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How corporate governance and expectations impact on the probability of default: Russian Manufacturing

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Motivation: to expand the decision-making factors

- "Picture" of the manufacturing:
  - The leading branch of Russian industry
    - manufacturing ≈ 65% of production value
    - mining operations ≈ 24% of production value
    - electric-power industry ≈ 11% of production value
  - Volume of the sector in Russian Economics ≈ 13% GDP per year
  - >10 million jobs
- **Object:** Medium & Large manufacturing

  (Revenue > 6 million euros per year)
- **Subject:** Factors of corporate governance and expectations
- **Purpose:** To understand the impact of corporate governance factors and expectations on the probability of **default**
- ***Default "Event"****: Negative Net Worth – the book value of all assets below the book value of all liabilities (by analogy with the model [Merton, 1974])*

Manufacturing: sample

Manufacturing	Number of companies	Number of NNW	Frequency, %
DA: Food products, beverages, tobacco products	716	75	10.5%
DB: Textiles, wearing apparel	47	4	8.5%
DC: Leather and related products	7	0	0%
DD: Wood and products of wood	66	9	13.6%
DE: Paper and products of paper, printing	108	15	13.9%
DF: Coke and refined petroleum products	61	9	14.8%
DG: Chemicals and chemical products	238	18	7.6%
DH: Rubber and plastic products	148	17	11.5%
DI: Other non-metallic mineral products	229	28	12.2%
DJ: Basic metals and fabricated metal products	321	43	13.4%
DK: Machinery and equipment	253	26	10.4%
DL: Electronic and optical products	257	21	8.2%
DM: Other transport equipment	195	31	15.9%
DN: Other manufacturing	54	5	9.3%

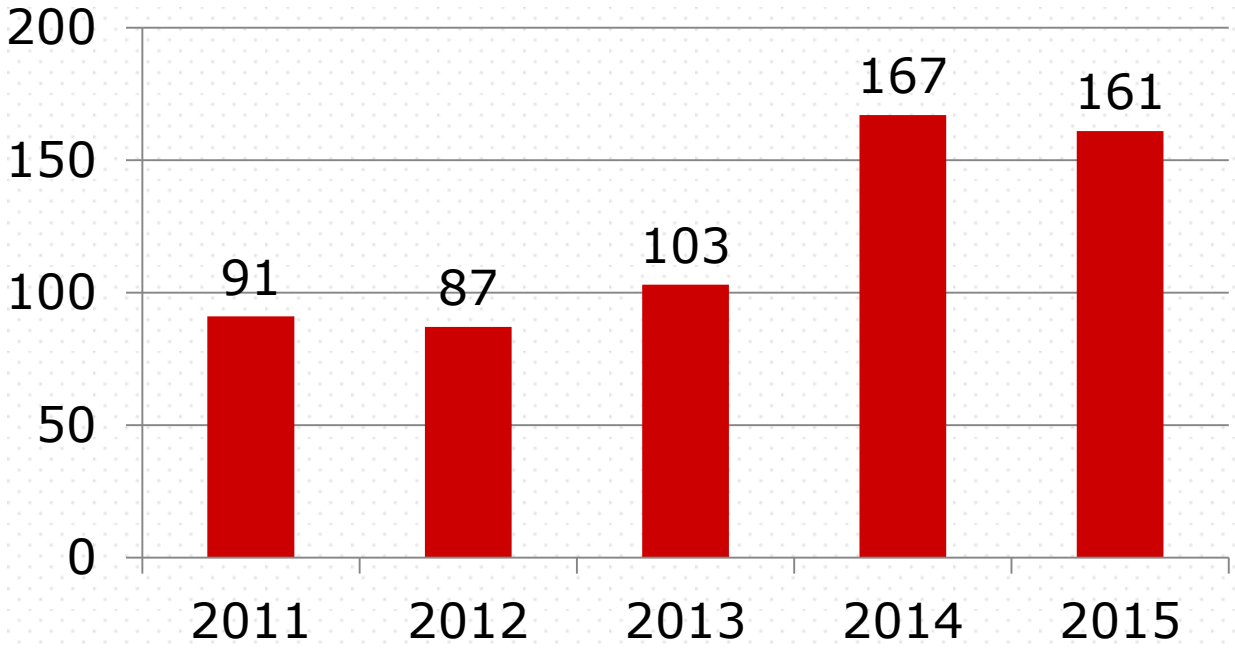
Corporate governance: Enron scandal (2001)

Sarbanes-Oxley Act (2002) is nearly a mirror image of **Enron**: the company's perceived **corporate governance** failings are matched virtually point for point in the principal provisions of the Act.

What about corporate governance?

Key idea	Source
CEO characteristics: • CEO-duality (also is owner) • CEO tenure • CEO age	• Farrel (University of Nebraska Lincoln, 2003) • Fiordelisi (Journal of Corporate Finance, 2014) • Shailer (Emerging Market Review, 2014) • Jiaxing You (Corporate Governance, 2012)
Board structure: • board size • outside directors • co-owners • internal directors • board political connect	• Bushman (Journal of Financial Economics, 2010) • Ichiro Iwasaki (Journal of Comparative Economics, 2013) • Deron Liang (European Journal of Operational Research, 2016) • Shailer (Emerging Market Review, 2014) • Weisbach (Journal of Financial Economics, 1988) • Jiaxing You (Corporate Governance, 2012)
Ownership structure: • ownership concentration • state control • private control	• Ichiro Iwasaki (Journal of Comparative Economics, 2013) • Deron Liang (European Journal of Operational Research, 2016) • Shailer (Emerging Market Review, 2014) • Jiaxing You (Corporate Governance, 2012)

Sample: Negative Net Worth



Year	2011	2012	2013	2014	2015	Training Set №1 (2011-2014)	Test Set №1 (2015)	Training Set №2 (2012-2014)	Test Set №2 (2011 и 2015)
Number of NNW	91	87	103	167	161	448	161	357	252
Observations	2427	2499	2612	2610	2603	10148	2603	7721	5030
Frequency, %	3.8%	3.5%	3.9%	6.4%	6.2%	4.4%	6.2%	4.6%	5.0%

Financial data: descriptive statistics

Group	*Variable*	*n*	*event*	*mean*	*sd*	*median*	*min*	*max*
Size	Ln(Revenue)	617	NNW = 1	14.37	1.04	14.18	10.65	19.07
		12142	NNW = 0	14.45	1.04	14.23	8.83	19.73
Profitability	ROA	617	NNW = 1	-0.08	0.16	-0.04	-1.26	0.33
		12142	NNW = 0	0.07	0.11	0.04	-2.13	2.48
Liquidity	Net working capital	617	NNW = 1	-0.14	0.39	-0.09	-1.63	0.87
		12142	NNW = 0	0.2	0.26	0.19	-1.42	0.95
Business activity	|Z_A|	617	NNW = 1	0.27	0.3	0.17	0	2.07
		12142	NNW = 0	0.18	0.16	0.13	0	1.87
Financial stability	Real value	617	NNW = 1	0.64	0.22	0.68	0.01	0.98
		12142	NNW = 0	0.61	0.2	0.64	0	0.99
Debt leverage	Long term debt ratio	617	NNW = 1	0.41	0.42	0.31	0	2.49
		12142	NNW = 0	0.15	0.2	0.04	0	1.41
Dynamics	Dummy: Dynamic ROA	617	NNW = 1	1.67	1.78	1	0	8
		12142	NNW = 0	0.21	0.8	0	0	9

Hypothesis: variables

hypothesis	variable	event	mean
Expectations of CEOs	Business confidence index	NNW = 1	-2.55
		NNW = 0	-2.01
CEO characteristics	Dummy: CEO also is owner	NNW = 1	0.05
		NNW = 0	0.24
Board structure	Board size: number of owners	NNW = 1	1.78
		NNW = 0	2.37
Ownership structure	Dummy: Low concentration (<25%)	NNW = 1	0.04
		NNW = 0	0.06
	Dummy: Medium concentration (25%-50%)	NNW = 1	0.06
		NNW = 0	0.13
	Dummy: High concentration (>50%)	NNW = 1	0.87
		NNW = 0	0.76
Private vs. State	Dummy: Private	NNW = 1	0.55
		NNW = 0	0.7

Methodology: empirical design

Logistic regression (J.Ohlson, 1980)

$$P(y_i = 1) = \frac{1}{1 + e^{-(A_0 + B_1 * X_{j1} + B_2 * X_{j2} + \cdots + B_n * X_{jn})}},$$

where $P(y_i = 1)$ – probability of default of the i-th company, X_{ij} - the value of the j-th factor for i-th company, B_j - the regression coefficient for the j-th factor, A_0 - constant.

Out-of-sample: size of error I ("skip goal") and error II ("false alarm"), sensitivity and specificity.

Threshold cut off point: minimize the sum of errors I and II types.

Some features of the model:

- Possible dependence of the results obtained from the sample:
  - coefficient of variance inflation VIF;
- Strong sensitivity of the logit model to the multicollinearity of the variables:
  - cross-validation, ridge and lasso regularization;
- Lag in specification of models is 1 year.

Results: base model (only financial data)

Independent variables (Lag = 1 year)	Logit-model-1 (2011-2014)	Logit-model-2 (2012 – 2014)
Ln(Revenue)	-0.18*** (0.06)	-0.21*** (0.07)
ROA	-4.10*** (0.90)	-4.24*** (1.01)
Net working capital	-6.61*** (0.34)	-6.34*** (0.37)
|Z_A|	1.63*** (0.32)	1.55*** (0.36)
Real value	-4.70*** (0.36)	-4.44*** (0.41)
Long term debt ratio	6.74*** (0.33)	6.59*** (0.37)
Dynamics ROA	0.19*** (0.05)	0.18*** (0.05)
Dummy-control: year	+	+
Dummy-control: industry	+	+
Const	-0.11 (0.89)	0.14 (1.09)

Results: base model (Predictive power)

Predictive power	Logit-model-1		Logit-model-2	
	In-sample (2011-2014)	Out-of-sample (2015)	In-sample (2012-2014)	Out-of-sample (2011 и 2015)
Observations	10148	2603	7721	5030
Frequency, %	448 (4.4%)	161 (6.2%)	357 (4.6%)	252 (5.0%)
Log Likelihood	-1049.82	-1049.82	-835.74	-835.74
AUC	**0.93**	**0.933**	**0.931**	**0.935**
Error II ("false alarm")	0.158	0.133	0.132	0.133
Error I ("skip goal")	0.116	0.131	0.141	0.129
Average error	**0.137**	**0.131**	**0.136**	**0.131**
Cut-off point	0.0616	0.0531	0.0543	0.0425

Results: corporate governance

	H1	H2	H3	H4(I)	H4 (II)	H4(III)	H4(IV)	H5
Expectations of CEOs	**-0.19*** (0.04)**							
CEO owner		**-1.24*** (0.28)**						
Board size			**-0.50*** (0.19)**					
Ownership concentration				**0.68** (0.27)**				
Low concentration					-0.11 (0.33)			
Medium concentration						**-0.53* (0.27)**		
High concentration							**0.39* (0.22)**	
Private								**-0.59*** (0.15)**
Base model: financial data	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Const	0.04 (1.07)	0.88 (1.08)	0.23 (1.07)	-0.48 (1.08)	0.04 (1.06)	0.12 (1.07)	-0.28 (1.08)	0.92 (1.08)
Dummy-control: year	+	+	+	+	+	+	+	+
Dummy-control: industry	+	+	+	+	+	+	+	+

Results: corporate governance

Out-of-sample (2011 and 2015)

Predictive power	H1	H2	H3	H4(I)	H4 (II)	H4(III)	H4 (IV)	H5
Observations	5030	5030	5030	5030	5030	5030	5030	5030
Frequency, %	252 (5.0%)	252 (5.0%)	252 (5.0%)	252 (5.0%)	252 (5.0%)	252 (5.0%)	252 (5.0%)	252 (5.0%)
Log Likelihood	-845.45	-832.2	-841.8	-842.2	-845.3	-843.4	-843.7	-837.4
AUC	**0.945**	**0.944**	**0.944**	**0.942**	**0.942**	**0.942**	**0.942**	**0.941**
II: “False alarm"	0.143	0.099	0.135	0.151	0.143	0.142	0.142	0.123
I: “Skip goal"	0.109	0.157	0.114	0.104	0.109	0.103	0.104	0.142
Average error	**0.126**	**0.128**	**0.124**	**0.128**	**0.125**	**0.123**	**0.123**	**0.133**
Cut-off point	0.1194	0.0838	0.1159	0.1266	0.1201	0.1256	0.1257	0.0943

Cross-validation

1000 iterations	Marginal effects	VIF	Sign	Significance at 10% level
Ln Revenue	-0.001	1.17	(-) 1000	999
ROA	-0.024	1.43	(-) 1000	1000
Net working capital	-0.039	2.51	(-) 1000	1000
|Z_A|	0.011	1.28	(+) 1000	1000
Real value	-0.027	2.15	(-) 1000	1000
Lt debt ratio	0.040	2.69	(+) 1000	1000
Dynamics ROA	0.001	1.55	(+) 1000	971
Expectations of CEOs	-0.001	2.33	(-) 1000	979
CEO owner	-0.005	1.05	(-) 1000	1000
Private	-0.003	1.14	(-) 1000	980
Const	0.009		(+) 901	23

Take away

- Factors of corporate governance and expectations are significant in models of NNW probability (case: Russian manufacturing):
  - If Expectations of CEOs is higher – prob. of NNW is lower
  - If CEO also is owner – prob. of NNW is lower
  - If number of co-owners is higher – prob. of NNW is lower
  - If High concentration (>50%) – prob. of NNW is higher (Moreover, it is can be like U-shape dependence)
  - If company is private – prob. of NNW is lower

Thank you for your attention!

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Cross-validation - 2

Cross-validation: 0.75 (training)/0.25 (test)	AUC (1000 iterations)	Gini (1000 iterations)
Max value	0.962	0.924
Min value	0.906	0.813
Mean value	0.934	0.867
Median value	0.934	0.868