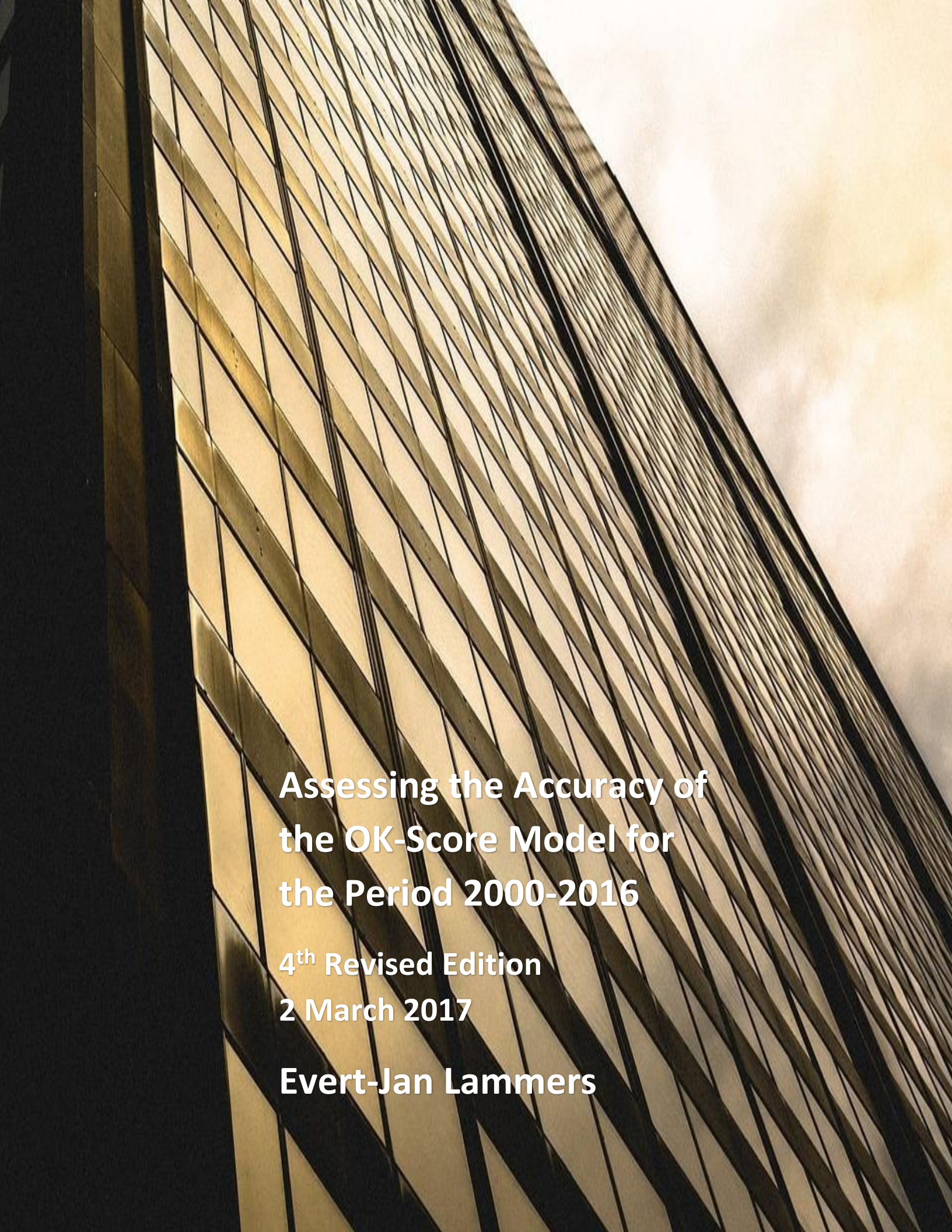

Assessing the Accuracy of the OK-Score Model for the Period 2000-2016

4th Revised Edition
2 March 2017

Evert-Jan Lammers

Colofon

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Preface

The author Evert-Jan Lammers has started assessing the accuracy of the OK Score Model in 2013 at the request of European Rating House, the publisher of this document. Evert-Jan Lammers is Chairman of the Institute of Fraud Auditors (Brussels), board member at Transparency International Belgium (Brussels), Chair of the Chamber 'International Cooperation' at Institute for Financial Crime (The Hague), Chairman of the Board of Directors at European Rating House (Brussels), Partner at EBBEN Partners (Brussels), and Executive Professor at Antwerp Management School (Antwerp). He has written this publication on his own behalf.

Content

Introduction

The OK-Score™ Model is a diagnostic tool that can be used for making credit risk assessments of a company. The input consists of the financial statements of a company, with a minimum of five consecutive fiscal years. The output is a credit score[i] for every one of these years.

The Model is a learning model, which means that the accuracy of the credit score improves with the number of imputed years: after five fiscal years, the credit score is considered reliable, and as from the fifth fiscal year the credit scores are official *OK-Scores*[ii].

The OK-Score Model has been developed by Mr. Willem Okkerse[iii]. After the Model had become operational in 2000, it has determined 2,741 credit scores[iv], a mix of real life monitoring[v] and backtracking[vi]. This population includes 70 situations of *Business Failure*[vii].

The current accuracy assessment relates to the entire population of 2,741 credit scores, and more specifically the 70 cases of *Business Failure*. All 70 *Business Failures* relate to the fiscal year ended 31 December 2016 or before.

Methodology

The OK-Score Model requires input from the financial statements of (minimum) five consecutive financial years: balance sheet, profit and loss account, cash-flow statement. The Model determines a credit score for every single year but only as from the fifth fiscal year this is considered a true OK-Score.

The Model is a learning model, which means that the reliability of the annual credit scores improves until and including the fifth year. For this reason the backtracking period is five years.

The OK-Score is based on two separate ratios. The first ratio is the *OK-Solvency*, a modified version of the solvency ratio. The second ratio is the *OK-Ratio*, based on an in-depth analysis of the five financial statements. Apart from the usual financial ratios this analysis is based on 125 input fields, 25 per fiscal year.

The OK-Score Model can be applied to all sorts of companies, except financial institutions and real estate companies. The main reason is that the structure of the financial statements of companies in these industries is too different.

Classification

Both the *OK-Solvency* and the *OK-Ratio* are reported on a scale from 1-9.

OK-Solvency The best class (1) consists of companies with an OK-Solvency from 49-100%. The next classes (2-8) have a 0-49% solvency. The weakest class (9) consists of companies with negative shareholders' equity.

OK-Ratio The OK-Ratio is also divided into 9 classes. The best classes (1-2) have positive ratios of [+0,5] and [0] respectively. The next classes (3-9) have negative ratios: [-1] [-2] [-4] [-16] [-256] [-65536] [-∞].

The OK-Score is derived from the 81 possible combinations of *OK-Solvency* and *OK-Ratio* (9 x 9). An OK-Score Grade-1 stands for a perfect certainty about creditworthiness and vitality. Grade-10 warns for *Business Failure*. This can be analyzed as follows:

Grade	Rating	Meaning
1	AAA	Almost perfect security. Very large capacity for expansion, also with borrowed capital.
2	AA	Excellent security. Large capacity for expansion, also with borrowed capital.
3	A	Solid security. Capacity for expansion, also with borrowed capital.
4	BBB	Good security, potential for expansion, also with borrowed capital.
5	BB	Normal security. Some potential for expansion, however alert in expansion with borrowed capital.
6	B	Moderate security. Improvements desirable. Expansion with borrowed capital is not wise.
7	CCC	Inadequate security. Improvements necessary. Expansion with borrowed capital dissuaded strongly.
8	CC	Worrying security. Improvements urgently needed. Expansion with borrowed capital can be life threatening.
9	C	Hazardous situation. Substantial improvements needed by return. Expansion with borrowed capital not possible.
10	D	*Business Failure* in 3 years. Immediate action required either turnaround, asset stripping, recapitalization or forced sale. Otherwise: default, Chapter 11, bankruptcy or state support.

Companies with an OK-Solvency of more than 49% will not automatically obtain a Grade-1. Several companies (WorldCom, L&H, Tulip) had a top solvency ratio (>49%) in combination with a Grade-9. The final judgment must be based on the combination of OK-Solvency and OK-Ratio.

Material Bias

While determining the credit scores, the OK-Score Model will also flag any values in the financial statements that don't make sense. The sum of such values is named *Material Bias*. If the *Material Bias* is substantial, immediate investigation is required. It appears from our assessments that in many cases this can be explained by manipulation of the financial statements or another material fraud.

Fraud

The *Business Failures* Data Base contains 2,741 credit scores determined in the period 2000-2016 (closing: 31 December 2016). It contains several cases (real life monitoring or backtracking) where fraud is involved. The Model has flagged these frauds at least one year before they came out in the media. The Model flags fraud via the item *Material Bias* (see previous section).

In the *Business Failures* Data Base, the various cases of corporate fraud have been earmarked "FR": Moulinex, LCI and Enron (2001), WorldCom and Ahold[viii] (2002), Weyl and Landis (2003), Parmalat (2004), Imtech (2013), Abengoa (2015) and Valeant (2016). There have been many other cases of corporate fraud during these years, but these companies were not monitored by the OK-Score and hence are not included In the *Business Failures* Data Base.

Accountability

The possibility to reproduce research results is a cornerstone of scientific research. Since the OK-Score Model has become operational in the year 2000, regulators, scientists and journalists have had the opportunity to verify all public OK-Scores.

The following conditions apply to all OK-Scores that are included in the published statistics:

- Real life monitoring: the OK-Score can be reproduced[ix] and compared to the real events;
- Backtracking: the OK-Score can be reproduced and the backtracking is normally performed under the supervision from qualified external parties.

Accuracy

Portfolio and errors

After the OK-Score Model became operational in 2000, it has warned for 98.6% of the *Business Failures* that have occurred in the portfolio by giving an OK-Score 10.

Since the model became operational 2,741 credit scores (as at 31 December 2016) have been computed by the Model, a mix of backtracking[x] and real live monitoring.

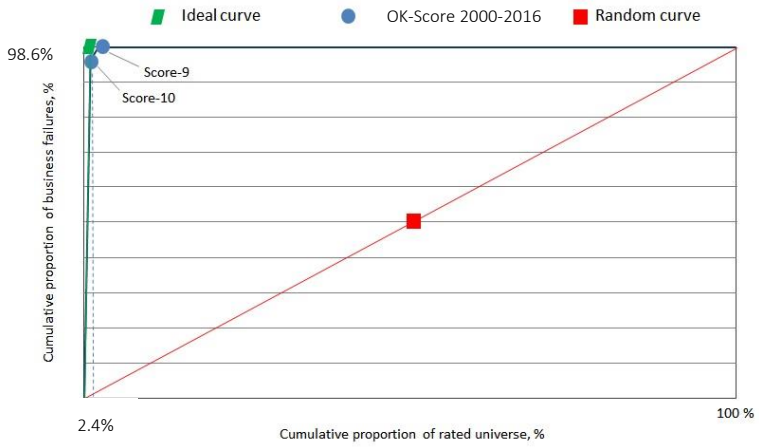
This population included 70 *Business Failures*, and 2,671 non-Business Failures.

Since the Model became operational it has given a Grade-10 on 70 occasions. On 69 occasions a *Business Failure* occurred within 3 years. The moment when the scores were issued has been documented.

Error	Percentage
False positive error / Type-1 error: The likelihood that a company that does not have a *Business Failure,* does have an OK-Score 10 *(divided by the number of companies without Business Failure)*	1/2,671 = 0.04%
Non-detection error / Type-2 error: The likelihood that a *Business Failure* has not been preceded by an OK-Score 10 in the three previous years *(divided by the number of companies with a Business Failure)*	1/70 = 1.43%
False warning rate: The likelihood that an OK-Score 10 does not lead to a *Business Failure* within three years. *(divided by the number of OK-Scores 10)*	1/70 = 1.43%

Cumulative Accuracy Profile[xi]

The reliability of a credit score or a credit rating can also be expressed with the Cumulative Accuracy Profile, which is based on the Lorenz-curve. The 3 years' Lorenz-curve for the OK-Score Model is as follows:



As can be seen from the above graph, the CAP-profile of the OK-Score Model is strong: if we compare it to the CAP-profiles of credit rating agencies or audit firms, we see a substantial difference.

Credit Rating agencies predict default. Audit firms predict going concern issues. The OK-Score Model predicts *Business Failure* which is a broader concept. Credit rating agencies and audit firms predict 1-year default and 1-year going concern issues respectively.

The OK-Score Model has chosen the term that suits the model best: 3 years. This term is more valuable to stakeholders than the 1-year term that is mandatory to CRA's and audit firms.

Gini-coefficient

The Gini-coefficient is based on the Lorenz-curve (see next paragraph). The Gini-coefficient of the OK-Score Model is 98.6% which can be analyzed as follows: 100% minus 1.4% (Type-2 error) minus 0.04% (Type-1 error). It corresponds to the area above the curve divided by the area between the Lorenz-curve and the 45° line (the random curve).

Business Failures Data Base

The *Business Failures* Data Base shows all *Business Failures* and all Grade-10 scores that can be reproduced and that have been issued in the period 2000-2016 (closing date 31 December 2016). The data base contains 2,741 credit scores as per that date. Hereafter we only mention the *Business Failures.*

Backtracking portfolio

Company	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Supervision	Business Failure #	Event
Moulinex-FR	10	R	B/FR	†															ABP	1	B
LCI-NL	10	R	B/FR	†															VEB	2	B
Numico-NL	10	10	AS																Auditor	3	AS
Enron-USA		10	B/FR	†															FD	4	B
Parmalat-IT				10	B/FR	†													NRC	5	B
Laurus-NL					10	R	S	†											Laurus	6	B
Neschen-GER					10	R													Everling	7	R
Vilenzo-NL					10	B	†												Receiver	8	B
Lockheed-USA						10	SS												Dubash	9	SS
Comcast-USA						10	LC		10	LC									Dubash	10/11	LC
Ford-USA						10	SS												Dubash	12	SS
ASR-BE							10	B	†										TRIFORENSIC	13	B
Weyl-NL							10	10	FR/AS	†									ERH	56	FR/AS/B
Anonymous								10	B	†									PwC	14	B
Anonymous								10	B	†									PwC	15	B
Anonymous								10	B	†									PwC	16	B
Anonymous								10	B	†									PwC	17	B
Sprint-USA									10	R									Dubash	18	R
Weyerhauser-USA										10	10	R							Dubash	19	R
Caterpillar-USA											10	R							Dubash	20	R
EastmanKodak-USA											10	10	10	CH	B	†			Dubash	21	B
OAD-NL														10	B				PwC	68	B

Real life monitoring

Company	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Supervision	Business Failure #	Event
Landis-NL		10	10	B/FR	†														R.Kamer	22	B
Getronics-NL		10	AS	AS	R	10	10	10	S	†									Todays Beheer	23/24	AS/R/S
Unilever-NL		10	T	T															Todays Beheer	25	T
Ahold-NL		10	R	FR	R	10	AS												Todays Beheer	26/27	R/FR/AS
Wolters Kluwer-NL		10	10	AS	AS	10	R	10	10	R									Todays Beheer	28/29/30	AS/R
KPN-NL			10	10	R														Todays Beheer	31	R
ASML-NL			10	10	10	R													Todays Beheer	32	R
Numico-NL				10	AS	10	10	R	S	†									Todays Beheer	33/34	AS/R/S
SBM-NL						10	R							10	R				Todays Beheer	35/36	R
Innoconcepts-NL											10	10	FR,B	†					University	37	FR/B
Air Berlin-GER											10	10		R					Effectenhuis	38	R
Abengoa-ESP												10	10	R			FR		Effectenhuis	39	R/FR
Norske Skog-NO													10	AS	AS				Effectenhuis	40	AS
Praktiker-GER													10	10	B	†			Effectenhuis	41	B
Alpine-AUT														10	B	†			Effectenhuis	42	B
AirFrance-KLM-NL														10	R	10			Effectenhuis	43/62	R
Porr-AUT														10	R				Effectenhuis	44	R
Imtech-NL														10	FR,R				ERH	45	FR/R
Grontmij-NL														10	R	10	†		ERH	47	B
BAM-NL												10	R	10	R	10	FS		Effectenhuis	48/53/57	FS
Alcatel-FR													10	10	R	FS			ERH	49	R/FS
Scholtz-GER														10	AS				Effectenhuis	50	AS
New World-POL															10	R			Effectenhuis	51	R
Siem Offsh-NOR													10	R					Effectenhuis	52	R
Wessanen-NL															10	AS			ERH	54	AS
Golden Oc.-BMD														10	AS	FS			Effectenhuis	55	AS/FS
AMG-NL															10	AS			ERH	58	AS
PNE Wind-GER															10	R			Effectenhuis	59	R
Vedes-GER																10	R		Effectenhuis	61	T
Heijmans-NED																10	R		Effectenhuis	63	R
Valeant-US															10	10	10	AS/FR	Effectenhuis	64	AS/FR
Tullow Oil-US																	10	R	Effectenhuis	65	R
Vallourec-FR																	10	R	Effectenhuis	66	R
Underberg-GER																10	R		Effectenhuis	67	R
Rickmers-GER													10	10	R	R	R	CH	Effectenhuis	69	R/CH
Hellenic-GR																10	T		Effectenhuis	70	T

Errors

Company	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Error	Business failure	Event
WorldCom-US	9	9	9	FR	†														ND	46	B
Anonymous											10	NBF	NBF	NBF					FW	60	NBF

Legend

Abbreviation	Meaning	Abbreviation	Meaning
AS	Asset stripping	NA	Not available
B	Bankruptcy	NBF	No Business Failure
CH	Chapter 11	R	Forced Recapitalization
FR	Fraud	SS	State Support
FS	Forced Sale of the company	T	Turnaround
LC	Litigation Claim	NVT	Not applicable
ND	Non-detection error (Type-2)	9, 10	Score grade-9, grade-10
FW	False-warning error (Type-1)	MB	Material Bias

References

Engelman B., Hayden, E., Tache D, Testing Rating Accuracy, www.risk.net, January 2003.

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Footnotes

[i] A credit score is a number that reflects the creditworthiness and vitality of a company

[ii] OK-Score: a credit score based on the OK-Score Model™ that has been developed by Mr. W.D. Okkerse during a PhD research at Universiteit van Amsterdam in the years 1995-2000. OK-Scores are reported on a scale from 1 to 10, where Grade-1 is given to highly creditworthy and vital companies and Grade-10 to companies facing a *Business Failure*.

[iii] Willem D. Okkerse (1946) is Managing Director of the OK-Score Institute and Chairman of the Rating Committee of European Rating House.

[iv] Input updated until 31 December 2016

[v] Real life monitoring: The computation of a credit score over a recent period. The accuracy of the credit score cannot yet be assessed as the rating period has ended only recently. Real time monitoring is usually performed as a part of the global monitoring of an organization by shareholders, bondholders or credit suppliers.

[vi] Backtracking (also: backtesting): The computation of a credit score over a period, lying one or more years in the past. After computing the credit score it can be compared directly to real developments since. Example: today credit scores could be computed for Enron over the five years' period (1996-2000) preceding the *Business Failure* (2001). With hindsight one can then assess whether these credit scores reflect the increased risk timely and accurately.

[vii] *Business Failure*: The situation of Default, Chapter 11 or Bankruptcy or strong measures such as asset stripping, forced recapitalization, turnaround or forced take-over, in combination with a substantial decline of the stock price of the company. Such strong measures are the responsibility of the Executive Board and the Supervisory Board and they are usually forced by the shareholders and other stakeholders. A timely warning will be of importance. The OK-Score Model warns up to three years in advance. The substantial decline of the stock price that comes with most *Business Failures*, can cause serious damage to shareholders, bondholders and other stakeholders. In some cases fraud can be identified as the main cause of the *Business Failure* as many accounting scandals have shown.

[viii] More information on these fraud cases is available on http://ok-score.nl

[ix] Reproduction: The re-computation of a credit score by using the same information and credit scoring model as in the past. If one can determine that the credit scoring model is unchanged (via hash totals of other checks) one can assess whether the first credit score had been computed accurately. Reproduction is normally performed by or in presence of another person than the credit rating analyst. Reproduction can be real time (self-control, internal control, etc.) or via backtracking (regulatory compliance, due diligence, etc.).

[x] The Cumulative Accuracy Profile is determined by the Lorenz-curve and is calculated as follows: The horizontal (X) axis shows the cumulative amount of credit scores, as a percentage. Counting from the center it starts with the *Business Failures*. The vertical (Y) axis shows the cumulative amount of *Business Failures*, as a percentage. Counting from the center it starts with the poorest credit scores. The curve shows in which zone of the credit scores the *Business Failures* can be found.

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