Result of the Large Corporate Scorecard

22/6/2014

Large Corporate (LC) Model Development

Observation Window | **Performance Window**

09/2011 ········· 08/2012 | 09/2012 ········ 08/2013

1 Year
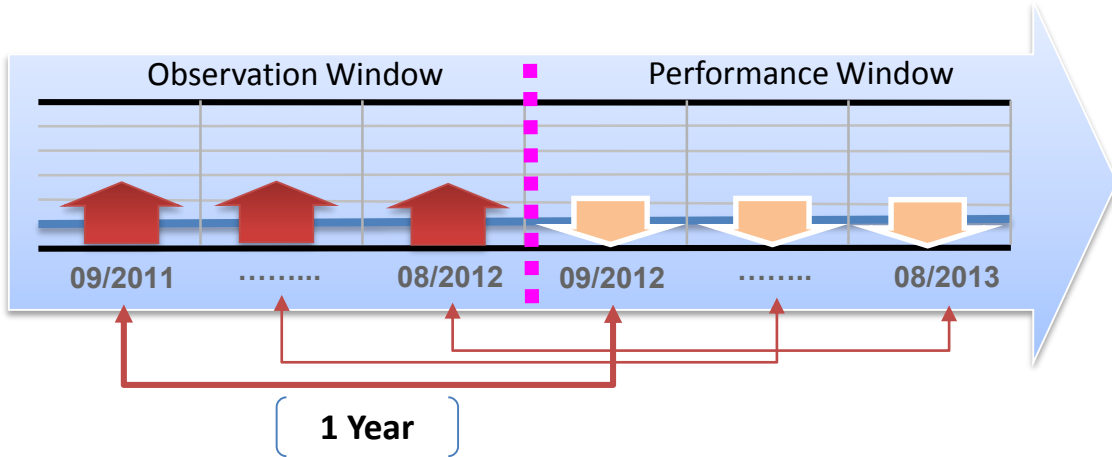
We define observation window from 01/09/2011 to 31/08/2012 and performance window from 01/09/2012 to 31/08/2013. We fix the performance duration for 12 months, that means when we develop the Large Corporate (LC) model, we are estimating the probability of default within 12 months.

Large Corporate Sample (One year FS)

#Good	904
#Bad	57
Total Sample	961

After we select the relevant data according to our definition of observation window (E.g. Select only those financial statement within our observation window) we come up with sample size above;

Accounting Relationship Checking

We check totally 30 accounting relationship in our data set. We exclude those observation which violate the accounting relationship to enhance the correctness of our data. Find the accounting relationship checking rules below:

Accounting Relationship

Final LC Development Data (One year FS)

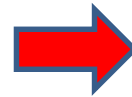|	
#Good	875
#Bad	56
Total Sample	931

After checking accounting relationship, we found 30 observation does not match the accounting relationship; 1 of them are bad customer and 29 of them are good.

Clarity in Complexity

Example of Transformation: Logistic Transformation
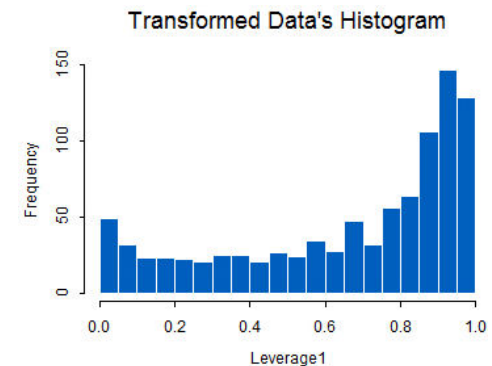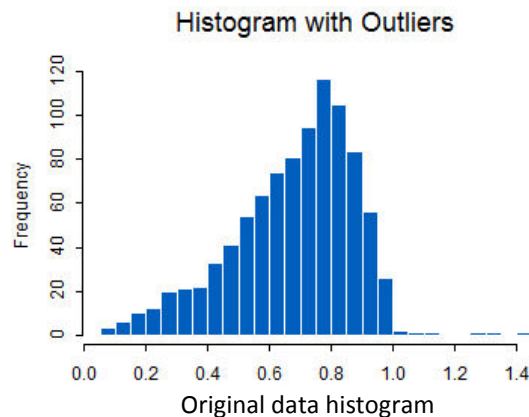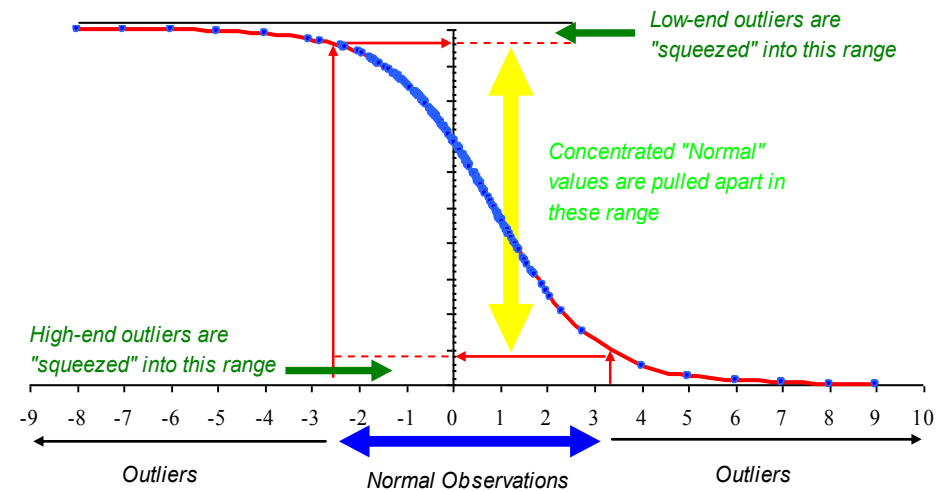
Treatment of Outliers

Original Data → Include Outliers to Data Analysis →

For continuous factors, score transformation is a mathematical function that maps a ratio into a score

➤ This determines the range of values over which the factor has most impact

➤ It also allows for smoothing of noise in the data

Low-end outliers are "squeezed" into this range

Concentrated "Normal" values are pulled apart in these range

High-end outliers are "squeezed" into this range

-9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Outliers — Normal Observations — Outliers

Original data histogram

Logistic transformation to make the data scale from 0 to 1

List of Candidates Shortlisted by Single-factor Analysis
Refer to Excel File [*Financial Ratio List v1.0*]

LC Candidate List

Return		Profitability		Efficiency		Liquidity		DSCR		Leverage	
Return1	34.92%	Profitability2	20.80%	Efficiency1	29.31%	Liquidity1	20.32%	DSCR1	28.01%	Leverage1	27.68%
Return3	29.62%	Profitability3	19.18%	Efficiency2	29.06%	Liquidity3	20.32%	DSCR2	31.53%	Leverage2	34.53%
Return5	35.48%	Profitability4	20.13%	Efficiency3	26.00%	Liquidity4	23.14%	DSCR3	33.10%	Leverage3	27.86%
Return7	30.75%	Profitability13	19.98%	Efficiency4	31.04%	Liquidity11	27.31%	DSCR5	39.11%	Leverage4	21.13%
Return11	28.81%	Profitability14	13.06%	Efficiency6	21.69%	Liquidity12	12.42%	DSCR6	34.71%	Leverage5	26.43%
Return12	26.97%			Efficiency7	30.99%	Liquidity13	19.58%	DSCR7	33.03%	Leverage6	24.18%
Return13	30.60%			Efficiency8	32.24%	Liquidity16	17.87%	DSCR8	37.98%	Leverage7	32.42%
Return13n	33.94%					Liquidity17	26.71%	DSCR9	30.62%	Leverage8	23.51%
Return14	25.51%					Liquidity20	17.51%	DSCR10	24.61%	Leverage9	23.54%
Return14n	22.96%							DSCR12	33.74%	Leverage10	25.54%
Return15	18.65%							DSCR18	27.89%	Leverage18	20.74%
Return16	17.17%							DSCR19	22.13%	Leverage19	22.41%
Return17	21.63%							DSCR20	26.86%	Leverage20	23.38%
Return18	28.40%							DSCR21	33.56%	Leverage21	24.18%

- All financial ratios are calculated based on one year financial statement data.
- Note that because we only use one-year financial statement data, this will affect the natural formula for original BPF DSCR. (E.g. No depreciation)
- No Size risk factors pass the Single-factor Analysis
- Here we only take absolute value of AR

FS Ratio

Clarity in Complexity

CIC Variables Results

CIC variables list

CIC1	Months of oldest bank contract
CIC2	Month of youngest bank contract
CIC3	Inquiry times in last 12 months
CIC4	Inquiry times in last 6months
CIC5	Inquiry times in last 3months
CIC6	Q1:When was the borrowing company founded? (day/month/year)
CIC7	Q16:What is the number of lenders outstanding from the CIC form?
CIC8	Q17:How much is the company's total oustanding lending balance from CIC form?
CIC9	Q18:Has the borrowing company had overdue debts in any credit institutions in the last 12 months? (DPD more than 90 days) YES/NO/NA
CIC10	Geography Information
CIC11	Has the customer at observation point has debts in group 2 or not?
CIC12	How many times a customer have debts in group 2 in the past 12 months from observation point?
CIC13	How many months since the latest debts in group 2 the customer have?

CIC 2 recorded high missing in SME/MSME, for security of data availability we do not recommend

CIC8, CIC 13 are dropped after correlation analysis (see next page)

Variable	AR	% Miss
CIC1	-7.49%	12.5%
CIC2	31.29%	12.5%
CIC3	4.48%	0.0%
CIC4	10.00%	0.4%
CIC5	8.88%	2.6%
CIC6	-3.01%	2.6%
CIC7	-35.32%	0.0%
CIC8	-35.27%	0.0%
CIC9	67.61%	0.0%
CIC10	34.14%	0.0%
CIC11	-44.29%	0.0%
CIC12	-55.82%	0.0%
CIC13	55.12%	0.0%

Factors have low AR will not be used in the model

VPB suggested to exclude due to operational consideration

We propose CIC9, CIC11 and CIC12 to be knock-out (KO) factor (see next page)

Clarity in Complexity

Correlation Analysis

Pearson Correlation Analysis

	CIC7	CIC8	CIC11	CIC12	CIC13
CIC7	1	0.54			
CIC8	0.54	1			
CIC11			1	0.55	-0.75
CIC12			0.55	1	-0.70
CIC13			-0.75	-0.70	1

Since CIC7 is chosen as risk factor to enter the model, CIC8 can be forgone from the **high positive correlation** to CIC7 as shown above (0.54).

We see that CIC13 has very **high negative correlation** with CIC11 and CIC12 respectively (-0.75, -0.70), hence CIC13 can be forgone as it provides similar information as CIC11 and CIC12.

We propose CIC11 and CIC12 to be KNOCK-OUT (KO) factors given their high AR.

CIC 9 is directly proposed as KO factor, it has 67% AR, which is the highest among all variables.

KNOCK-OUT (KO) FACTOR

- **KO1: CIC9 (Has the customer had DPD more than 90days in the p12m?)**

- **KO2: CIC11 (Does the customer at observation point have any debts in group 2 or not?)**

- **KO3: CIC12 (How many times of debts in group2 the customer have in the p12m?)**

Clarity in Complexity

Performance of the Selected Model (Highest AR in Multi-factor Analysis) Refer to Excel File [*Large Corp Multiselect*]

New Variables	Formula	Weight (Abs.)
Return14n	(Operating Income+Investment Income)/Equity	15.1%
Profitability13	Profit after tax/COGS	18.3%
Efficiency3	Accounts Receivable*365 / Sales	19.3%
Liquidity4	Working Capital / total Assets	7.1%
DSCR9	(cash+cash equivalents +short-term receivables+inventories)/(total debt+interest expenses)	15.1%
Leverage10	Total Debt / (Total Equity+Long Term Liabilities)	11.6%
CIC7	What is the number of lenders outstanding from the CIC form?	14.6%

AR:51.13%

* Size risk factors disappear in this model as no one of them pass the tests of Single-factor Analysis

Weight of the Model

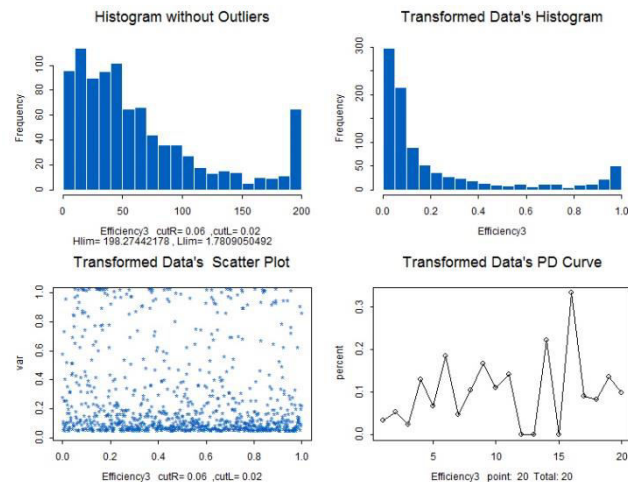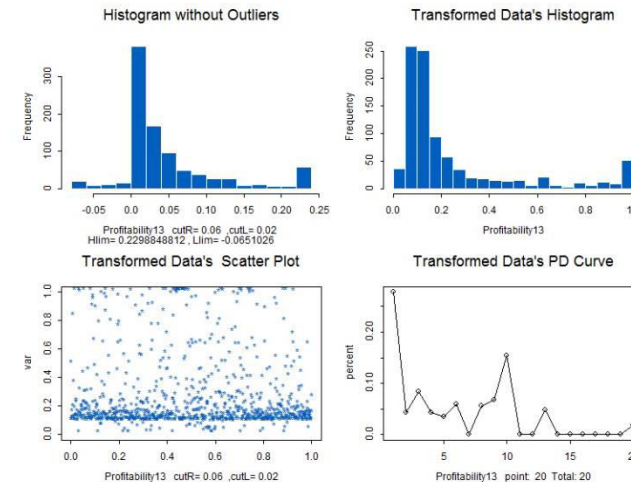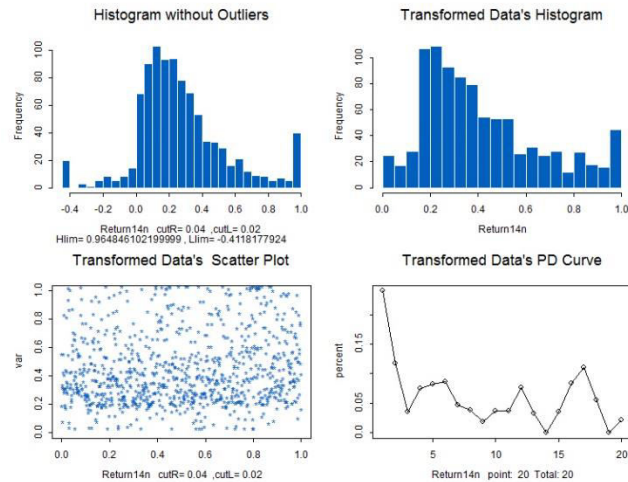Quantitative (85%)
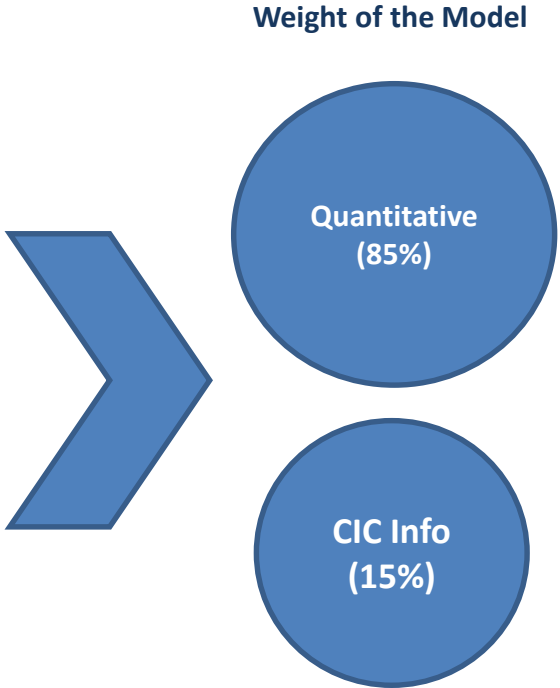
CIC Info (15%)

The weight of CIC Information (CIC7) in this model is only 15%, we don't need to cap it to 30% in weight adjustment (but still other kinds of adjustment will be tried, e.g. rounding)

Large Corp Multiselect

VPBank
Vietnam Prosperity Bank

Clarity in Complexity
ENTROFINE

Return14n

(Operating Income+Investment Income)/Equity

Profitability13

Profit after tax/COGS

Efficiency3

Accounts Receivable*365 / Sales

Clarity in Complexity

Average PD Trend and Distribution of Selected Financial Ratio in Final LC Model (2/3)
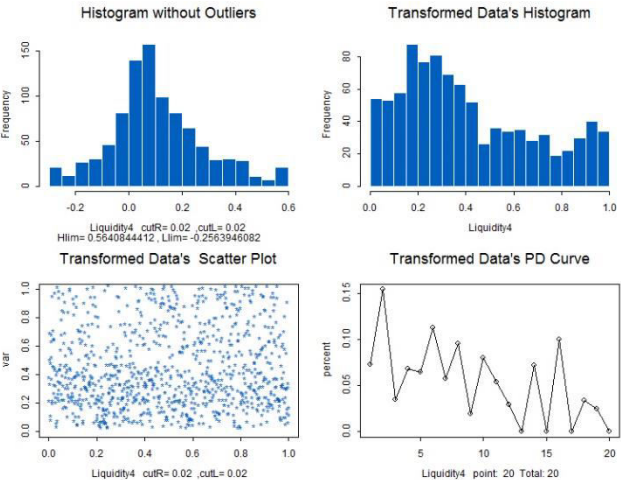
Liquidity4

Working Capital / total Assets
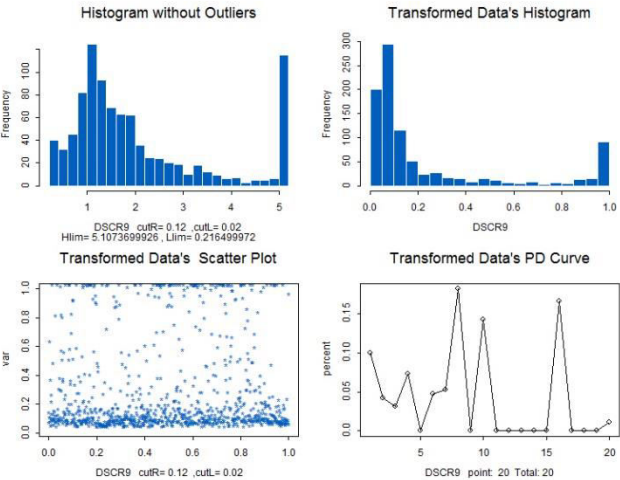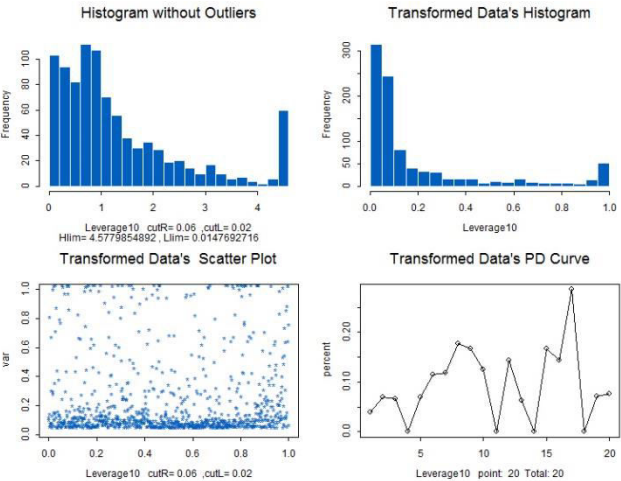
DSCR9

(cash+cash equivalents +short term receivables+inventories)/(total debt+interest expenses)

Leverage10

Total Debt / (Total Equity+Long Term Liabilities)

Average PD Trend and Distribution of Selected CIC Variable in Final LC Model (3/3)

Distribution and Avg.BR for CIC7
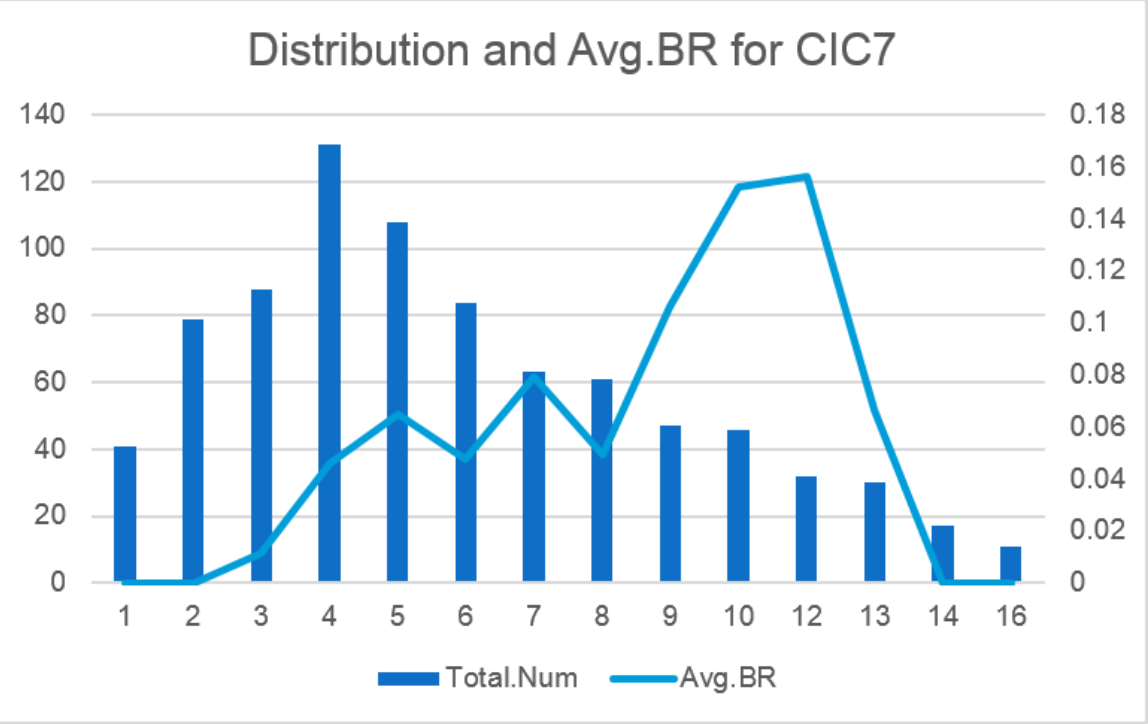
CIC7 (What is the number of lenders outstanding from the CIC form?)

The chart clear shows the distribution of number of lenders outstanding from CIC form, it is right-skewed. The average bad rate trend is very clearly increasing in number of lenders up to 12. The zero bad rates observed for number of lenders equal to 14 and 16 are not reliable statistics to the population bad rates because the sample size in these numbers of lenders drop significantly to below 20, they are too small and so not enough to get enough observable bad counts for valid estimation.

Hence we conclude in average, the bad rate has an increasing trend in CIC7.

Clarity in Complexity

ENTROFINE

Cross Validation to Test Model Stability

Model Cross Validation
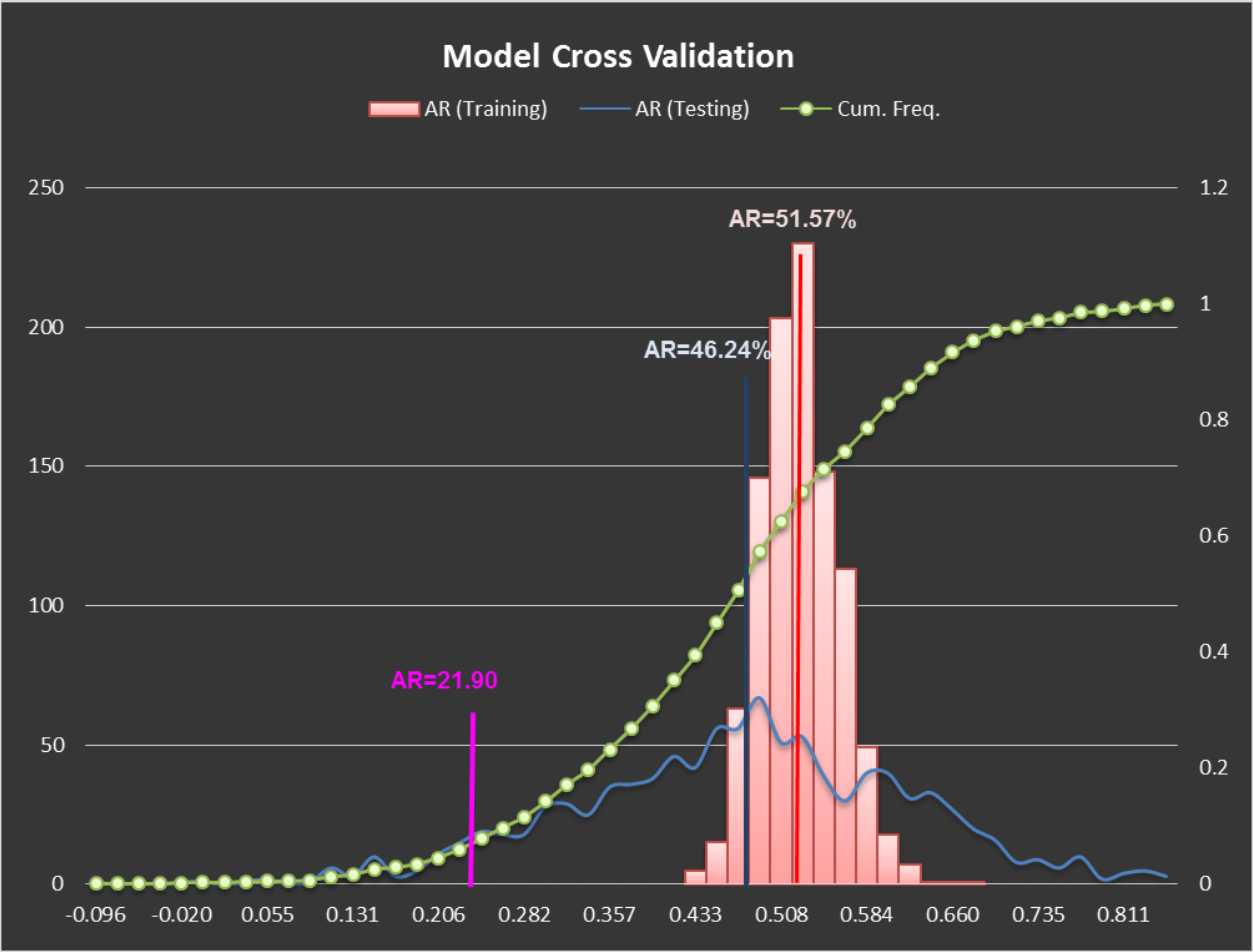
	AR(Training)	AR(Testing)
5th Pctl	46.20%	21.90%
Average	51.57%	46.24%
95th Pctl	57.30%	69.15%

After we conduct 1000 times cross-validation and check the variability of AR, we find that the model for selected financial ratios is stable. We have 90 percent chance the AR being in the range of 21.90% to 69.15%.

Cross Validation to Test Model Stability (Cont'd)
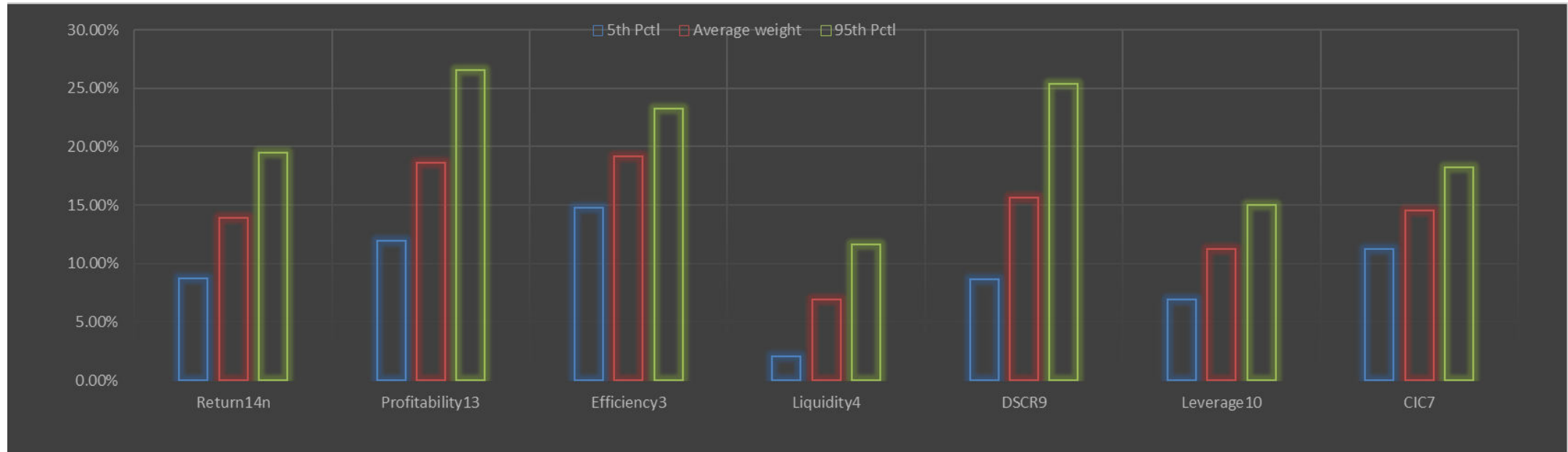
	Return14n	Profitability13	Efficiency3	Liquidity4	DSCR9	Leverage10	CIC7
min	1.87%	6.05%	7.77%	0.03%	4.67%	1.90%	7.41%
5th Pctl	8.71%	11.95%	14.80%	2.02%	8.67%	6.90%	11.23%
Mean	13.92%	18.58%	19.20%	6.90%	15.62%	11.23%	14.55%
95th Pctl	19.51%	26.55%	23.26%	11.66%	25.37%	15.04%	18.20%
max	29.71%	36.79%	27.54%	16.79%	40.13%	17.98%	26.09%
STD	3%	5%	3%	3%	5%	2%	2%

The weight for each ratio is also quite stable.

Weight Adjustment Methods

Weight Adjustment Methods

1 — Original

Quantitative (Weight base on analysis)

CIC (Weight base on analysis)

Quantitative (85.41%)			CIC (14.59%)
Return14n (14.05%)	Profitability13 (18.31%)	Efficiency3 (19.33%)	CIC7 (14.59%)
Liquidity4 (7.06%)	DSCR9 (15.09%)	Leverage10 (11.57%)	

2 — Rounding to Integral%

Quantitative (Weight adjust after cap on CIC factor and round to nearest integral%)

CIC (Cap to 30% or less and round to nearest integral%)

Quantitative (85%)			CIC (15%)
Return14n (14%)	Profitability13 (18%)	Efficiency3 (19%)	CIC7 (15%)
Liquidity4 (7%)	DSCR9 (15%)	Leverage10 (12%)	

3 — Rounding to Multiples of 5%

Quantitative (Weight adjust after cap on CIC factor and around to the nearest 5%)

CIC (Cap to 30% or less and around to the nearest 5%)

Quantitative (85%)			CIC (15%)
Return14n (15%)	Profitability13 (20%)	Efficiency3 (20%)	CIC7 (15%)
Liquidity4 (5%)	DSCR9 (15%)	Leverage10 (10%)	

Results Based on Different Weight Adjustment Methods

1 Original

Cumulative Accuracy Profile

— New Model — Random.Model — Perfect.Model

AR 51.13%

2 Integral Percentages

Cumulative Accuracy Profile

— New Model — Random.Model — Perfect.Model

AR 51.20%

3 Multiples of 5%

Cumulative Accuracy Profile

— New Model — Random.Model — Perfect.Model

AR 51.23%
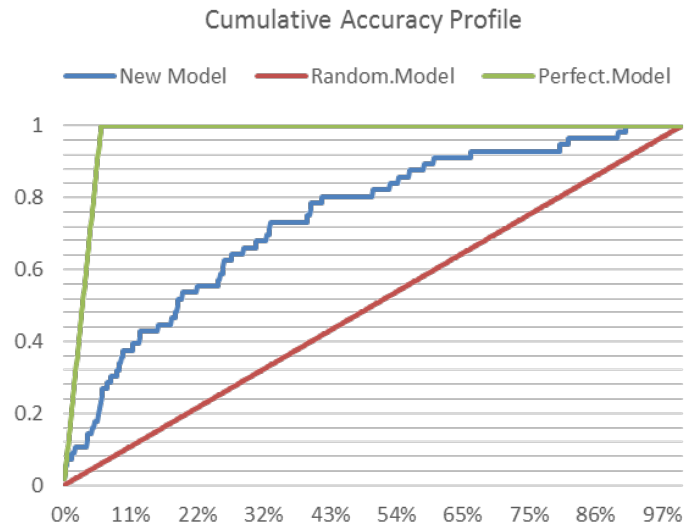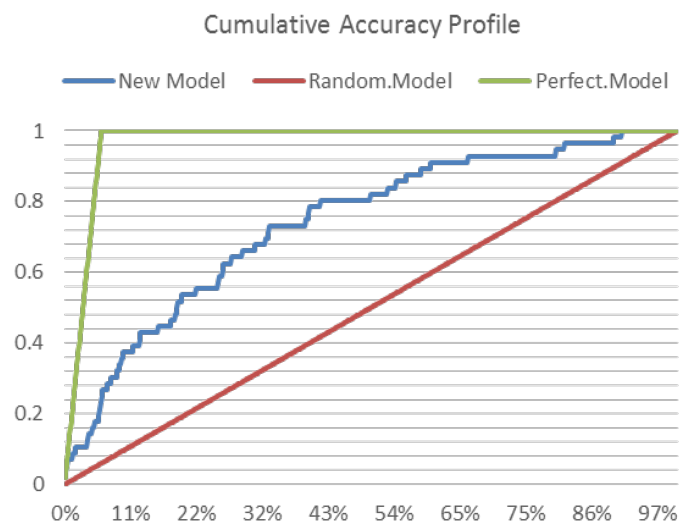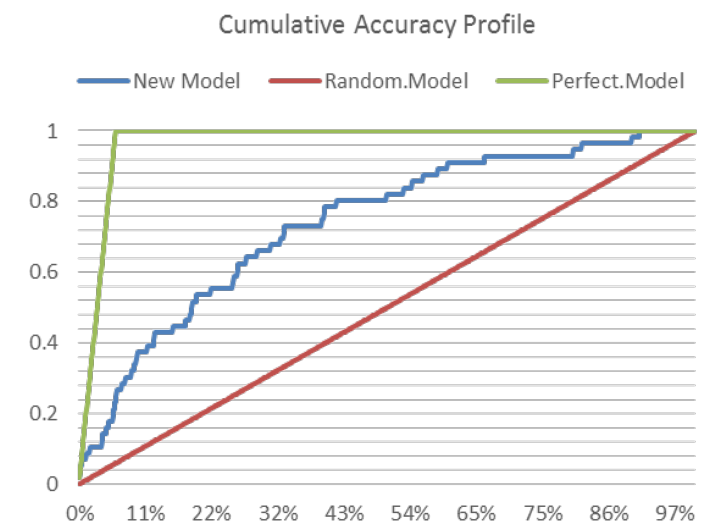
Performance of the Whole Credit Approval System Including KO Factors

KO1

CIC9: Whether the customer have DPD more than 90 days in the p12m or not?

YES — NO

Score=Minimum

KO2

CIC11: Whether the customer currently have debt on group2 or not?

YES — NO

Score=Minimum

KO3

CIC12: Number of times of debt in group2 more than 2 or not?

YES — NO

Score=Minimum — Apply Scorecard to get Score
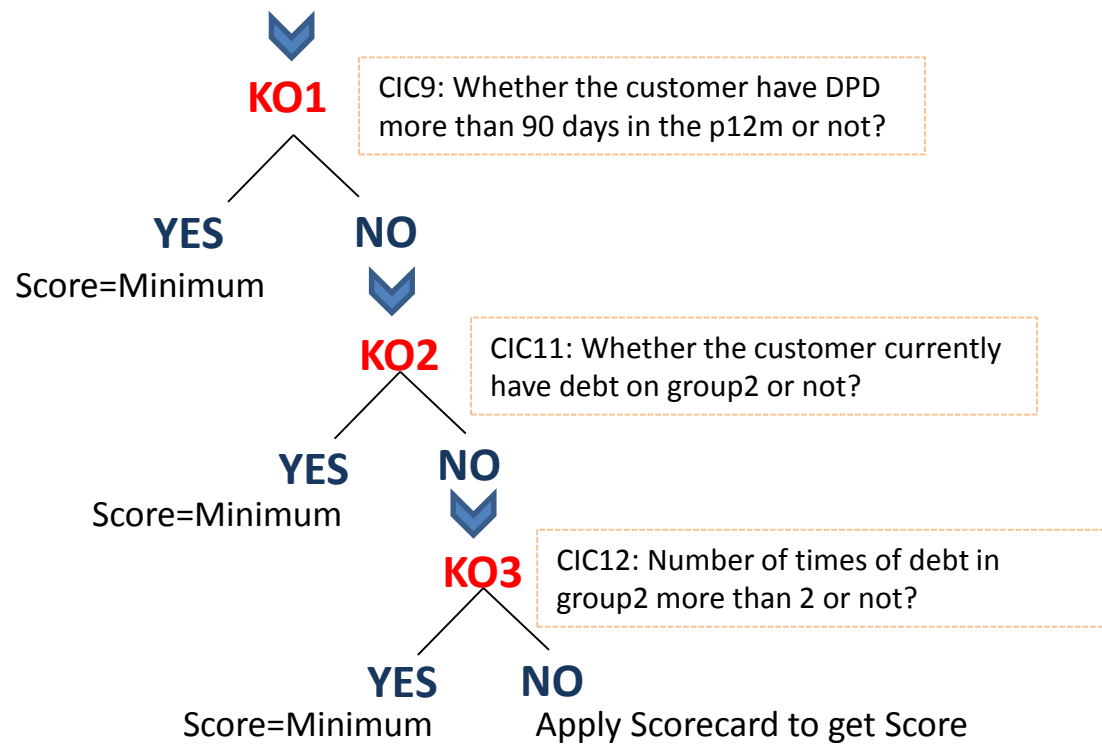
Large Corporate Credit Approval System

Cumulative Accuracy Profile

— New Model — Random.Model — Perfect.Model
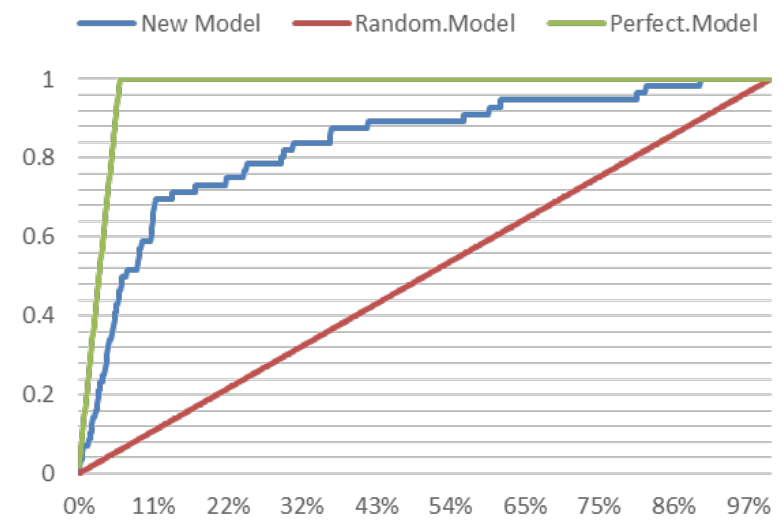
AR 70.26%

By assigning minimum score to those customers knocked-out by CIC9, CIC11, CIC12, we can assess the overall performance of the credit approval system (3 KO factors + scorecard). As a result, we get over 70% of AR.

VPBank
Vietnam Prosperity Bank

Clarity in Complexity
EntroFine

Effects of Using Different Sets of KO Factors

	CIC9	CIC11	CIC12	AR
None				51.23%
1 KO Factor	X			73.09%
		X		60.35%
			X	58.78%
2 KO Factors	X	X		71.80%
	X		X	73.13%
		X	X	59.43%
3 KO Factors	X	X	X	70.26%

Instead of using all of CIC9, CIC11 and CIC12 as the KO factors, using a selective combination of them is also possible. And when we choose different combinations of them, we can achieve different degree of discriminatory power (AR) of the resulting credit approval system.

From the previous 2 slides, we already know the scorecard itself has AR equal to 51.23%, which is the same as the credit approval system when no KO-factors are used; if all of 3 KO factors are used, AR will be 70.26%.

The combination which gives the highest AR (73.13%) to the credit approval system is to use CIC9 and CIC12 as KO factors (highlighted in light blue).

VPBank Vietnam Prosperity Bank

Clarity in Complexity

ENTROFINE

Long Run Average PD

Default Rate By Sement
(have segment info)
Legend: MSME, SME, LC

Yearly Default Rate
Legend: ALL, HAVE SEGMENT INFO
- 2009: ALL 1.59%, HAVE SEGMENT INFO 1.46%
- 2010: ALL 1.81%, HAVE SEGMENT INFO 2.77%
- 2011: ALL 2.95%, HAVE SEGMENT INFO 4.81%
- 2012: ALL 9.00%, HAVE SEGMENT INFO 13.46%
- 2013: ALL 13.08%, HAVE SEGMENT INFO 20.47%

Adjusted PD by Segment
Legend: MSME, SME, LC, SME*

Step 1	Step 2	Step 3	Step 4
Calculate Log-odds of PD Series for each segment and Overall Sample that have Segment Info	Calculate the relative log-odds of each segment to the Overall Sample that have Segment Info	Use the relative Log-odds multiplied by Log-odds of whole portfolio (with and without segment info)	Calculate the Adjusted PD from the adjusted Log-odds

Clarity in Complexity

Long Run Average PD (Cont'd)

	Non-Adjusted PD					
Year	MSME	SME	LC	NO INFO	ALL	HAVE SEGMENT INFO
2009	1.52%	0.89%	0.00%	1.62%	1.59%	1.46%
2010	2.97%	0.78%	0.00%	1.60%	1.81%	2.77%
2011	5.19%	1.28%	0.00%	2.60%	2.95%	4.81%
2012	13.39%	14.38%	11.76%	7.90%	9.00%	13.46%
2013	19.93%	27.48%	8.33%	11.47%	13.08%	20.47%
AVERAGE	8.60%	8.96%	4.02%	5.04%	5.69%	8.59%

	Adjusted PD		
Year	MSME	SME	LC
2009	1.66%	0.99%	0.00%
2010	1.96%	0.43%	0.00%
2011	3.23%	0.61%	0.00%
2012	8.93%	9.81%	7.55%
2013	12.56%	20.52%	3.40%
AVERAGE	5.67%	6.47%	2.19%

The Long Run Average PD used for the Large Corporate scorecard is 3.0 %

(we round up to 3% for conservativeness and it is consistent to our experience)

Clarity in Complexity

PD Calibration and Rating Master Scale

After we estimate the long run average PD (CT), we calibrate our PD by scaled logistic method.

Scaled Logistic Method

$$PD_i = \frac{1}{1 + \kappa \exp(-\alpha - \beta \times score_i)}$$

$$\kappa = \frac{1 - CT}{CT} \cdot \frac{B}{G}$$

After we get the calibrated PD, we map to the corresponding internal ratings (Level 1 & Level 2) and external ratings (S&P, Moody's) by the rating master scale we designed.
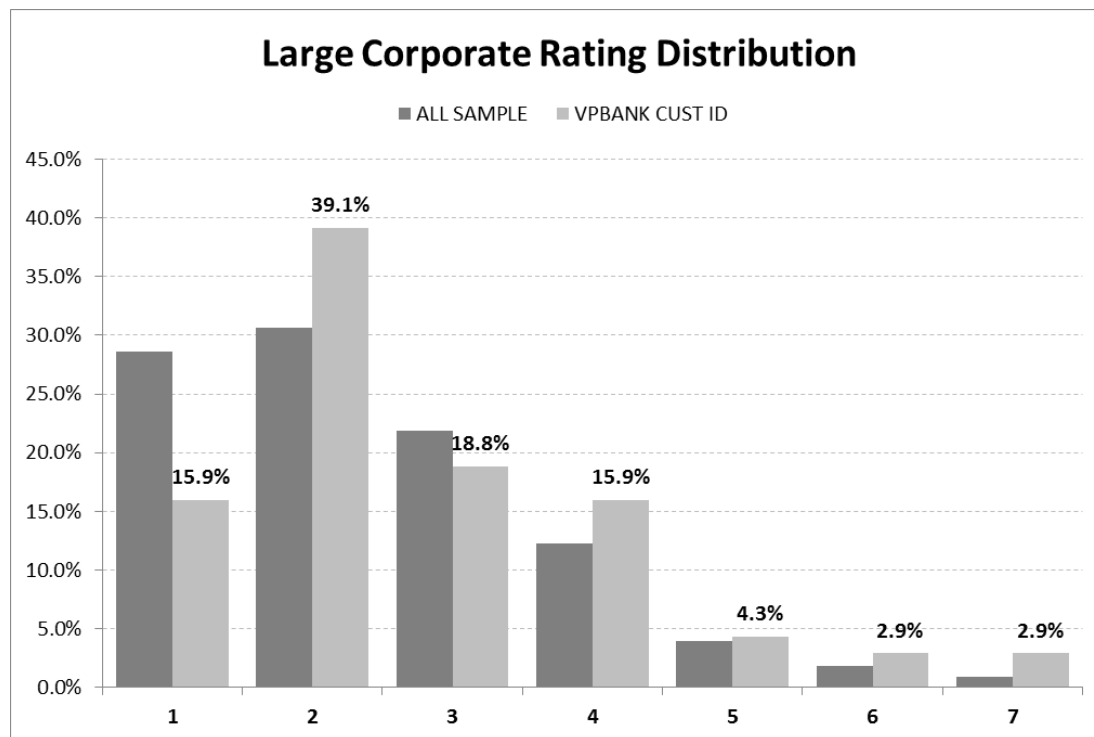
RATING MASTER SCALE

Internal Ratings		S&P Ratings	Moody's Ratings	PD Range (Level 1 Rating Scale)			PD Range (Level 2 Rating Scale)		
Level 1	Level 2			PD-Low	PD-Mid	PD-High	PD-Low	PD-Mid	PD-High
1	1.1	BB+ or above	Ba1 or above	0.00%	0.88%	1.19%	0.00%	0.57%	0.72%
	1.2	BB	Ba2				0.72%	0.90%	1.19%
2	2.1	BB-	Ba3	1.19%	1.96%	2.64%	1.19%	1.57%	1.87%
	2.2						1.87%	2.22%	2.64%
3	3.1	B+	B1	2.64%	3.56%	4.66%	2.64%	3.14%	3.59%
	3.2						3.59%	4.09%	4.66%
4	4.1	B	B2	4.66%	5.94%	7.70%	4.66%	5.31%	6.02%
	4.2						6.02%	6.81%	7.70%
5	5.1	B-	B3	7.70%	9.64%	12.46%	7.70%	8.70%	9.82%
	5.2						9.82%	11.07%	12.46%
6	6.1	CCC+	Caa1	12.46%	15.49%	19.35%	12.46%	13.99%	15.62%
	6.2						15.62%	17.41%	19.35%
7	7.1	CCC or below	Caa2 or below	19.35%	24.37%	100.00%	19.35%	21.46%	23.76%
	7.2						23.76%	26.23%	100.00%
8	8.1	Default Grade		100%			100.0%		
	8.2								
	8.3								

VPBank
Vietnam Prosperity Bank

Clarity in Complexity
ENTROFINE

Rating Distributions

After mapping the calibrated PD to ratings, we can plot the rating distributions. We see more than 90% of VPBank LC customers get the Level 1 ratings 1 – 4. The mode of the Level 1 rating of VPBank LC customers is 2, which corresponds to BB- of S&P ratings, which is consistent to the current country rating of Vietnam rated by S&P.

Level 1 Ratings

Level 2 Ratings