

The model brief: the decision, the population and the definition

Chapters 1 to 6. Written and dated before any model is fitted. Every later figure is only as good as this page.

Lender		Prepared by	
Portfolio		Date	

Item	Brechin	Yours
The decision the model informs	Accept or decline a small-business loan application at a score cut-off	
Definition of bad	Ninety or more days past due within eighteen months of drawdown; fixed first, never varied	
Development sample	6,000 applications, 2015-2019: 379 bad, 6.3167 per cent	
Out-of-time sample	2,400 applications, 2020-2021: 303 bad, 12.6250 per cent	
Through the door	8,400 applications: 682 bad, 8.1190 per cent	
Declined by the previous policy, and is their outcome known?	3,230; known here, never known in practice	
Characteristics available at the decision	Seven: age of business, debt service cover, net debt / EBITDA, sector, worst county court judgment, bank conduct score, loan to value	
Characteristics excluded, and why	Days past due at month three: populated three months after the money is lent	
The points scale	20 points to double the odds; 600 points at 50 to 1	
Unit economics of one loan	185,000 of exposure, 4.12 per cent margin, 41.7 per cent loss given default, 640 of cost	
What is carried rather than computed, and why	Eight fitted coefficients (no regression in a spreadsheet); the order of 180 boosted trees	

Four questions to settle before fitting	Answered?	Where it is written
Before the first model		
Is the definition of bad written down, dated, and the same for every sample?		
Is the out-of-time sample held back from every choice, the bins included?		
Is each field's population date checked against the decision date?		
Is the price of a wrong decision known, so that a cut-off can be priced?		

If the definition of bad changes, the book changes: every count, weight, point and profit downstream is a different number.

The characteristic review: availability, information value, verdict

Chapters 1 to 6. One line per candidate field. The verdict bands are the book's: under 0.02 unusable, 0.10 weak, 0.30 medium, 0.50 strong, above that suspicious.

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Characteristic	Known at decision?	Bins	Information value	Verdict	Your IV	Include?
Age of business (months)	Yes	5	0.0201	weak		
Debt service cover	Yes	5	0.2002	medium		
Net debt / EBITDA	Yes	5	0.1082	medium		
Sector	Yes	6	0.1208	medium		
Worst CCJ	Yes	4	0.2471	medium		
Bank conduct score	Yes	5	0.0831	weak		
Loan to value	Yes	5	0.0293	weak		
Days past due at month three	No: month three	4	2.8606	suspiciously strong: exclude		

Test	Brechin	Yours
Strongest usable field, and its information value	Worst CCJ, 0.2471	
Any field above 0.5? Its multiple of the strongest usable one	Days past due at month three: 2.8606, 11.58 times	
Fields below 0.02, dropped	None; age of business sits just above at 0.0201	

A field that strong is a field that is not available when the decision is taken. Check the date before the statistic.

The bin table: one characteristic, built from counts

Chapters 1 to 6. Weight of evidence is $\text{LN}(\text{share of goods} / \text{share of bads})$; the information value is the column of $(\text{share of goods} - \text{share of bads}) \times \text{weight}$; points are $\text{minus coefficient} \times \text{weight} \times \text{factor}$.

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Bin	Goods	Bads	n	Bad rate %	Share of goods %	Share of bads %	Weight of evidence	IV part	Points
Brechin: debt service cover, development 2015-2019, coefficient -1.0890									
<1.00	893	106	999	10.61	15.89	27.97	-0.5656	0.0683	-17.77
1.00-1.24	1,007	97	1,104	8.79	17.91	25.59	-0.3567	0.0274	-11.21
1.25-1.49	1,204	73	1,277	5.72	21.42	19.26	0.1062	0.0023	3.34
1.50-1.99	1,988	89	2,077	4.29	35.37	23.48	0.4095	0.0487	12.87
2.00+	529	14	543	2.58	9.41	3.69	0.9352	0.0535	29.39
Total	5,621	379	6,000	6.32	100.00	100.00	IV	0.2002	

Bin	Goods	Bads	n	Bad rate %	Share of goods %	Share of bads %	Weight of evidence	IV part	Points
Your characteristic									
Total					100.00	100.00	IV		

Test on any bin table	Brechin	Yours
Shares of goods and of bads each add to 100	Yes	
Bad rate moves one way across ordered bins	Yes: 10.61 down to 2.58	
No bin with no goods or no bads (the logarithm fails)	None	
Every bin holds enough cases to trust its rate	Smallest bin 543	

The points table: the scale, and the card it produces

Chapters 1 to 6. The factor and offset are derived, not typed: factor = points to double the odds / LN(2); offset = anchor score - factor x LN(anchor odds).

Lender		Prepared by	
Portfolio		Date	

Scale	Brechin	Yours
Points to double the odds; anchor score; anchor odds	20; 600; 50 to 1	
Factor	28.8539	
Offset	487.1229	
Intercept of the fit; base score	-2.698320; 564.9799	
Lowest and highest score the card can produce	436.05 and 657.26	

Characteristic	Bin	Points	Characteristic	Bin	Points
Age of business (months)	0-11	-6.83		Professional services	10.61
	12-23	-0.70		Hospitality	-17.32
	24-47	2.93		Transport	5.98
	48-95	8.18	Worst CCJ	None	8.04
	96+	2.19		Over 36m	-3.23
Debt service cover	<1.00	-17.77		12-36m	-20.66
	1.00-1.24	-11.21		Under 12m	-35.95
	1.25-1.49	3.34	Bank conduct score	0-49	-19.20
	1.50-1.99	12.87		50-64	-2.62
	2.00+	29.39		65-74	1.96
Net debt / EBITDA	<1.50	10.66		75-84	7.64
	1.50-2.49	4.99		85-100	14.41
	2.50-3.49	1.64	Loan to value	<0.45	9.29
	3.50-4.49	-4.16		0.45-0.59	1.66
	4.50+	-22.78		0.60-0.74	-0.49
Sector	Manufacturing	12.32		0.75-0.89	-9.08
	Wholesale	0.56		0.90+	-3.12
	Construction	-8.98			

Doubling the points to double the odds doubles every point and moves no bin's rank: the scale is a unit of measurement, not a measurement.

The leakage test: five questions for a field that looks too good

Chapters 1 to 6. Ask them of every field whose information value is above 0.5, before it reaches the model.

Lender		Prepared by	
Portfolio		Date	

#	The question	Days past due at month three	Your field
1	When is the field populated, relative to the decision?	Three months after drawdown	
2	What is its information value against the strongest field known at the decision?	2.8606 against 0.2471: 11.58 times	
3	What does it do to the area under the curve if it goes into the model?	0.7353 to 0.9125	
4	Does its strongest bin describe the outcome itself?	60+ days: 95 of 117 go bad, 81.2 per cent	
5	Is there a use for it that does not decide the loan?	Yes: as a monitoring alarm, read at month three (case three)	

Days past due at month three, development	Goods	Bads	Bad rate %	Weight of evidence	IV part
0	5,085	88	1.70	1.3600	0.9145
1-29	424	94	18.15	-1.1903	0.2054
30-59	90	102	53.12	-2.8219	0.7143
60+	22	95	81.20	-4.1596	1.0264
Total	5,621	379	6.32	IV	2.8606

Sign-off	Name	Date
Field excluded from the card		
Field added to the monitoring pack		

A model that uses tomorrow's information to decide today's loan will validate beautifully and fail on the first application.

The discrimination report, with its population stated

Chapters 7 to 10. Area under the curve by the ranks, Gini and KS, in both cohorts. The score is rebuilt from the points table, not carried.

Lender		Prepared by	
Portfolio		Date	

Measure	Development 2015-2019	Out of time 2020-2021	Yours
Bads; goods	379; 5,621	303; 2,097	
Sum of the ranks of the bads	635,853.5	224,910.0	
U statistic	563,843.5	178,854.0	
Area under the curve	0.735329	0.718513	
Gini	0.470659	0.437027	
KS, and the score at which it is reached	0.341154 at 565.22	0.324311 at 561.06	

Every area under the curve carries its population	Fields	Years	Area	Yours
The card, development	Seven	2015-2019	0.7353	
The card, out of time	Seven	2020-2021	0.7185	
180 boosted trees, development	Seven	2015-2019	0.7651	
180 boosted trees, out of time	Seven	2020-2021	0.7078	
The card with the leaking field (the book's fit)	Eight	2015-2019	0.9125	
Span of the five			0.2047	

An area under the curve without its population, its fields and its year is not a figure. Five correct ones for one model span 0.2047.

The calibration table: ten fixed bands, both cohorts

Chapters 7 to 10. Predicted is the average probability the scores imply; observed is the bad rate seen; the gap is observed less predicted, in percentage points. The boundaries are cut once, on development.

Lender		Prepared by	
Portfolio		Date	

Band	Dev n	Dev predicted %	Dev observed %	Dev gap	OOT n	OOT predicted %	OOT observed %	OOT gap	Your gap
1	600	21.589	22.167	0.578	355	22.219	31.831	9.612	
2	599	10.783	9.516	-1.267	315	10.897	16.190	5.293	
3	601	7.722	6.489	-1.233	308	7.816	13.636	5.820	
4	600	5.914	6.000	0.086	285	5.961	11.579	5.618	
5	600	4.721	5.833	1.112	246	4.768	7.317	2.549	
6	598	3.855	4.013	0.159	203	3.867	7.389	3.522	
7	602	3.127	3.322	0.195	219	3.110	5.936	2.826	
8	600	2.469	2.167	-0.302	179	2.468	5.587	3.118	
9	600	1.850	2.667	0.817	162	1.857	4.321	2.464	
10	600	1.146	1.000	-0.146	128	1.197	0.781	-0.416	
All	6,000		6.317		2,400		12.625		

Reading	Brechin	Yours
Bands under-predicted out of time	Nine of ten	
Largest under-prediction, points	9.612, band 1	
Area under the curve, development to out of time	0.735329 to 0.718513	
Development bands on the fixed boundaries	600, 599, 601, 600, 600, 598, 602, 600, 600, 600: three tied goods move	

The ranking barely moves; the level moves a great deal. A model is signed off on two numbers, not one.

The recalibration memo: one number, and what it cannot do

Chapters 7 to 10. A single shift in the intercept, solved so the out-of-time predictions average to the observed rate.

Lender		Prepared by	
Portfolio		Date	

Line	Brechin	Yours
Observed bad rate the shift must reach	12.625 per cent	
Mean predicted before the shift	7.9007 per cent	
Intercept shift, log-odds; in points	0.573620; 16.55	
A cut-off of 550, restated to mean what it meant	566.55	
Largest under-prediction before and after the shift	9.612 and 1.470	
Bands still under-predicted after the shift; largest over-prediction	6; 1.629	

Band	OOT n	Observed %	Predicted after %	Gap after	Gap before	Your gap after
1	355	31.831	32.884	-1.053	9.612	
2	315	16.190	17.819	-1.629	5.293	
3	308	13.636	13.075	0.561	5.820	
4	285	11.579	10.109	1.470	5.618	
5	246	7.317	8.160	-0.843	2.549	
6	203	7.389	6.662	0.727	3.522	
7	219	5.936	5.389	0.547	2.826	
8	179	5.587	4.298	1.288	3.118	
9	162	4.321	3.249	1.072	2.464	
10	128	0.781	2.104	-1.322	-0.416	

Decision	Signed	Date
Apply the shift and restate the cut-off		
Rebuild instead: the shape is wrong, not only the level		

The shift repairs the level on average. It cannot repair the shape: the top band's gap widens from 0.416 to 1.322 points.

The stability report, on the development boundaries

Chapters 11 and 12. Each term is $(\text{new share} - \text{old share}) \times \text{LN}(\text{new share} / \text{old share})$. The boundaries are never recut: recutting puts ten per cent in every band and the index reads zero whatever happened.

Lender		Prepared by	
Portfolio		Date	

Band	From	To	Dev n	Dev share %	OOT n	OOT share %	LN ratio	Term	Your term
1	lowest	541.82	600	10.00	355	14.79	0.3915	0.018758	
2	541.82	554.02	599	9.98	315	13.12	0.2736	0.008596	
3	554.02	563.04	601	10.02	308	12.83	0.2478	0.006980	
4	563.04	570.66	600	10.00	285	11.88	0.1719	0.003222	
5	570.66	577.01	600	10.00	246	10.25	0.0247	0.000062	
6	577.01	583.02	598	9.97	203	8.46	-0.1641	0.002475	
7	583.02	589.67	602	10.03	219	9.12	-0.0949	0.000862	
8	589.67	597.27	600	10.00	179	7.46	-0.2933	0.007454	
9	597.27	607.38	600	10.00	162	6.75	-0.3930	0.012774	
10	607.38	highest	600	10.00	128	5.33	-0.6286	0.029335	
Total			6,000	100.00	2,400	100.00	Index	0.090517	

Reading	Brechin	Yours
Index; verdict on the rule of thumb	0.090517; no material shift	
Largest term and its band	0.029335, band 10: 10.00 to 5.33 per cent	
And the outcome over the same years	Bad rate 6.3167 to 12.6250 per cent: doubled	

Stability of the inputs is not stability of the outcome. The index watches the applicants; nobody watches the level unless the pack says so.

The through-the-door reconciliation

Chapters 11 and 12. The only cases a real project has outcomes for are the ones the previous policy accepted. This page states how far that population sits from the door.

Lender		Prepared by	
Portfolio		Date	

Population	Cases	Share %	Bads	Bad rate %	Yours: cases	Yours: bads
Accepted by the previous policy	5,170	61.55	270	5.2224		
Declined by the previous policy	3,230	38.45	412	12.7554		
Through the door	8,400	100.00	682	8.1190		

Reconciliation	Brechin	Yours
Bads on the data sheet; accepted plus declined; difference	682; 682; 0	
Declined bad rate over accepted	2.44 times	
Through the door over accepted	1.55 times	

The previous policy's rules	Testable on the bins?	Exceptions found	Yours
Decline a county court judgment in the last 12 months	Yes	0	
Decline debt service cover below 1.05	Only below 1.00	0 below 1.00	
Decline under 9 months of trading	No: inside the 0-11 bin		
Decline a bank conduct score below 45	No: inside the 0-49 bin		

A model fitted on accepted cases is fitted on a population at 5.2224 per cent and asked at the door about one at 8.1190. Case one prices what that does to the cut-off.

The unit economics and the break-even bad rate

Chapters 13 to 15. Four inputs give the only number that sets the cut-off. No accuracy statistic can give it.

Lender		Prepared by	
Portfolio		Date	

Line	How	Brechin	Yours
Average exposure	input	185,000	
Lifetime net interest margin	input	4.12 per cent	
Loss given default	input	41.7 per cent	
Cost of underwriting one case	input	640	
Margin on a loan that performs	exposure x margin - cost	6,982	
Cost of a loan that defaults	-(exposure x loss) - cost	-77,785	
The swing between them	margin - cost of default	84,767	
Break-even bad rate	margin / swing	8.2367 per cent	
Good loans one default is worth	cost of default / margin	11.1408	
Loans per default at the break-even	1 / break-even rate	12.1408	

How far the price can move before the cut-off does (case two)	Brechin	Yours
Development: 550 stays best for margins between	3.59 and 5.21 per cent	
Development: 580 would be best at a margin of at most	2.65 per cent, or a loss given default of 68.4	
Out of time: 550 would still be best at a margin of at least	7.81 per cent	

A pool whose bad rate is under the break-even adds money; one above it takes money away. Read the band over which a cut-off is best before the point.

The cut-off paper: both years on one page

Chapters 13 to 15. Every row is a count over the score column, priced with the unit economics. The same cut-offs in points, two populations.

Lender		Prepared by	
Portfolio		Date	

Cut-off	Dev accepted	Dev bad rate %	Dev profit	OOT accepted	OOT bad rate %	OOT profit	Your profit
520	5,853	5.54	13,401,138	2,305	11.63	-6,624,046	
530	5,698	5.07	15,285,773	2,223	10.80	-4,823,094	
540	5,454	4.66	16,549,010	2,077	9.58	-2,367,019	
550	5,010	4.15	17,348,284	1,824	8.33	-149,416	
560	4,424	3.75	16,817,046	1,519	6.98	1,620,356	
570	3,657	3.17	15,700,202	1,156	5.80	2,391,803	
580	2,677	2.43	13,180,959	780	4.36	2,563,882	
590	1,769	1.98	9,384,313	460	3.70	1,770,681	
600	1,008	1.69	5,596,817	238	1.68	1,322,648	
610	478	0.84	2,998,328	91	0.00	635,362	

Line	Brechin	Yours
Optimum, development: cut-off, approval, profit	550; 83.50 per cent; 17,348,284	
Optimum, out of time	580; 32.50 per cent; 2,563,882	
The inherited 550, out of time	-149,416: thirty points were worth 2,713,298	
550 against 600, development: the cost of carefulness	11,751,467	
550 to 600, loan by loan	4,002 not written: 191 defaults, 3,811 good loans; 19.95 good loans per default against a break-even of 11.14	

Three questions for any cut-off in front of a committee	Answer
On what population was it optimised?	
Over what period?	
What does it earn on the most recent population available?	

The card against the trees, and the sign-off

Chapters 13 to 15. Two scales that cannot be compared point for point are compared at the same approval rate, in both years, in money.

Lender		Prepared by	
Portfolio		Date	

Approval %	Dev card	Dev trees	Trees less card	OOT card	OOT trees	Trees less card	Yours
95	15,221,952	16,232,174	1,010,222	-5,781,392	-5,950,926	-169,534	
90	16,850,118	17,697,788	847,670	-3,652,387	-3,482,853	169,534	
85	17,298,528	19,163,402	1,864,874	-1,862,450	-1,947,217	-84,767	
80	17,499,619	19,025,425	1,525,806	-665,882	-1,004,950	-339,068	
75	16,923,843	18,294,079	1,370,236	-316,984	-486,518	-169,534	
70	16,609,350	18,142,138	1,532,788	377,964	-137,620	-515,584	
60	15,471,762	17,590,937	2,119,175	1,753,896	1,153,545	-600,351	
50	14,249,407	15,351,378	1,101,971	2,275,176	2,190,409	-84,767	

Before the model decides a loan	Brechin	Signed
Ranking, with its population: area under the curve	0.735329 development; 0.718513 out of time	
Level: largest calibration gap, and the fix applied	9.612 points; shift of 16.55 points	
Stability on fixed boundaries, and the outcome beside it	0.090517; bad rate doubled	
The population the outcomes come from	Accepted 5.2224 against the door 8.1190	
The cut-off, priced on the most recent population	580, not the inherited 550	
The challenger, priced at equal approval	Trees ahead in development, not out of time	

In development the trees earn more at every approval rate; out of time the advantage disappears and at most rates reverses. That is the argument about model class, priced.