneously of the solvency, liquidity and profitability dimensions. Those dimensions are complementary in the establishment of a financial diagnosis, as a high debt level, for example, may be offset by a strong cash position or a plentiful cash flow, and vice versa. The indicator also takes account of the companies' age and size, particularly through interaction variables.

The indicator constitutes a strictly financial assessment of the companies at a given moment. That assessment is based on data from the annual accounts, and therefore disregards any other fundamental elements, such as development prospects, competition, management calibre or shareholders' willingness to provide financial support. In that respect, it must be regarded as one of the factors enabling an overall appraisal of a firm's situation.

In order to ensure a minimum standard of reliability, the indicator is calculated for companies satisfying a number of conditions, relating to such factors as size, length of the accounting period and content of the annual accounts. The population thus defined contains over 200,000 sets of accounts for recent financial years (225,000 in 2008). It is significantly larger than populations examined in most comparable studies. The model nevertheless obtains very satisfactory and stable performances; the number of companies covered moreover implies that the results are very widely applicable.

On the basis of the indicator, ten financial health classes were defined. These classes gather companies in groups which are homogeneous and stable in terms of failure rate at 3 years observed in the past. Each class is thus associated with a different risk level. The first four classes correspond to below-average failure rates and are therefore equivalent to a favourable financial situation. However, the rates are not zero, which means that these classes are not totally risk free. Conversely, the last five classes are associated with above-average failure rates, and therefore correspond to a situation of vulnerability. That is why belonging to one of these classes can be interpreted as a warning sign, which becomes stronger as one moves from class 6 to class 10. Finally, class 5 corresponds to an average failure rate (2.3%) and is therefore neutral in terms of interpretation.

These classes, like the indicator from which they are derived, constitute a strictly financial assessment of the companies at a given moment. That assessment is based on data from

the annual accounts, and therefore disregards any other fundamental elements, such as development prospects, competition, management skills or shareholders' willingness to provide financial support. In that respect, it must be regarded as one of the factors enabling an overall appraisal of a firm's situation.

The financial health classes are to be used in the enterprise files compiled by the Central Balance Sheet Office, under the form presented in section III.4. In order to take account of the latest trends, the model's parameters will be updated at regular intervals.

BIBLIOGRAPHY

Agresti A. (2002), *Categorical data analysis*, Hoboken, John Wiley and Sons Inc.

Allison P. (1999), *Logistic regression using SAS - theory and application*, Cary, SAS Institute Inc.

Altman E. (1968), "Financial Ratio's, Discriminant Analysis and the Prediction of Corporate Bankruptcy", *The Journal of Finance*, 23.

Altman E., G. Marco and F. Varetto (1994), "Corporate distress diagnosis: comparisons using linear discriminant analysis and neural networks (the Italian experience)", *Journal of Banking and Finance*, 18.

Altman E. and P. Narayanan (1997), "An international survey of business failure classification models", *Financial Markets, Institutions & Instruments*, New-York University Salomon Center, 6 (2).

Belgian Bankers Association (1997), *Lois sur le concordat judiciaire et les faillites*, Brussels.

Audretsch D. and J. Elston (2002), "Does firm size matter ? Evidence on the impact of liquidity constraints on firm investment behavior in Germany", *International Journal of Industrial Organization*, 20 (1).

Balcaen S. (2009), *Explaining distress-related firm exit: analysis of exit paths*, PhD series, Faculty of Economics and Business Administration, Ghent University.

Ball R. and G. Foster (1982), "Corporate financial reporting: a methodological review of empirical research", *Journal of Accounting Research*, 20.

Bamber D. (1975), "The area above the ordinal dominance graph and the area below the receiver operating characteristic graph", *Journal of mathematical psychology*, 12.

Banque de France (1998), "Le score BDFI - Du diagnostic individuel à l'analyse de portefeuille", *Les études de l'observatoire des entreprises*, Direction des entreprises, Banque de France.

National Bank of Belgium (2010), "Statistics relating to the annual accounts of firms – explanatory note for the 2008 financial year", Central Balance Sheet Office.

Bardos M. (2007), "What is at stake when estimating the probability of default using a scoring function ?", in Working group on risk assessment, *Credit risk assessment*

revisited, European Committee of Central Balance-Sheet Data Offices, Oesterreichische Nationalbank, Vienna.

Bardos M. (2005), "Les scores de la Banque de France: leur développement, leurs applications, leur maintenance", *Bulletin de la Banque de France*, 144.

Bardos M. (1998), "Detecting the risk of company failure at the Banque de France", *Journal of Banking and Finance*, 22.

Bardos M. and W. Zhu (1997), "Comparaison de l'analyse discriminante linéaire et des réseaux de neurones - application à la détection de défaillances d'entreprises", *Revue de statistique appliquée*, XLV (4).

Basel Committee on Banking Supervision (2005), *Studies on the validation of internal rating systems*, Bank for International Settlements, Working paper 14.

Beaver W. (1966), "Financial ratios as predictors of failure", *Journal of Accounting Research*, 4.

Benito A. and G. Vlieghe (2000), "Stylised facts on UK corporate financial health: evidence from micro-data", Bank of England, Financial Stability Review 8.

Bernhardsen E. (2001), *A model of bankruptcy prediction*, Norges Bank, working paper 2001/10.

Bradford Jensen R. and R. McGuckin (1997), "Firm performance and evolution: empirical regularities in the U.S. microdata", in *The evolution of firms and industries*, Statistics Finland.

Breiman L., J. Friedman, R. Olshen and C. Stone (1984), *Classification and regression trees*, Belmont, Wadsworth Inc.

Bunn P. and V. Redwood (2003), *Company accounts based modelling of business failures and the implications for financial stability*, Bank of England, working paper 210.

Cabral L. and J. Mata (2003), "On the evolution of the firm size distribution: facts and theory", *The American Economic Review*, 93 (4).

Cochran W. (1977), *Sampling techniques*, New-York, John Wiley and Sons Inc.

Cohen E. (2004), *Analyse financière*, Paris, Economica.

Cramer J. (2001), *An introduction to the logit model for economists*, London, Timberlake Consultants Ltd.

Crutzen N. (2010), "Essays on the prevention of small business failure: taxonomy and validation of five explanatory failure patterns", in CeFiP, *Academic awards 2009*, Brussels, De Boeck.

De Boitselier J. (2003), *De economische knipperlichten*, Antwerp, Standaard Uitgeverij.

Declerc M., B. Heins and C. Van Wymeersch (1992), "The use of value added ratios in statistical failure prediction models: some evidence on Belgian annual accounts", *Cahiers économiques de Bruxelles*, 135.

Declerc M., B. Heins and C. Van Wymeersch (1992), "Flux financiers et prévision de faillite: une analyse comportementale de l'entreprise", *Cahiers économiques de Bruxelles*, 136.

Demaris A. (1992), *Logit modelling - practical applications*, Sage University Papers on Quantitative applications in the Social Sciences, series n°07-086, Newbury Park, Sage.

Dunne T., M. Roberts and L. Samuelson (1989), "The growth and failure of U.S. manufacturing plants", *Quarterly Journal of Economics*, 104 (4).

Eisenbeis R. (1978), "Problems in applying discriminant analysis in credit scoring models", *Journal of Banking and Finance*, 2.

Evans D. (1987), "Tests of alternative theories of firm growth", *Journal of Political Economy*, 95 (4).

Goudie A. (1987), "Forecasting corporate failure: the use of discriminant analysis within a disaggregated model of the corporate sector", *Journal of the Royal Statistical Society*, 150 (1).

Graydon Belgium (2010), *Gerechtelijke reorganisatie bijna een jaar oud* (www.graydon.be).

Gujarati D. (2003), *Basic econometrics*, McGraw-Hill.

Hand D. and W. Henley (1997), "Statistical classification methods in consumer credit scoring: a review", *Journal of the Royal Statistical Society*, 160 (3).

Hanley J.(1989), "Receiver operating characteristic (ROC) methodology: the state of the art", *Critical Reviews in Diagnostic Imaging*, 29 (3).

Hanley J. and B. McNeil (1982), "The meaning and use of the area under a receiver operating characteristic (ROC) curve", *Radiology*, 143 (1).

Hastie T., R. Tibshirani and J. Friedman (2001), *The elements of statistical learning. Data mining inference and prediction*, New-York, Springer.

Hosmer D. and S. Lemeshow (2000), *Applied logistic regression*, Hoboken, John Wiley & Sons Inc.

Huyghebaert N., A. Gaeremynck, F. Roodhooft and L. Van de Gucht (2000), "New firm survival: the effects of start-up characteristics", *Journal of Business Finance and Accounting*, 27 (5).

INSEE (2000), *L'économétrie et l'étude des comportements. Présentation et mise en oeuvre de modèles de regression qualitatifs*, Statistical methodology, working paper n°0001, Paris, INSEE.

Institut des Réviseurs d'Entreprises (1994), *Interpréter les comptes annuels: analyse par la méthode des ratios*, Brussels, IRE.

Jaccard J. (2001), *Interaction effects in logistic regression*, Sage University Papers on Quantitative applications in the Social Sciences, series n°07-135, Thousand Oaks, Sage.

Jacobson T., R. Kindell, J. Lindé and K. Roszbach (2008), *Firm default and aggregate fluctuations*, Sveriges Riksbank, working paper 226.

Jorissen A. (1991), *Het getrouwe beeld van de jaarrekening: een creatieve zaak ?*, Centrum voor rechtspraktijk, Kluwer rechtswetenschappen.

Krzanowski W. (1977), "The Performance of Fisher's linear discriminant function Under non-optimal conditions", *Technometrics*, 19 (2).

Lennox C. (1999), "Identifying failing companies: a re-evaluation of the Logit, Probit and MDA", *Journal of Economics and Business*, 51 (4).

Lurkin P., N. Descendre and D. Lievens (1990), *États financiers - analyse et interprétation*, Brussels, De Boeck-Wesmael.

Malherbe J. and al. (2009), *Droit des sociétés - précis*, Brussels, Bruylant.

Menard S. (2001), *Applied logistic regression analysis*, Sage University Papers on Quantitative applications in the Social Sciences, series n°07-106, Thousand Oaks, Sage.

Mercken R. (2010), "Vervallen fiscale schulden in de toelichting van grote Belgische ondernemingen, een doolhof ?", *Accountancy en bedrijfskunde*, 7/2010.

Mitchell J. and P. Van Roy (2007), *Failure prediction models: performance, disagreements, and internal rating systems*, National Bank of Belgium, working paper 123.

Ohlson J. (1980), "Financial ratios and the probabilistic prediction of bankruptcy", *Journal of Accounting Research*, 18 (1).

Ooghe H. and C. Van Wymeersch (2006), *Traité d'analyse financière*, Namur, Intersentia, Antwerp-Oxford.

Ooghe H., P. Joos and C. De Bourdeaudhuij (1995), "Financial distress models in Belgium: the results of a decade of empirical research", *The International Journal of Accounting*, 30.

O'Leary D. (1998), "Using neural networks to predict corporate failure", *International Journal of Intelligent Systems in Accounting, Finance and Management*, 7 (3).

Pepe M. (2002), "Receiver operating characteristic methodology", in *Statistics in the 21st century*, Chapman & Hall, The American Statistical Association.

Pompe P. (2001), *New developments in bankruptcy prediction*, Universiteit Twente.

Reichert A., C. Chien-Ching and G. Wagner (1983), "An examination of the conceptual issues involved in developing credit-scoring models", *Journal of Business & Economic Statistics*, 1 (2).

Simon H. and C. Bonini (1958), "The size distribution of business firms", *The American Economic Review*, 48 (4).

Skogsvik K. (1988), "Predicting failure by means of financial ratios", *Skandinaviska Enskilda Banken Quarterly Review*, 2.

Soens P. and K. Cusse (2010), "La procédure de la sonnette d'alarme: une importante cause de responsabilité des administrateurs", Bulletin de l'Institut professionnel des comptables et fiscalistes agréés, n°294.

Tiest R. (2009), *La société en poche*, Wolters Kluwer.

Toledo Falcon L. (2007), "Logit models to assess credit risk", in Working group on risk assessment, *Credit risk assessment revisited*, European Committee of Central Balance-Sheet Data Offices, Oesterreichische Nationalbank, Vienna.

Van Wymeersch C. and Wolfs (1996), *La "trajectoire de faillite" des entreprises: une analyse chronologique sur base des comptes annuels*, Facultés universitaires de Namur, Cahiers de la Faculté des sciences économiques and sociales, n°172.

Vivet D. (2010), "Financial structure and results of firms in 2009", National Bank of Belgium, Economic Review, December 2010.

Windey J. (2009), "La loi du 31 janvier 2009 relative à la continuité des entreprises", in *Journal des tribunaux* , 4 April 2009, Brussels, Larcier.

Zavgren C. (1985), "Assessing the vulnerability to failure of American industrial firms: a logistic analysis", in *Journal of Business Finance and Accounting*, 12 (1).

ANNEX 1 DEFINITION OF THE INDEPENDENT VARIABLES

A. FINANCIAL RATIOS

	Items in the full format	Items in the abbreviated format
EQUITY	**Equity in proportion to total assets**	
Numerator	10/15	10/15
Denominator	10/49	10/49
SELFIN	**Degree of self-financing**	
Numerator	13+14	13+14
Denominator	10/49	10/49
DEBT1	**Debt level**	
Numerator	16+17+42/48	16+17+42/48
Denominator	10/49	10/49
DEBT2	**Short-term debt level**	
Numerator	42/48	42/48
Denominator	10/49	10/49
DEBT3	**Long-term debt level**	
Numerator	16+17	16+17
Denominator	10/49	10/49
DEBT4	**Financial debts in proportion to total liabilities**	
Numerator	170/4+42+43	170/4+42+43
Denominator	10/49	10/49
DEBT5	**Debts to credit institutions in proportion to total liabilities**	
Numerator	173+8831+430/8	172/3+42+430/8
Denominator	10/49	10/49
CHARGES	**Debt interest charges in proportion to total liabilities**	
Numerator	650	65
Denominator	10/49	10/49
COVERAGE1	**Cash flow to debt coverage ratio**	
Numerator	9904+630+631/4+6501+635/7+651 +6560-6561+660+661+662-760 -761-762+663-9125-780+680	9904+8079+8279+631/4+635/7 +656+8475-8089-8289-8485 -9125-780+680
Denominator	16+17/49	16+17/49
COVERAGE2	**Cash flow to short-term debt coverage ratio**	
Numerator	9904+630+631/4+6501+635/7+651 +6560-6561+660+661+662-760-761 -762+663-9125-780+680	9904+8079+8279+631/4+635/7 +656+8475-8089-8289-8485 -9125-780+680
Denominator	42/48	42/48

	Items in the full format	Items in the abbreviated format
LIQ1	**Liquidity in the broad sense**	
Numerator	3+40/41+50/53+54/58+490/1	3+40/41+50/53+54/58+490/1
Denominator	42/48+492/3	42/48+492/3
LIQ2	**Liquidity in the strict sense**	
Numerator	40/41+50/53+54/58	40/41+50/53+54/58
Denominator	42/48	42/48
LIQ3	**Net cash position in proportion to total assets**	
Numerator	50/53+54/58-43	50/53+54/58-43
Denominator	20/58	20/58
LIQ4	**Cash and current investment in proportion to total assets**	
Numerator	50/53+54/58	50/53+54/58
Denominator	20/58	20/58
LIQ5	**Cash and current investment in proportion to current assets**	
Numerator	50/53+54/58	50/53+54/58
Denominator	29/58-29	29/58-29
OVERDUE	**Overdue debts to tax authority and/or NSSO in proportion to total liabilities**	
Numerator	9072+9076	9072+9076
Denominator	10/49	10/49
RETURN1	**Gross return on total assets before tax and interest charges**	
Numerator	9904+650+653-9125-9126+630+631/4+ 635/7+651+6560-6561+660+661+662- 760-761-762+663+9134-780+680	9904+65-9125-9126+631/4+635/7 +8079 +8279+8475-8089-8289- 8485+67/77-780+680
Denominator	20/58	20/58
RETURN2	**Net return on total assets before tax and interest charges**	
Numerator	9904+650+653-9126+9134	9904+65-9126+67/77
Denominator	20/58	20/58
RETURN3	**Gross operating profitability**	
Numerator	9901+630+631/4+635/7	9901+630+631/4+635/7
Denominator	20/58	20/58
RETURN4	**Net operating profitability**	
Numerator	9901+9125	9901+9125
Denominator	20/58	20/58
RETURN5	**Value added in proportion to total assets**	
Numerator	9800-740	9800
Denominator	20/58	20/58

B. ADDITIONAL VARIABLES

CASHNEG CASHNEG = 1 if numerator of COVERAGE1 < 0; CASHNEG = otherwise 0.
EQNEG EQNEG = 1 if item 10/15 < 0; EQNEG = otherwise 0.
RNEG RNEG = 1 if item 9904 < 0; RNEG = otherwise 0.
OVERPOS OVERPOS = 1 if OVERDUE > 0; OVERPOS = otherwise 0.
CREDPOS CREDPOS = 1 if (172/3+173+430/8) > 0; CREDPOS = otherwise 0.
DISTRIB DISTRIB = 1 if profits are distributed (item 694/6 > 0), otherwise 0.
REMCAP REMCAP = 1 if capital is remunerated (item 694 > 0), otherwise 0.
ALARM1 ALARM1 = 1 if net assets (item 10/15) are less than half of the authorised capital (item 100), otherwise 0.
ALARM2 ALARM2 = 1 if net assets (item 10/15) are less than a quarter of the authorised capital (item 100), otherwise 0.

LOGDEBT1 = ln(DEBT1+0.05)
LOGDEBT2 = ln(DEBT2+0.05)
LOGLIQ1 = ln(LIQ1+0.05)
LOGLIQ2 = ln(LIQ2+0.05)
LOGLIQ4 = ln(LIQ4+0.05)
LOGLIQ5 = ln(LIQ5+0.05)

C. SIZE VARIABLES

SIZE = balance sheet total
LOGSIZE = ln(SIZE)
FORMAT = 1 if abbreviated format, otherwise 0.

SIZECLASS
SIZECLASS = 1 if balance sheet total (item 10/49) < €250,000;
SIZECLASS = 2 if €250,000 ≤ balance sheet total < €5,000,000;
SIZECLASS = 3 if balance sheet total ≥ €5,000,000.

SIZE1 = 1 if SIZECLASS=1, otherwise SIZE1 = 0.
SIZE2 = 1 if SIZECLASS=2, otherwise SIZE2 = 0.
SIZE3 = 1 if SIZECLASS=3, otherwise SIZE3 = 0.

D. AGE VARIABLES

AGE = age
LOGAGE = ln(AGE)

AGECLASS
AGECLASS = 1 if AGE ≤ 5;
AGECLASS = 2 if 5 < AGE ≤ 10;
AGECLASS = 3 if AGE > 10.

AGE1 = 1 if AGECLASS = 1, otherwise AGE1 = 0.
AGE2 = 1 if AGECLASS = 2, otherwise AGE2 = 0.
AGE3 = 1 if AGECLASS = 3, otherwise AGE3 = 0.

ANNEX 2 FAILURE FREQUENCY BY BRANCH OF ACTIVITY

(2006 financial year, NACE-Bel 2008, aggregation level A38)

Branch of activity	Percentage of observations DEF=1
Agriculture, forestry and fisheries	1.9
Mining and quarrying	1.0
Manufacture of foods, beverages and tobacco products	2.5
Manufacture of textiles, clothing industry, leather and footwear industry	4.1
Woodworking, paper and printing industries	2.8
Coking and refining	5.9
Chemical industry	1.5
Pharmaceutical industry	3.1
Manufacture of rubber and plastic products and other non-metallic mineral products	1.8
Metallurgy and manufacture of metallic products other than machinery and equipment	2.3
Manufacture of data processing products, electronic products and optical products	3.2
Manufacture of electrical equipment	2.0
Manufacture of machinery and equipment	1.8
Manufacture of transport equipment	3.4
Other manufacturing industries; repair and installation of machinery and equipment	1.9
Production and distribution of electricity, gas, steam and conditioned air	2.7
Supply and distribution of water; sewerage, waste management and cleansing	2.3
Construction	3.2
Trade; repair of motor vehicles and motor cycles	2.5
Transport and storage	3.6
Hotels and restaurants	4.4
Publishing, audiovisual and broadcasting	2.0
Telecommunications	6.2
Data processing activities and information services	1.7
Financial and insurance activities	0.4
Real estate activities	0.7
Legal, accounting, management, architectural, engineering, control and technical analysis activities	0.8
Scientific research and development	2.3
Other specialist, scientific and technical activities	1.9
Administrative and support service activities	2.5
Education	1.3
Arts, culture and leisure activities	2.0
Other service activities	3.3
Manufacturing branches	2.4
Non-manufacturing branches	2.2

Source: NBB.

ANNEX 3 IMPACT OF WINSORISATION

A. DISTRIBUTION OF THE FINANCIAL RATIOS BEFORE WINSORISATION (2006)

	MIN	P1	P2	P5	P25	P50	P75	P95	P98	P99	MAX
EQUITY	-393.11	-1.25	-0.70	-0.24	0.12	0.32	0.59	0.92	0.98	0.99	1.00
SELFIN	-699.34	-2.00	-1.23	-0.60	-0.03	0.12	0.36	0.75	0.86	0.90	4.27
DEBT1	0.00	0.01	0.02	0.07	0.40	0.67	0.87	1.23	1.68	2.22	393.78
DEBT2	0.00	0.00	0.01	0.04	0.19	0.38	0.63	1.00	1.36	1.80	147.18
DEBT3	0.00	0.00	0.00	0.00	0.00	0.11	0.35	0.75	0.90	1.05	284.93
DEBT4	0.00	0.00	0.00	0.00	0.01	0.19	0.46	0.82	0.96	1.09	368.49
DEBT5	0.00	0.00	0.00	0.00	0.00	0.13	0.38	0.76	0.89	0.98	67.69
CHARGES	-0.17	0.00	0.00	0.00	0.01	0.02	0.03	0.06	0.09	0.12	24.53
COVERAGE1	-6060.50	-0.74	-0.34	-0.12	0.05	0.15	0.36	1.54	3.64	7.53	54942.00
COVERAGE2	-6060.50	-1.42	-0.61	-0.20	0.07	0.27	0.66	2.51	6.42	14.07	66534.60
LIQ1	0.00	0.01	0.03	0.10	0.77	1.28	2.38	12.55	38.64	96.91	541742.00
LIQ2	0.00	0.00	0.01	0.05	0.45	1.00	2.05	12.47	42.08	111.14	541742.00
LIQ3	-146.57	-0.54	-0.39	-0.21	0.00	0.06	0.24	0.67	0.83	0.91	1.00
LIQ4	0.00	0.00	0.00	0.00	0.02	0.08	0.25	0.67	0.84	0.91	1.00
LIQ5	0.00	0.00	0.00	0.00	0.05	0.22	0.56	0.97	1.00	1.00	1.01
OVERDUE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.09	4.28
RETURN1	-25.62	-0.32	-0.18	-0.05	0.06	0.13	0.22	0.44	0.59	0.74	88.84
RETURN2	-40.11	-0.43	-0.27	-0.13	0.01	0.06	0.13	0.34	0.50	0.65	88.84
RETURN3	-25.53	-0.33	-0.19	-0.07	0.04	0.11	0.20	0.41	0.55	0.66	88.78
RETURN4	-40.11	-0.43	-0.29	-0.14	0.00	0.05	0.11	0.31	0.45	0.58	88.78
RETURN5	-21.57	-0.17	-0.08	-0.01	0.09	0.22	0.44	0.98	1.37	1.72	88.80

B. DISTRIBUTION OF THE FINANCIAL RATIOS AFTER WINSORISATION (2006)

	MIN	P1	P2	P5	P25	P50	P75	P95	P98	P99	MAX
EQUITY	-1.25	-1.25	-0.70	-0.24	0.12	0.32	0.59	0.92	0.98	0.99	0.99
SELFIN	-2.00	-2.00	-1.23	-0.60	-0.03	0.12	0.36	0.75	0.86	0.90	0.90
DEBT1	0.01	0.01	0.02	0.07	0.40	0.67	0.87	1.23	1.68	2.22	2.22
DEBT2	0.00	0.00	0.01	0.04	0.19	0.38	0.63	1.00	1.36	1.80	1.80
DEBT3	0.00	0.00	0.00	0.00	0.00	0.11	0.35	0.75	0.90	1.05	1.05
DEBT4	0.00	0.00	0.00	0.00	0.01	0.19	0.46	0.82	0.96	1.09	1.09
DEBT5	0.00	0.00	0.00	0.00	0.00	0.13	0.38	0.76	0.89	0.98	0.98
CHARGES	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.06	0.09	0.12	0.12
COVERAGE1	-0.74	-0.74	-0.34	-0.12	0.05	0.15	0.36	1.54	3.64	7.53	7.53
COVERAGE2	-1.42	-1.42	-0.61	-0.20	0.07	0.27	0.66	2.51	6.42	14.07	14.07
LIQ1	0.01	0.01	0.03	0.10	0.77	1.28	2.38	12.55	38.64	96.91	96.91
LIQ2	0.00	0.00	0.01	0.05	0.45	1.00	2.05	12.47	42.08	111.14	111.14
LIQ3	-0.54	-0.54	-0.39	-0.21	0.00	0.06	0.24	0.67	0.83	0.91	0.91
LIQ4	0.00	0.00	0.00	0.00	0.02	0.08	0.25	0.67	0.84	0.91	0.91
LIQ5	0.00	0.00	0.00	0.00	0.05	0.22	0.56	0.97	1.00	1.00	1.00
OVERDUE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.09
RETURN1	-0.32	-0.32	-0.18	-0.05	0.06	0.13	0.22	0.44	0.59	0.74	0.74
RETURN2	-0.43	-0.43	-0.27	-0.13	0.01	0.06	0.13	0.34	0.50	0.65	0.65
RETURN3	-0.33	-0.33	-0.19	-0.07	0.04	0.11	0.20	0.41	0.55	0.66	0.66
RETURN4	-0.43	-0.43	-0.29	-0.14	0.00	0.05	0.11	0.31	0.45	0.58	0.58
RETURN5	-0.17	-0.17	-0.08	-0.01	0.09	0.22	0.44	0.98	1.37	1.72	1.72

Source: NBB. P1=percentile1, P2= percentile2, ..., P99= percentile 99, min = minimum, max=maximum.

ANNEX 4 DESCRIPTIVE STATISTICS AS A FUNCTION OF DEFDETAIL

	DEF01	DEF02	DEF03	DEF04	DEF05	NODEF
EQUITY						
Decile 1	-0.91	-0.60	-0.39	-0.32	-0.26	0.00
Quartile 1	-0.39	-0.17	-0.06	-0.01	0.01	0.12
Median	-0.02	0.05	0.09	0.12	0.13	0.30
Mean	-0.15	-0.04	0.05	0.09	0.11	0.33
Quartile 3	0.13	0.17	0.23	0.26	0.28	0.56
Decile 9	0.26	0.33	0.42	0.45	0.49	0.81
SELFIN						
Decile 1	-1.33	-0.98	-0.76	-0.63	-0.58	-0.24
Quartile 1	-0.69	-0.43	-0.30	-0.23	-0.19	-0.04
Median	-0.24	-0.12	-0.06	-0.03	-0.02	0.08
Mean	-0.42	-0.28	-0.19	-0.14	-0.11	0.09
Quartile 3	-0.03	0.01	0.04	0.05	0.07	0.29
Decile 9	0.08	0.11	0.17	0.21	0.24	0.54
DEBT1						
Decile 1	0.71	0.66	0.56	0.54	0.50	0.18
Quartile 1	0.86	0.82	0.76	0.73	0.71	0.43
Median	1.01	0.94	0.90	0.87	0.86	0.69
Mean	1.14	1.03	0.94	0.90	0.88	0.66
Quartile 3	1.38	1.16	1.05	1.00	0.99	0.87
Decile 9	1.89	1.57	1.38	1.30	1.24	0.99
DEBT2						
Decile 1	0.40	0.36	0.30	0.27	0.25	0.08
Quartile 1	0.62	0.57	0.49	0.46	0.44	0.20
Median	0.86	0.77	0.70	0.67	0.65	0.40
Mean	0.89	0.80	0.72	0.68	0.66	0.44
Quartile 3	1.14	0.97	0.89	0.86	0.84	0.63
Decile 9	1.60	1.32	1.13	1.08	1.04	0.83
DEBT3						
Decile 1	0.00	0.00	0.00	0.00	0.00	0.00
Quartile 1	0.00	0.00	0.01	0.00	0.00	0.00
Median	0.12	0.12	0.12	0.12	0.12	0.12
Mean	0.22	0.22	0.21	0.21	0.21	0.21
Quartile 3	0.34	0.33	0.33	0.33	0.32	0.35
Decile 9	0.62	0.60	0.58	0.58	0.57	0.59
DEBT4						
Decile 1	0.00	0.00	0.00	0.00	0.00	0.00
Quartile 1	0.13	0.12	0.11	0.10	0.10	0.03
Median	0.34	0.31	0.31	0.30	0.30	0.22
Mean	0.39	0.36	0.35	0.34	0.34	0.29
Quartile 3	0.58	0.55	0.53	0.53	0.51	0.47
Decile 9	0.84	0.79	0.76	0.75	0.73	0.70
DEBT5						
Decile 1	0.00	0.00	0.00	0.00	0.00	0.00
Quartile 1	0.10	0.08	0.08	0.07	0.07	0.01
Median	0.29	0.26	0.25	0.25	0.25	0.16
Mean	0.34	0.32	0.31	0.30	0.29	0.24
Quartile 3	0.52	0.48	0.47	0.46	0.45	0.40
Decile 9	0.76	0.72	0.69	0.68	0.68	0.63

	DEF01	DEF02	DEF03	DEF04	DEF05	NODEF
CHARGES						
Decile 1	0.01	0.01	0.01	0.00	0.00	0.00
Quartile 1	0.02	0.02	0.02	0.02	0.02	0.01
Median	0.04	0.04	0.04	0.03	0.03	0.02
Mean	0.05	0.04	0.04	0.04	0.04	0.03
Quartile 3	0.07	0.06	0.06	0.05	0.05	0.04
Decile 9	0.11	0.09	0.08	0.08	0.08	0.06
COVERAGE1						
Decile 1	-0.29	-0.22	-0.16	-0.13	-0.11	-0.02
Quartile 1	-0.15	-0.08	-0.03	-0.01	0.00	0.05
Median	-0.02	0.02	0.04	0.06	0.07	0.14
Mean	-0.03	0.01	0.08	0.10	0.11	0.32
Quartile 3	0.05	0.09	0.12	0.15	0.16	0.31
Decile 9	0.15	0.20	0.26	0.30	0.32	0.68
COVERAGE2						
Decile 1	-0.39	-0.30	-0.21	-0.18	-0.15	-0.02
Quartile 1	-0.19	-0.11	-0.04	-0.01	0.00	0.07
Median	-0.03	0.02	0.05	0.08	0.09	0.24
Mean	-0.02	0.03	0.14	0.16	0.19	0.57
Quartile 3	0.07	0.12	0.18	0.22	0.24	0.57
Decile 9	0.24	0.30	0.41	0.47	0.50	1.20
LIQ1						
Decile 1	0.24	0.33	0.35	0.37	0.36	0.27
Quartile 1	0.48	0.60	0.69	0.71	0.72	0.78
Median	0.79	0.91	0.98	1.00	1.02	1.23
Mean	0.95	1.12	1.41	1.41	1.56	3.04
Quartile 3	1.08	1.15	1.25	1.30	1.33	2.10
Decile 9	1.36	1.55	1.85	1.90	2.01	4.80
LIQ2						
Decile 1	0.05	0.09	0.10	0.11	0.11	0.12
Quartile 1	0.20	0.27	0.29	0.32	0.32	0.40
Median	0.46	0.56	0.62	0.65	0.68	0.90
Mean	0.71	0.83	1.10	1.12	1.32	2.81
Quartile 3	0.77	0.89	0.98	1.02	1.06	1.69
Decile 9	1.14	1.25	1.47	1.55	1.65	4.22
LIQ3						
Decile 1	-0.37	-0.31	-0.28	-0.27	-0.26	-0.14
Quartile 1	-0.18	-0.15	-0.13	-0.12	-0.12	-0.01
Median	-0.05	-0.03	-0.02	0.00	0.00	0.04
Mean	-0.09	-0.06	-0.04	-0.03	-0.02	0.09
Quartile 3	0.02	0.03	0.04	0.05	0.07	0.18
Decile 9	0.10	0.12	0.15	0.17	0.18	0.39
LIQ4						
Decile 1	0.00	0.00	0.00	0.00	0.00	0.00
Quartile 1	0.00	0.00	0.00	0.00	0.01	0.01
Median	0.02	0.02	0.02	0.03	0.03	0.06
Mean	0.05	0.06	0.06	0.07	0.08	0.14
Quartile 3	0.05	0.06	0.08	0.09	0.09	0.19
Decile 9	0.12	0.15	0.17	0.19	0.21	0.40

	DEF01	DEF02	DEF03	DEF04	DEF05	NODEF
LIQ5						
Decile 1	0.00	0.00	0.00	0.00	0.00	0.00
Quartile 1	0.01	0.01	0.01	0.01	0.01	0.04
Median	0.03	0.03	0.04	0.05	0.05	0.17
Mean	0.09	0.10	0.11	0.12	0.13	0.29
Quartile 3	0.10	0.11	0.13	0.16	0.17	0.46
Decile 9	0.25	0.26	0.32	0.35	0.38	0.81
OVERDUE						
Decile 1	0.00	0.00	0.00	0.00	0.00	0.00
Quartile 1	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Mean	0.04	0.03	0.02	0.02	0.01	0.00
Quartile 3	0.07	0.01	0.00	0.00	0.00	0.00
Decile 9	0.15	0.15	0.09	0.07	0.05	0.00
RETURN1						
Decile 1	-0.27	-0.22	-0.12	-0.09	-0.06	0.01
Quartile 1	-0.12	-0.04	0.01	0.02	0.03	0.06
Median	0.01	0.06	0.08	0.09	0.10	0.13
Mean	0.00	0.05	0.08	0.10	0.11	0.15
Quartile 3	0.11	0.13	0.16	0.17	0.18	0.21
Decile 9	0.22	0.24	0.27	0.29	0.29	0.32
RETURN2						
Decile 1	-0.38	-0.31	-0.21	-0.17	-0.13	-0.04
Quartile 1	-0.21	-0.11	-0.05	-0.03	-0.02	0.01
Median	-0.04	0.01	0.03	0.03	0.04	0.06
Mean	-0.07	-0.03	0.01	0.02	0.03	0.07
Quartile 3	0.05	0.06	0.08	0.08	0.09	0.12
Decile 9	0.13	0.14	0.16	0.17	0.17	0.21
RETURN3						
Decile 1	-0.28	-0.22	-0.13	-0.10	-0.07	0.00
Quartile 1	-0.13	-0.05	0.00	0.01	0.02	0.05
Median	0.01	0.05	0.07	0.08	0.09	0.11
Mean	-0.01	0.03	0.07	0.09	0.10	0.13
Quartile 3	0.10	0.12	0.15	0.17	0.17	0.20
Decile 9	0.20	0.22	0.25	0.28	0.28	0.30
RETURN4						
Decile 1	-0.39	-0.32	-0.22	-0.18	-0.15	-0.05
Quartile 1	-0.21	-0.12	-0.06	-0.04	-0.03	0.00
Median	-0.04	-0.01	0.02	0.03	0.03	0.05
Mean	-0.08	-0.04	0.00	0.01	0.02	0.06
Quartile 3	0.04	0.05	0.07	0.08	0.08	0.10
Decile 9	0.12	0.12	0.15	0.16	0.16	0.19
RETURN5						
Decile 1	-0.09	-0.03	0.00	0.00	0.01	0.03
Quartile 1	0.04	0.07	0.10	0.11	0.11	0.10
Median	0.22	0.24	0.25	0.27	0.28	0.24
Mean	0.31	0.34	0.35	0.37	0.38	0.33
Quartile 3	0.48	0.51	0.50	0.54	0.54	0.46
Decile 9	0.83	0.83	0.86	0.89	0.89	0.75

Source: NBB. Financial years 1997, 1998 and 1999.

ANNEX 5 OVERDUE DEBTS TO THE TAX AUTHORITY AND/OR THE NSSO

COMPLETE POPULATION

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of sets of accounts reporting overdue debts to the tax authority and/or the NSSO (a)	14,667	14,206	13,400	12,644	12,594	12,266	11,536	9,879	7,976	6,613
Number of sets of accounts reporting no overdue debt to the tax authority and/or the NSSO	149,069	156,516	160,157	167,140	179,139	188,564	194,629	203,589	213,233	218,776
Total	**163,736**	**170,722**	**173,557**	**179,784**	**191,733**	**200,830**	**206,165**	**213,468**	**221,209**	**225,389**
Percentage of (a)	9.0	8.3	7.7	7.0	6.6	6.1	5.6	4.6	3.6	2.9

Source: NBB.

ABBREVIATED FORMATS

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of sets of accounts reporting overdue debts to the tax authority and/or the NSSO (a)	13,937	13,486	12,596	11,908	11,924	11,636	10,978	9,275	7,409	6,071
Number of sets of accounts reporting no overdue debts to the tax authority and/or the NSSO	136,090	143,321	146,833	153,440	165,248	174,431	180,489	189,270	198,281	203,423
Total	**150,027**	**156,807**	**159,429**	**165,348**	**177,172**	**186,067**	**191,467**	**198,545**	**205,690**	**209,494**
Percentage of (a)	9.3	8.6	7.9	7.2	6.7	6.3	5.7	4.7	3.6	2.9

Source: NBB.

FULL FORMATS

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of sets of accounts reporting overdue debts to the tax authority and/or the NSSO (a)	730	720	804	736	670	630	558	604	567	542
Number of sets of accounts reporting no overdue debts to the tax authority and/or the NSSO	12,979	13,195	13,324	13,700	13,891	14,133	14,140	14,319	14952	15,353
Total	**13,709**	**13,915**	**14,128**	**14,436**	**14,561**	**14,763**	**14,698**	**14,923**	**15519**	**15,895**
Percentage of (a)	5.3	5.2	5.7	5.1	4.6	4.3	3.8	4.0	3.7	3.4

Source: NBB.

ANNEX 6 UNIVARIATE LOGISTIC REGRESSIONS SIZE AND AGE VARIABLES (REFERENCE POPULATION)

Variable	Coefficient	Standard error	p	C
SIZE	-7.52E-8	6.37E-9	<0.001	0.552
LOGSIZE	-0.2547	0.0092	<0.001	0.589
SCHEMA	0.8813	0.0613	<0.001	0.520
SIZECLASS	-0.5422	0.0197	<0.001	0.576
SIZE1	0.5773	0.0215	<0.001	0.572
SIZE2	-0.4661	0.0216	<0.001	0.558
SIZE3	-0.8285	0.0717	<0.001	0.514
AGE	-0.0383	0.0013	<0.001	0.610
LOGAGE	-0.4904	0.0134	<0.001	0.610
AGECLASS	-0.4412	0.0126	<0.001	0.594
AGE1	0.7222	0.0236	<0.001	0.563
AGE2	0.2187	0.0242	<0.001	0.520
AGE3	-0.6717	0.0215	<0.001	0.583

Source: NBB.

ANNEX 7 CORRELATION MATRIX – FINANCIAL RATIOS (REFERENCE POPULATION)

	EQUITY	SELFIN	DEBT1	DEBT2	DEBT3	DEBT4	DEBT5	CHARGES	COVERAGE1	COVERAGE2	LIQ1	LIQ2	LIQ3	OVERDUE	LIQ4	LIQ5	RETURN1	RETURN2	RETURN3	RETURN4	RETURN5
EQUITY	1	0.78	-0.99	-0.73	-0.47	-0.52	-0.43	-0.47	0.42	0.34	0.35	0.33	0.39	-0.08	0.35	0.28	0.19	0.29	0.16	0.26	-0.03
SELFIN		1	-0.78	-0.59	-0.33	-0.35	-0.26	-0.37	0.32	0.25	0.20	0.19	0.35	-0.07	0.32	0.19	0.29	0.37	0.27	0.35	0.05
DEBT1			1	0.73	0.47	0.53	0.44	0.47	-0.41	-0.34	-0.35	-0.33	-0.40	0.08	-0.36	-0.28	-0.19	-0.29	-0.16	-0.26	0.03
DEBT2				1	-0.24	-0.02	-0.01	0.20	-0.30	-0.34	-0.31	-0.29	-0.30	0.11	-0.19	-0.30	-0.16	-0.20	-0.14	-0.19	0.14
DEBT3					1	0.80	0.67	0.43	-0.21	-0.05	-0.12	-0.11	-0.21	-0.02	-0.28	-0.03	-0.07	-0.15	-0.04	-0.12	-0.13
DEBT4						1	0.86	0.56	-0.25	-0.14	-0.20	-0.19	-0.44	0.00	-0.36	-0.14	-0.07	-0.17	-0.03	-0.14	-0.09
DEBT5							1	0.52	-0.22	-0.13	-0.19	-0.18	-0.40	0.00	-0.34	-0.14	-0.03	-0.13	0.00	-0.10	-0.06
CHARGES								1	-0.20	-0.15	-0.19	-0.18	-0.33	0.09	-0.27	-0.18	0.04	-0.05	0.02	-0.07	0.06
COVERAGE1									1	0.82	0.54	0.53	0.31	-0.03	0.31	0.23	0.37	0.39	0.29	0.31	0.07
COVERAGE2										1	0.58	0.60	0.24	-0.04	0.23	0.24	0.33	0.33	0.22	0.24	0.02
LIQ1											1	0.96	0.27	-0.03	0.28	0.18	-0.03	0.03	-0.07	-0.01	-0.13
LIQ2												1	0.27	-0.03	0.28	0.19	-0.03	0.03	-0.07	-0.01	-0.12
LIQ3													1	-0.04	0.92	0.66	0.23	0.26	0.20	0.24	0.08
OVERDUE														1	-0.03	-0.06	0.01	-0.01	0.01	-0.01	0.09
LIQ4															1	0.67	0.22	0.26	0.18	0.23	0.09
LIQ5																1	0.13	0.14	0.11	0.13	-0.07
RETURN1																	1	0.89	0.90	0.79	0.46
RETURN2																		1	0.78	0.89	0.34
RETURN3																			1	0.89	0.52
RETURN4																				1	0.39
RETURN5																					1

Source: NBB.

ANNEX 8 FAILURE RATES IN THE FINANCIAL HEALTH CLASSES PER YEAR AND CONFIDENCE INTERVALS FOR THE MEAN

Financial health classes	2000	2001	2002	2003	2004	2005	2006	Mean	Standard deviation	Confidence interval for the mean (1)	
										Lower limit	Upper limit
Class 1	0.08	0.11	0.08	0.09	0.06	0.12	0.08	0.09	0.02	0.07	0.11
Class 2	0.20	0.24	0.26	0.21	0.20	0.16	0.24	0.22	0.03	0.19	0.24
Class 3	0.49	0.50	0.43	0.46	0.41	0.40	0.54	0.46	0.05	0.41	0.51
Class 4	0.91	1.00	0.98	0.86	0.89	0.87	1.08	0.94	0.07	0.87	1.01
Class 5	2.51	2.52	2.25	2.24	2.14	2.19	2.61	2.35	0.18	2.19	2.51
Class 6	5.67	6.09	5.48	5.22	5.28	5.34	6.03	5.59	0.33	5.28	5.89
Class 7	11.36	11.34	10.37	10.57	9.55	8.65	9.72	10.22	0.92	9.37	11.07
Class 8	16.58	16.10	15.41	14.09	14.56	14.43	16.34	15.36	0.93	14.49	16.22
Class 9	22.80	20.45	21.61	17.65	20.82	17.52	19.35	20.03	1.83	18.34	21.72
Class 10	27.81	29.63	23.74	26.77	27.01	24.19	24.63	26.26	2.00	24.41	28.10

Source: NBB.

(1) Confidence interval at the 95% level. If mean=M and standard deviation= STD, then the lower limit is $M - (2{,}45 \times STD/\sqrt{7})$, and the upper limit is $M + (2{,}45 \times STD/\sqrt{7})$

ANNEX 9 FAILURE RATE AT ONE, TWO AND THREE YEARS BY FINANCIAL HEALTH CLASS (REFERENCE POPULATION)

Financial health classes	Failure rate at 1 year	Failure rate at 2 years	Failure rate at 3 years
Class 1	0.00	0.04	0.09
Class 2	0.02	0.10	0.22
Class 3	0.05	0.20	0.46
Class 4	0.11	0.43	0.94
Class 5	0.28	1.19	2.35
Class 6	0.76	3.03	5.58
Class 7	1.92	6.19	10.20
Class 8	3.52	10.27	15.32
Class 9	5.58	14.16	20.01
Class 10	8.83	20.46	26.25

Source: NBB.

ANNEX 10 DISTRIBUTION OF OBSERVATIONS BY FINANCIAL HEALTH CLASS (PERCENTAGES)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Class 1	7.02	7.17	7.22	7.91	8.45	8.96	9.58	10.38	10.70	11.80
Class 2	14.85	15.31	15.59	16.26	16.97	17.71	18.38	18.94	19.07	19.67
Class 3	15.45	15.65	15.65	15.63	15.97	16.27	16.49	16.63	16.43	15.95
Class 4	16.31	16.23	15.95	16.04	15.89	15.93	15.80	15.64	15.35	14.83
Class 5	26.58	25.87	25.74	25.07	24.58	23.99	23.29	22.28	21.84	21.08
Class 6	12.86	12.73	12.64	12.11	11.51	11.03	10.64	10.37	10.35	10.08
Class 7	4.98	4.93	5.02	4.92	4.70	4.38	4.18	4.09	4.31	4.48
Class 8	1.28	1.33	1.37	1.30	1.26	1.15	1.07	1.08	1.21	1.30
Class 9	0.47	0.54	0.55	0.49	0.45	0.42	0.40	0.41	0.51	0.54
Class 10	0.20	0.23	0.28	0.26	0.21	0.16	0.16	0.18	0.23	0.28
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Class 6 to 10	19.79	19.76	19.84	19.08	18.13	17.14	16.45	16.14	16.61	16.68
Class 7 to 10	6.92	7.03	7.21	6.97	6.62	6.11	5.81	5.77	6.26	6.60
Class 8 to 10	1.95	2.10	2.19	2.05	1.92	1.73	1.63	1.67	1.95	2.11
Class 9 to 10	0.66	0.77	0.82	0.75	0.66	0.58	0.56	0.59	0.74	0.82

SOURCE: NBB.

ANNEX 11 DISTRIBUTION OF THE OBSERVATIONS BY FINANCIAL HEALTH CLASS

MANUFACTURING INDUSTRY (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	8.15	8.30	9.40	9.89	10.90
Class 2	18.08	19.07	19.44	19.63	20.28
Class 3	17.58	17.76	18.05	17.16	16.70
Class 4	16.83	16.51	16.56	16.52	15.80
Class 5	24.82	24.27	22.90	23.13	21.26
Class 6	9.97	9.64	9.17	9.11	9.65
Class 7	3.32	3.26	3.15	3.20	3.67
Class 8	0.75	0.77	0.83	0.83	1.00
Class 9	0.33	0.29	0.37	0.41	0.53
Class 10	0.17	0.13	0.16	0.11	0.21
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	1.26	1.19	1.35	1.36	1.74
Classes 9 to 10	0.50	0.42	0.52	0.52	0.74

Source: NBB.
(1) NACE-BEL 2008: divisions 10-33.

CONSTRUCTION (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	5.61	6.00	7.13	7.35	8.62
Class 2	15.33	15.61	16.89	17.02	17.75
Class 3	15.70	15.95	16.21	15.80	15.58
Class 4	17.15	16.87	16.26	16.09	15.30
Class 5	26.67	26.58	25.04	24.37	23.35
Class 6	13.11	12.67	12.12	11.88	11.74
Class 7	4.77	4.61	4.60	5.16	5.55
Class 8	1.16	1.18	1.12	1.47	1.22
Class 9	0.39	0.39	0.48	0.64	0.64
Class 10	0.11	0.14	0.15	0.21	0.25
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	1.66	1.71	1.74	2.33	2.12
Classes 9 to 10	0.49	0.53	0.63	0.86	0.90

Source: NBB.
(1) NACE-BEL 2008: divisions 41-43.

TRADE (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	5.30	5.89	6.68	6.97	8.00
Class 2	14.25	15.07	15.73	15.89	16.94
Class 3	14.83	15.24	15.29	15.21	14.96
Class 4	15.78	15.85	16.02	15.53	15.21
Class 5	27.55	26.65	25.47	25.02	24.20
Class 6	14.08	13.58	13.27	13.30	12.50
Class 7	5.79	5.56	5.36	5.54	5.52
Class 8	1.60	1.40	1.42	1.56	1.65
Class 9	0.59	0.54	0.52	0.66	0.68
Class 10	0.23	0.22	0.24	0.32	0.34
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	2.42	2.16	2.18	2.54	2.67
Classes 9 to 10	0.82	0.76	0.76	0.99	1.02

Source: NBB.
(1) NACE-BEL 2008: divisions 45-47.

TRANSPORT AND STORAGE (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	6.30	7.11	7.76	8.54	9.78
Class 2	16.86	17.99	19.21	18.73	19.18
Class 3	16.92	16.91	17.77	17.33	15.86
Class 4	17.31	17.88	17.09	16.36	15.51
Class 5	25.91	24.69	24.01	23.22	22.39
Class 6	10.73	9.93	9.40	9.76	10.16
Class 7	4.19	3.86	3.46	4.30	5.12
Class 8	1.19	1.07	0.87	1.01	1.49
Class 9	0.36	0.42	0.32	0.48	0.64
Class 10	0.22	0.15	0.10	0.28	0.42
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	1.77	1.64	1.29	1.77	2.55
Classes 9 to 10	0.58	0.57	0.43	0.75	1.06

Source: NBB.
(1) NACE-BEL 2008: divisions 49-53.

HOTELS AND RESTAURANTS (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	4.42	4.58	4.90	4.86	4.68
Class 2	12.96	13.70	14.14	13.71	13.52
Class 3	15.58	15.58	16.12	15.96	16.23
Class 4	16.59	17.35	16.79	16.67	15.80
Class 5	27.73	26.90	25.59	25.77	25.63
Class 6	13.36	13.21	13.26	13.45	12.69
Class 7	6.40	6.27	6.22	6.20	7.07
Class 8	2.04	1.50	1.92	2.11	2.41
Class 9	0.71	0.64	0.65	0.83	1.13
Class 10	0.22	0.29	0.40	0.45	0.83
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	2.97	2.42	2.98	3.39	4.37
Classes 9 to 10	0.93	0.92	1.05	1.28	1.96

Source: NBB.
(1) NACE-BEL 2008: divisions 55-56.

INFORMATION AND COMMUNICATION (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	10.31	11.16	11.91	12.62	13.80
Class 2	20.68	21.90	21.91	22.28	21.76
Class 3	16.45	16.82	17.24	17.46	17.51
Class 4	15.14	15.18	14.54	15.00	13.46
Class 5	20.73	19.71	20.13	18.25	18.21
Class 6	10.36	9.47	8.86	8.66	8.58
Class 7	4.13	3.91	3.58	3.85	4.24
Class 8	1.27	1.12	1.06	1.12	1.79
Class 9	0.62	0.50	0.47	0.50	0.43
Class 10	0.32	0.24	0.30	0.26	0.21
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	2.21	1.86	1.84	1.88	2.43
Classes 9 to 10	0.93	0.74	0.77	0.76	0.64

Source: NBB.
(1) NACE-BEL 2008: divisions 58-63.

REAL ESTATE ACTIVITIES (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	21.98	22.63	23.01	22.17	23.23
Class 2	24.15	23.86	23.77	23.41	23.90
Class 3	16.31	16.31	16.64	16.42	15.57
Class 4	13.41	12.93	12.52	12.39	12.56
Class 5	15.05	15.09	14.29	14.72	14.30
Class 6	5.96	5.94	6.21	6.50	6.37
Class 7	2.42	2.48	2.58	3.03	2.85
Class 8	0.52	0.55	0.68	0.91	0.77
Class 9	0.18	0.19	0.24	0.34	0.20
Class 10	0.04	0.04	0.06	0.13	0.25
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	0.73	0.78	0.98	1.38	1.23
Classes 9 to 10	0.22	0.23	0.30	0.47	0.46

Source: NBB.
(1) NACE-BEL 2008: division 68.

SPECIALIST, SCIENTIFIC AND TECHNICAL ACTIVITIES (1)
(percentages)

	2005	2006	2007	2008	2009
Class 1	11.82	12.93	14.25	14.87	16.26
Class 2	21.74	22.84	23.28	23.53	24.15
Class 3	18.17	18.41	18.41	17.94	16.78
Class 4	15.91	15.17	15.00	14.89	14.25
Class 5	19.98	18.92	17.90	17.76	17.16
Class 6	8.15	7.71	7.37	7.22	7.03
Class 7	3.17	2.85	2.71	2.68	2.91
Class 8	0.73	0.77	0.71	0.71	0.97
Class 9	0.23	0.29	0.24	0.28	0.36
Class 10	0.10	0.11	0.13	0.13	0.13
Total	100.0	100.0	100.0	100.0	100.0
Classes 8 to 10	1.06	1.18	1.08	1.11	1.46
Classes 9 to 10	0.33	0.40	0.37	0.41	0.49

Source: NBB.
(1) NACE-BEL 2008: divisions 69-75.

NATIONAL BANK OF BELGIUM - WORKING PAPERS SERIES

1. "Model-based inflation forecasts and monetary policy rules", by M. Dombrecht and R. Wouters, *Research Series*, February 2000.
2. "The use of robust estimators as measures of core inflation", by L. Aucremanne, *Research Series*, February 2000.
3. "Performances économiques des Etats-Unis dans les années nonante", by A. Nyssens, P. Butzen and P. Bisciari, *Document Series*, March 2000.
4. "A model with explicit expectations for Belgium", by P. Jeanfils, *Research Series*, March 2000.
5. "Growth in an open economy: Some recent developments", by S. Turnovsky, *Research Series*, May 2000.
6. "Knowledge, technology and economic growth: An OECD perspective", by I. Visco, A. Bassanini and S. Scarpetta, *Research Series*, May 2000.
7. "Fiscal policy and growth in the context of European integration", by P. Masson, *Research Series*, May 2000.
8. "Economic growth and the labour market: Europe's challenge", by C. Wyplosz, *Research Series*, May 2000.
9. "The role of the exchange rate in economic growth: A euro-zone perspective", by R. MacDonald, *Research Series*, May 2000.
10. "Monetary union and economic growth", by J. Vickers, *Research Series*, May 2000.
11. "Politique monétaire et prix des actifs: le cas des États-Unis", by Q. Wibaut, *Document Series*, August 2000.
12. "The Belgian industrial confidence indicator: Leading indicator of economic activity in the euro area?", by J.-J. Vanhaelen, L. Dresse and J. De Mulder, *Document Series*, November 2000.
13. "Le financement des entreprises par capital-risque", by C. Rigo, *Document Series,* February 2001.
14. "La nouvelle économie" by P. Bisciari, *Document Series*, March 2001.
15. "De kostprijs van bankkredieten", by A. Bruggeman and R. Wouters, *Document Series*, April 2001.
16. "A guided tour of the world of rational expectations models and optimal policies", by Ph. Jeanfils, *Research Series*, May 2001.
17. "Attractive prices and euro - Rounding effects on inflation", by L. Aucremanne and D. Cornille, *Documents Series*, November 2001.
18. "The interest rate and credit channels in Belgium: An investigation with micro-level firm data", by P. Butzen, C. Fuss and Ph. Vermeulen, *Research series*, December 2001.
19. "Openness, imperfect exchange rate pass-through and monetary policy", by F. Smets and R. Wouters, *Research series*, March 2002.
20. "Inflation, relative prices and nominal rigidities", by L. Aucremanne, G. Brys, M. Hubert, P. J. Rousseeuw and A. Struyf, *Research series*, April 2002.
21. "Lifting the burden: Fundamental tax reform and economic growth", by D. Jorgenson, *Research series*, May 2002.
22. "What do we know about investment under uncertainty?", by L. Trigeorgis, *Research series*, May 2002.
23. "Investment, uncertainty and irreversibility: Evidence from Belgian accounting data" by D. Cassimon, P.-J. Engelen, H. Meersman and M. Van Wouwe, *Research series*, May 2002.
24. "The impact of uncertainty on investment plans", by P. Butzen, C. Fuss and Ph. Vermeulen, *Research series*, May 2002.
25. "Investment, protection, ownership, and the cost of capital", by Ch. P. Himmelberg, R. G. Hubbard and I. Love, *Research series*, May 2002.
26. "Finance, uncertainty and investment: Assessing the gains and losses of a generalised non-linear structural approach using Belgian panel data", by M. Gérard and F. Verschueren, *Research series*, May 2002.
27. "Capital structure, firm liquidity and growth", by R. Anderson, *Research series*, May 2002.
28. "Structural modelling of investment and financial constraints: Where do we stand?", by J.-B. Chatelain, *Research series*, May 2002.
29. "Financing and investment interdependencies in unquoted Belgian companies: The role of venture capital", by S. Manigart, K. Baeyens, I. Verschueren, *Research series*, May 2002.
30. "Development path and capital structure of Belgian biotechnology firms", by V. Bastin, A. Corhay, G. Hübner and P.-A. Michel, *Research series*, May 2002.
31. "Governance as a source of managerial discipline", by J. Franks, *Research series*, May 2002.
32. "Financing constraints, fixed capital and R&D investment decisions of Belgian firms", by M. Cincera, *Research series*, May 2002.

33. "Investment, R&D and liquidity constraints: A corporate governance approach to the Belgian evidence", by P. Van Cayseele, *Research series*, May 2002.
34. "On the origins of the Franco-German EMU controversies", by I. Maes, *Research series*, July 2002.
35. "An estimated dynamic stochastic general equilibrium model of the euro area", by F. Smets and R. Wouters, *Research series*, October 2002.
36. "The labour market and fiscal impact of labour tax reductions: The case of reduction of employers' social security contributions under a wage norm regime with automatic price indexing of wages", by K. Burggraeve and Ph. Du Caju, *Research series*, March 2003.
37. "Scope of asymmetries in the euro area", by S. Ide and Ph. Moës, *Document series*, March 2003.
38. "De autonijverheid in België: Het belang van het toeleveringsnetwerk rond de assemblage van personenauto's", by F. Coppens and G. van Gastel, *Document series*, June 2003.
39. "La consommation privée en Belgique", by B. Eugène, Ph. Jeanfils and B. Robert, *Document series*, June 2003.
40. "The process of European monetary integration: A comparison of the Belgian and Italian approaches", by I. Maes and L. Quaglia, *Research series*, August 2003.
41. "Stock market valuation in the United States", by P. Bisciari, A. Durré and A. Nyssens, *Document series*, November 2003.
42. "Modeling the term structure of interest rates: Where do we stand?", by K. Maes, *Research series*, February 2004.
43. "Interbank exposures: An ampirical examination of system risk in the Belgian banking system", by H. Degryse and G. Nguyen, *Research series*, March 2004.
44. "How frequently do prices change? Evidence based on the micro data underlying the Belgian CPI", by L. Aucremanne and E. Dhyne, *Research series*, April 2004.
45. "Firms' investment decisions in response to demand and price uncertainty", by C. Fuss and Ph. Vermeulen, *Research series*, April 2004.
46. "SMEs and bank lending relationships: The impact of mergers", by H. Degryse, N. Masschelein and J. Mitchell, *Research series*, May 2004.
47. "The determinants of pass-through of market conditions to bank retail interest rates in Belgium", by F. De Graeve, O. De Jonghe and R. Vander Vennet, *Research series*, May 2004.
48. "Sectoral vs. country diversification benefits and downside risk", by M. Emiris, *Research series*, May 2004.
49. "How does liquidity react to stress periods in a limit order market?", by H. Beltran, A. Durré and P. Giot, *Research serie*s, May 2004.
50. "Financial consolidation and liquidity: Prudential regulation and/or competition policy?", by P. Van Cayseele, *Research series*, May 2004.
51. "Basel II and operational risk: Implications for risk measurement and management in the financial sector", by A. Chapelle, Y. Crama, G. Hübner and J.-P. Peters, *Research series,* May 2004.
52. "The efficiency and stability of banks and markets", by F. Allen, *Research series*, May 2004.
53. "Does financial liberalization spur growth?", by G. Bekaert, C.R. Harvey and C. Lundblad, *Research series*, May 2004.
54. "Regulating financial conglomerates", by X. Freixas, G. Lóránth, A.D. Morrison and H.S. Shin, *Research series*, May 2004.
55. "Liquidity and financial market stability", by M. O'Hara, *Research series*, May 2004.
56. "Economisch belang van de Vlaamse zeehavens: Verslag 2002", by F. Lagneaux, *Document series*, June 2004.
57. "Determinants of euro term structure of credit spreads", by A. Van Landschoot, *Research series*, July 2004.
58. "Macroeconomic and monetary policy-making at the European Commission, from the Rome Treaties to the Hague Summit", by I. Maes, *Research series*, July 2004.
59. "Liberalisation of network industries: Is electricity an exception to the rule?", by F. Coppens and D. Vivet, *Document series*, September 2004.
60. "Forecasting with a Bayesian DSGE model: An application to the euro area", by F. Smets and R. Wouters, *Research series*, September 2004.
61. "Comparing shocks and frictions in US and euro area business cycle: A Bayesian DSGE approach", by F. Smets and R. Wouters, *Research series*, October 2004.
62. "Voting on pensions: A survey", by G. de Walque, *Research series*, October 2004.
63. "Asymmetric growth and inflation developments in the acceding countries: A new assessment", by S. Ide and P. Moës, *Research series*, October 2004.
64. "Importance économique du Port Autonome de Liège: rapport 2002", by F. Lagneaux, *Document series*, November 2004.

65. "Price-setting behaviour in Belgium: What can be learned from an ad hoc survey", by L. Aucremanne and M. Druant, *Research series,* March 2005.
66. "Time-dependent versus state-dependent pricing: A panel data approach to the determinants of Belgian consumer price changes", by L. Aucremanne and E. Dhyne, *Research series*, April 2005.
67. "Indirect effects – A formal definition and degrees of dependency as an alternative to technical coefficients", by F. Coppens, *Research series,* May 2005.
68. "Noname – A new quarterly model for Belgium", by Ph. Jeanfils and K. Burggraeve, *Research series*, May 2005.
69. "Economic importance of the Flemish maritime ports: Report 2003", by F. Lagneaux, *Document series*, May 2005.
70. "Measuring inflation persistence: A structural time series approach", by M. Dossche and G. Everaert, *Research series*, June 2005.
71. "Financial intermediation theory and implications for the sources of value in structured finance markets", by J. Mitchell, *Document series*, July 2005.
72. "Liquidity risk in securities settlement", by J. Devriese and J. Mitchell, *Research series*, July 2005.
73. "An international analysis of earnings, stock prices and bond yields", by A. Durré and P. Giot, *Research series*, September 2005.
74. "Price setting in the euro area: Some stylized facts from Individual Consumer Price Data", by E. Dhyne, L. J. Álvarez, H. Le Bihan, G. Veronese, D. Dias, J. Hoffmann, N. Jonker, P. Lünnemann, F. Rumler and J. Vilmunen, *Research series*, September 2005.
75. "Importance économique du Port Autonome de Liège: rapport 2003", by F. Lagneaux, *Document series,* October 2005.
76. "The pricing behaviour of firms in the euro area: New survey evidence, by S. Fabiani, M. Druant, I. Hernando, C. Kwapil, B. Landau, C. Loupias, F. Martins, T. Mathä, R. Sabbatini, H. Stahl and A. Stokman, *Research series*, November 2005.
77. "Income uncertainty and aggregate consumption", by L. Pozzi, *Research series*, November 2005.
78. "Crédits aux particuliers - Analyse des données de la Centrale des Crédits aux Particuliers", by H. De Doncker, *Document series*, January 2006.
79. "Is there a difference between solicited and unsolicited bank ratings and, if so, why?", by P. Van Roy, *Research series*, February 2006.
80. "A generalised dynamic factor model for the Belgian economy - Useful business cycle indicators and GDP growth forecasts", by Ch. Van Nieuwenhuyze, *Research series*, February 2006.
81. "Réduction linéaire de cotisations patronales à la sécurité sociale et financement alternatif", by Ph. Jeanfils, L. Van Meensel, Ph. Du Caju, Y. Saks, K. Buysse and K. Van Cauter, *Document series*, March 2006.
82. "The patterns and determinants of price setting in the Belgian industry", by D. Cornille and M. Dossche, *Research series*, May 2006.
83. "A multi-factor model for the valuation and risk management of demand deposits", by H. Dewachter, M. Lyrio and K. Maes, *Research series*, May 2006.
84. "The single European electricity market: A long road to convergence", by F. Coppens and D. Vivet, *Document series*, May 2006.
85. "Firm-specific production factors in a DSGE model with Taylor price setting", by G. de Walque, F. Smets and R. Wouters, *Research series*, June 2006.
86. "Economic importance of the Belgian ports: Flemish maritime ports and Liège port complex - Report 2004", by F. Lagneaux, *Document series*, June 2006.
87. "The response of firms' investment and financing to adverse cash flow shocks: The role of bank relationships", by C. Fuss and Ph. Vermeulen, *Research series*, July 2006.
88. "The term structure of interest rates in a DSGE model", by M. Emiris, *Research series,* July 2006.
89. "The production function approach to the Belgian output gap, estimation of a multivariate structural time series model", by Ph. Moës, *Research series*, September 2006.
90. "Industry wage differentials, unobserved ability, and rent-sharing: Evidence from matched worker-firm data, 1995-2002", by R. Plasman, F. Rycx and I. Tojerow, *Research series,* October 2006.
91. "The dynamics of trade and competition", by N. Chen, J. Imbs and A. Scott, *Research series,* October 2006.
92. "A New Keynesian model with unemployment", by O. Blanchard and J. Gali, *Research series,* October 2006.
93. "Price and wage setting in an integrating Europe: Firm level evidence", by F. Abraham, J. Konings and S. Vanormelingen, *Research series,* October 2006.
94. "Simulation, estimation and welfare implications of monetary policies in a 3-country NOEM model", by J. Plasmans, T. Michalak and J. Fornero, *Research series,* October 2006.

95. "Inflation persistence and price-setting behaviour in the euro area: A summary of the Inflation Persistence Network evidence ", by F. Altissimo, M. Ehrmann and F. Smets, *Research series*, October 2006.
96. "How wages change: Micro evidence from the International Wage Flexibility Project", by W.T. Dickens, L. Goette, E.L. Groshen, S. Holden, J. Messina, M.E. Schweitzer, J. Turunen and M. Ward, *Research series*, October 2006.
97. "Nominal wage rigidities in a new Keynesian model with frictional unemployment", by V. Bodart, G. de Walque, O. Pierrard, H.R. Sneessens and R. Wouters, *Research series*, October 2006.
98. "Dynamics on monetary policy in a fair wage model of the business cycle", by D. De la Croix, G. de Walque and R. Wouters, *Research series*, October 2006.
99. "The kinked demand curve and price rigidity: Evidence from scanner data", by M. Dossche, F. Heylen and D. Van den Poel, *Research series*, October 2006.
100. "Lumpy price adjustments: A microeconometric analysis", by E. Dhyne, C. Fuss, H. Peseran and P. Sevestre, *Research series*, October 2006.
101. "Reasons for wage rigidity in Germany", by W. Franz and F. Pfeiffer, *Research series*, October 2006.
102. "Fiscal sustainability indicators and policy design in the face of ageing", by G. Langenus, *Research series*, October 2006.
103. "Macroeconomic fluctuations and firm entry: Theory and evidence", by V. Lewis, *Research series*, October 2006.
104. "Exploring the CDS-bond basis", by J. De Wit, *Research series*, November 2006.
105. "Sector concentration in loan portfolios and economic capital", by K. Düllmann and N. Masschelein, *Research series*, November 2006.
106. "R&D in the Belgian pharmaceutical sector", by H. De Doncker, *Document series*, December 2006.
107. "Importance et évolution des investissements directs en Belgique", by Ch. Piette, *Document series*, January 2007.
108. "Investment-specific technology shocks and labor market frictions", by R. De Bock, *Research series*, February 2007.
109. "Shocks and frictions in US business cycles: A Bayesian DSGE approach", by F. Smets and R. Wouters, *Research series*, February 2007.
110. "Economic impact of port activity: A disaggregate analysis. The case of Antwerp", by F. Coppens, F. Lagneaux, H. Meersman, N. Sellekaerts, E. Van de Voorde, G. van Gastel, Th. Vanelslander, A. Verhetsel, *Document series,* February 2007.
111. "Price setting in the euro area: Some stylised facts from individual producer price data", by Ph. Vermeulen, D. Dias, M. Dossche, E. Gautier, I. Hernando, R. Sabbatini, H. Stahl, *Research series,* March 2007.
112. "Assessing the gap between observed and perceived inflation in the euro area: Is the credibility of the HICP at stake?", by L. Aucremanne, M. Collin and Th. Stragier, *Research series,* April 2007.
113. "The spread of Keynesian economics: A comparison of the Belgian and Italian experiences", by I. Maes, *Research series,* April 2007.
114. "Imports and exports at the level of the firm: Evidence from Belgium", by M. Muûls and M. Pisu, *Research series,* May 2007.
115. "Economic importance of the Belgian ports: Flemish maritime ports and Liège port complex - Report 2005", by F. Lagneaux, *Document series*, May 2007.
116. "Temporal distribution of price changes: Staggering in the large and synchronization in the small", by E. Dhyne and J. Konieczny, *Research series,* June 2007.
117. "Can excess liquidity signal an asset price boom?", by A. Bruggeman, *Research series,* August 2007.
118. "The performance of credit rating systems in the assessment of collateral used in Eurosystem monetary policy operations", by F. Coppens, F. González and G. Winkler, *Research series*, September 2007.
119. "The determinants of stock and bond return comovements", by L. Baele, G. Bekaert and K. Inghelbrecht, *Research series*, October 2007.
120. "Monitoring pro-cyclicality under the capital requirements directive: Preliminary concepts for developing a framework", by N. Masschelein, *Document series*, October 2007.
121. "Dynamic order submission strategies with competition between a dealer market and a crossing network", by H. Degryse, M. Van Achter and G. Wuyts, *Research series*, November 2007.
122. "The gas chain: Influence of its specificities on the liberalisation process", by C. Swartenbroekx, *Document series*, November 2007.
123. "Failure prediction models: Performance, disagreements, and internal rating systems", by J. Mitchell and P. Van Roy, *Research series*, December 2007.
124. "Downward wage rigidity for different workers and firms: An evaluation for Belgium using the IWFP procedure", by Ph. Du Caju, C. Fuss and L. Wintr, *Research series*, December 2007.

125. "Economic importance of Belgian transport logistics", by F. Lagneaux, *Document series*, January 2008.
126. "Some evidence on late bidding in eBay auctions", by L. Wintr, *Research series*, January 2008.
127. "How do firms adjust their wage bill in Belgium? A decomposition along the intensive and extensive margins", by C. Fuss, *Research series*, January 2008.
128. "Exports and productivity – Comparable evidence for 14 countries", by The International Study Group on Exports and Productivity, *Research series*, February 2008.
129. "Estimation of monetary policy preferences in a forward-looking model: A Bayesian approach", by P. Ilbas, *Research series*, March 2008.
130. "Job creation, job destruction and firms' international trade involvement", by M. Pisu, *Research series*, March 2008.
131. "Do survey indicators let us see the business cycle? A frequency decomposition", by L. Dresse and Ch. Van Nieuwenhuyze, *Research series*, March 2008.
132. "Searching for additional sources of inflation persistence: The micro-price panel data approach", by R. Raciborski, *Research series,* April 2008.
133. "Short-term forecasting of GDP using large monthly datasets - A pseudo real-time forecast evaluation exercise", by K. Barhoumi, S. Benk, R. Cristadoro, A. Den Reijer, A. Jakaitiene, P. Jelonek, A. Rua, G. Rünstler, K. Ruth and Ch. Van Nieuwenhuyze, *Research series*, June 2008.
134. "Economic importance of the Belgian ports: Flemish maritime ports, Liège port complex and the port of Brussels - Report 2006", by S. Vennix, *Document series*, June 2008.
135. "Imperfect exchange rate pass-through: The role of distribution services and variable demand elasticity", by Ph. Jeanfils, *Research series*, August 2008.
136. "Multivariate structural time series models with dual cycles: Implications for measurement of output gap and potential growth", by Ph. Moës, *Research series*, August 2008.
137. "Agency problems in structured finance - A case study of European CLOs", by J. Keller, *Document series*, August 2008.
138. "The efficiency frontier as a method for gauging the performance of public expenditure: A Belgian case study", by B. Eugène, *Research series*, September 2008.
139. "Exporters and credit constraints. A firm-level approach", by M. Muûls, *Research series*, September 2008.
140. "Export destinations and learning-by-exporting: Evidence from Belgium", by M. Pisu, *Research series*, September 2008.
141. "Monetary aggregates and liquidity in a neo-Wicksellian framework", by M. Canzoneri, R. Cumby, B. Diba and D. López-Salido, *Research series*, October 2008.
142 "Liquidity, inflation and asset prices in a time-varying framework for the euro area, by Ch. Baumeister, E. Durinck and G. Peersman, *Research series*, October 2008.
143. "The bond premium in a DSGE model with long-run real and nominal risks", by G. D. Rudebusch and E. T. Swanson, *Research series*, October 2008.
144. "Imperfect information, macroeconomic dynamics and the yield curve: An encompassing macro-finance model", by H. Dewachter, *Research series*, October 2008.
145. "Housing market spillovers: Evidence from an estimated DSGE model", by M. Iacoviello and S. Neri, *Research series*, October 2008.
146. "Credit frictions and optimal monetary policy", by V. Cúrdia and M. Woodford, *Research series*, October 2008.
147. "Central Bank misperceptions and the role of money in interest rate rules", by G. Beck and V. Wieland*, Research series*, October 2008.
148. "Financial (in)stability, supervision and liquidity injections: A dynamic general equilibrium approach", by G. de Walque, O. Pierrard and A. Rouabah, *Research series*, October 2008.
149. "Monetary policy, asset prices and macroeconomic conditions: A panel-VAR study", by K. Assenmacher-Wesche and S. Gerlach, *Research series*, October 2008.
150. "Risk premiums and macroeconomic dynamics in a heterogeneous agent model", by F. De Graeve, M. Dossche, M. Emiris, H. Sneessens and R. Wouters, *Research series*, October 2008.
151. "Financial factors in economic fluctuations", by L. J. Christiano, R. Motto and M. Rotagno, *Research series*, to be published.
152. "Rent-sharing under different bargaining regimes: Evidence from linked employer-employee data", by M. Rusinek and F. Rycx, *Research series*, December 2008.
153. "Forecast with judgment and models", by F. Monti, *Research series*, December 2008.
154. "Institutional features of wage bargaining in 23 European countries, the US and Japan", by Ph. Du Caju, E. Gautier, D. Momferatou and M. Ward-Warmedinger, *Research series*, December 2008.
155. "Fiscal sustainability and policy implications for the euro area", by F. Balassone, J. Cunha, G. Langenus, B. Manzke, J Pavot, D. Prammer and P. Tommasino, *Research series*, January 2009.

156. "Understanding sectoral differences in downward real wage rigidity: Workforce composition, institutions, technology and competition", by Ph. Du Caju, C. Fuss and L. Wintr, *Research series*, February 2009.
157. "Sequential bargaining in a New Keynesian model with frictional unemployment and staggered wage negotiation", by G. de Walque, O. Pierrard, H. Sneessens and R. Wouters, *Research series*, February 2009.
158. "Economic importance of air transport and airport activities in Belgium", by F. Kupfer and F. Lagneaux, *Document series*, March 2009.
159. "Rigid labour compensation and flexible employment? Firm-Level evidence with regard to productivity for Belgium", by C. Fuss and L. Wintr, *Research series*, March 2009.
160. "The Belgian iron and steel industry in the international context", by F. Lagneaux and D. Vivet, *Document series*, March 2009.
161. "Trade, wages and productivity", by K. Behrens, G. Mion, Y. Murata and J. Südekum, *Research series*, March 2009.
162. "Labour flows in Belgium", by P. Heuse and Y. Saks, *Research series*, April 2009.
163. "The young Lamfalussy: An empirical and policy-oriented growth theorist", by I. Maes, *Research series*, April 2009.
164. "Inflation dynamics with labour market matching: Assessing alternative specifications", by K. Christoffel, J. Costain, G. de Walque, K. Kuester, T. Linzert, S. Millard and O. Pierrard, *Research series*, May 2009.
165. "Understanding inflation dynamics: Where do we stand?", by M. Dossche, *Research series*, June 2009.
166. "Input-output connections between sectors and optimal monetary policy", by E. Kara, *Research series*, June 2009.
167. "Back to the basics in banking? A micro-analysis of banking system stability", by O. De Jonghe, *Research series*, June 2009.
168. "Model misspecification, learning and the exchange rate disconnect puzzle", by V. Lewis and A. Markiewicz, *Research series*, July 2009.
169. "The use of fixed-term contracts and the labour adjustment in Belgium", by E. Dhyne and B. Mahy, *Research series*, July 2009.
170. "Analysis of business demography using markov chains – An application to Belgian data", by F. Coppens and F. Verduyn, *Research series*, July 2009.
171. "A global assessment of the degree of price stickiness - Results from the NBB business survey", by E. Dhyne, *Research series*, July 2009.
172. "Economic importance of the Belgian ports: Flemish maritime ports, Liège port complex and the port of Brussels - Report 2007", by C. Mathys, *Document series*, July 2009.
173. "Evaluating a monetary business cycle model with unemployment for the euro area", by N. Groshenny, *Research series*, July 2009.
174. "How are firms' wages and prices linked: Survey evidence in Europe", by M. Druant, S. Fabiani and G. Kezdi, A. Lamo, F. Martins and R. Sabbatini, *Research series*, August 2009.
175. "Micro-data on nominal rigidity, inflation persistence and optimal monetary policy", by E. Kara, *Research series*, September 2009.
176. "On the origins of the BIS macro-prudential approach to financial stability: Alexandre Lamfalussy and financial fragility", by I. Maes, *Research series*, October 2009.
177. "Incentives and tranche retention in securitisation: A screening model", by I. Fender and J. Mitchell, *Research series*, October 2009.
178. "Optimal monetary policy and firm entry", by V. Lewis, *Research series*, October 2009.
179. "Staying, dropping, or switching: The impacts of bank mergers on small firms", by H. Degryse, N. Masschelein and J. Mitchell, *Research series*, October 2009.
180. "Inter-industry wage differentials: How much does rent sharing matter?", by Ph. Du Caju, F. Rycx and I. Tojerow, *Research series*, October 2009.
181. "Empirical evidence on the aggregate effects of anticipated and unanticipated US tax policy shocks", by K. Mertens and M. O. Ravn, *Research series*, November 2009.
182. "Downward nominal and real wage rigidity: Survey evidence from European firms", by J. Babecký, Ph. Du Caju, T. Kosma, M. Lawless, J. Messina and T. Rõõm, *Research series*, November 2009.
183. "The margins of labour cost adjustment: Survey evidence from European firms", by J. Babecký, Ph. Du Caju, T. Kosma, M. Lawless, J. Messina and T. Rõõm, *Research series*, November 2009.
184. "Discriminatory fees, coordination and investment in shared ATM networks" by S. Ferrari, *Research series*, January 2010.
185. "Self-fulfilling liquidity dry-ups", by F. Malherbe, *Research series*, March 2010.
186. "The development of monetary policy in the 20th century - some reflections", by O. Issing, *Research series*, April 2010.

187. "Getting rid of Keynes? A survey of the history of macroeconomics from Keynes to Lucas and beyond", by M. De Vroey, *Research series*, April 2010.
188. "A century of macroeconomic and monetary thought at the National Bank of Belgium", by I. Maes, *Research series*, April 2010.
189. "Inter-industry wage differentials in EU countries: What do cross-country time-varying data add to the picture?", by Ph. Du Caju, G. Kátay, A. Lamo, D. Nicolitsas and S. Poelhekke, *Research series*, April 2010.
190. "What determines euro area bank CDS spreads?", by J. Annaert, M. De Ceuster, P. Van Roy and C. Vespro, *Research series*, May 2010.
191. "The incidence of nominal and real wage rigidity: An individual-based sectoral approach", by J. Messina, Ph. Du Caju, C. F. Duarte, N. L. Hansen, M. Izquierdo, *Research series*, June 2010.
192. "Economic importance of the Belgian ports: Flemish maritime ports, Liège port complex and the port of Brussels - Report 2008", by C. Mathys, *Document series,* July 2010.
193. "Wages, labor or prices: how do firms react to shocks?", by E. Dhyne and M. Druant, *Research series*, July 2010.
194. "Trade with China and skill upgrading: Evidence from Belgian firm level data", by G. Mion, H. Vandenbussche, and L. Zhu, *Research series*, September 2010.
195. "Trade crisis? What trade crisis?", by K. Behrens, G. Corcos and G. Mion, *Research series*, September 2010.
196. "Trade and the global recession", by J. Eaton, S. Kortum, B. Neiman and J. Romalis, *Research series*, October 2010.
197. "Internationalization strategy and performance of small and medium sized enterprises", by J. Onkelinx and L. Sleuwaegen, *Research series*, October 2010.
198. "The internationalization process of firms: From exports to FDI?", by P. Conconi, A. Sapir and M. Zanardi, *Research series*, October 2010.
199. "Intermediaries in international trade: Direct versus indirect modes of export", by A. B. Bernard, M. Grazzi and C. Tomasi, *Research series*, October 2010.
200. "Trade in services: IT and task content", by A. Ariu and G. Mion, *Research series*, October 2010.
201. "The productivity and export spillovers of the internationalisation behaviour of Belgian firms", by M. Dumont, B. Merlevede, C. Piette and G. Rayp, *Research series*, October 2010.
202. "Market size, competition, and the product mix of exporters", by T. Mayer, M. J. Melitz and G. I. P. Ottaviano, *Research series*, October 2010.
203. "Multi-product exporters, carry-along trade and the margins of trade", by A. B. Bernard, I. Van Beveren and H. Vandenbussche, *Research series*, October 2010.
204. "Can Belgian firms cope with the Chinese dragon and the Asian tigers? The export performance of multi-product firms on foreign markets" by F. Abraham and J. Van Hove, *Research series*, October 2010.
205. "Immigration, offshoring and American jobs", by G. I. P. Ottaviano, G. Peri and G. C. Wright, *Research series*, October 2010.
206. "The effects of internationalisation on domestic labour demand by skills: Firm-level evidence for Belgium", by L. Cuyvers, E. Dhyne, and R. Soeng, *Research series*, October 2010.
207. "Labour demand adjustment: Does foreign ownership matter?", by E. Dhyne, C. Fuss and C. Mathieu, *Research series*, October 2010.
208. "The Taylor principle and (in-)determinacy in a New Keynesian model with hiring frictions and skill loss", by A. Rannenberg, *Research series*, November 2010.
209. "Wage and employment effects of a wage norm: The Polish transition experience" by A. de Crombrugghe and G. de Walque, *Research series*, February 2011.
210. "Estimating monetary policy reaction functions: A discrete choice approach" by J. Boeckx, *Research series*, February 2011.
211. "Firm entry, inflation and the monetary transmission mechanism" by V. Lewis and C. Poilly, *Research series*, February 2011.
212. "The link between mobile telephony arrears and credit arrears" by H. De Doncker, *Document series*, March 2011.
213. "Development of a financial health indicator based on companies' annual accounts", by D. Vivet, *Document series*, April 2011.

National Bank of Belgium
Limited liability company
RLP Brussels – Company's number: 0203.201.340
Registered office: boulevard de Berlaimont 14 – BE-1000 Brussels
www.nbb.be

Editor

Jan Smets

Member of the Board of directors of the National Bank of Belgium

Layout: NBB Microeconomic Analysis
Cover: NBB TS – Prepress & Image

Published in April 2011