Credit Portfolio Management Model Analysis

Tristan Fletcher

June 26, 2017

1 Model Validation

Commerzbank's CPM model was replicated in Python code. It was applied to a Bloomberg (BBG) data set consisting of 909 companies (from a total universe of 1,100 names with companies from the financial sector excluded). However, only 609 companies had data of sufficient quality for this exercise.

The Bloomberg data gives both an average rating (calculated across the main ratings agencies) and an implied one (reverse engineered from the CDS curve for the company) for every company in the dataset. A key difference between the average and implied ratings is that the latter, based off the much more frequently changing CDS values, will be more contemporaneous, whereas the former are based of less frequently changing and hence dated financials.

These ratings are high level (i.e. *AA*, *A* etc) and not at a more granular one (such as *AA+*, *AA-* etc). The model also uses these high level rating categories and our analysis reflects this. However, we would expect further work to operate at the sub-category level.

Financial data available from annual reports for each year (as opposed to Last Twelve Month (LTM) data for example) is used when calculating each ratio. Note that the dataset does not have enough historical information (with a maximum of ten year's worth of data for each company) for it to be used to investigate changes in credit ratings or actual defaults[1].

In order to calibrate the model's performance, four simple metrics are used:

1. **Mean Absolute Deviation (MAD) Average**: This looks at how many rating levels each company is from the BBG Average rating and shows an average for the number of levels difference across the sample. It is called the Mean Absolute Deviation value because we look at the absolute value of the rating differences so that rating differences in different directions do not cancel each other out. For example a situation where the model had rated two companies *AA* and *BBB* but the BBG Average rating for them was both *A*, the MAD across the two companies would be 1.

   Mathematically, we denote MAD as follows:

$$MAD(\mathbf{y_{model}}, \mathbf{y_{market}}) = \frac{1}{N}\sum_{i=1}^{N}\left(|y^i_{model} - y^i_{market}|\right)$$

[1]As an aside, there is an average of 1.7 changes in the market average rating and 30.0 for the market implied rating over the ten years worth of market data investigated for each company

where N is the number of companies over which the metric is being calculated and y^i_{model} and y^i_{market} are the model (in this case the market average) and actual ratings for the i^{th} company from the vector of their values $\mathbf{y_{model}}$ and $\mathbf{y_{market}}$ respectively.

When comparing y^i_{model} to y^i_{market} for the i^{th} company, we use the market ratings for that company taken from the first day in the dataset after the financial results were released. This means that this calibration exercise is in no way predictive: it is simply establishing how closely the model tracks market ratings.

This metric does not penalise more substantial deviations between the model and market rating disproportionately. So for example a set of two companies with rating differences of 1 each would have the same MAD value as one company with no deviation and another where the model was 2 rating levels different to the market. In order to weight larger deviations more significantly, the Mean Squared Error (MSE) would be a more appropriate measure. It is slightly harder to interpret the meaning of MSE than the more intuitive MAD, and for this reason we leave its use until further on in the analysis.

2. **MAD Implied**: This is the same as in 1. but comparing the model's rating (i.e. y_{market}) with the BBG Implied rating.

3. **Bias Average**: This aims to see whether the model is on average assigning higher or lower credit ratings than the BBG average rating. Positive values indicate the former. In the previous example, a situation where the model had rated two companies *AA* and *BBB* but the BBG average rating for them was both *A*, the bias across the two companies would be 0.

   Mathematically, we denote bias as follows:

$$bias(\mathbf{y_{model}}, \mathbf{y_{market}}) = \frac{1}{N}\sum_{i=1}^{N}\left(y^i_{model} - y^i_{market}\right)$$

4. **Bias Implied**: This is the same as 3. but comparing the model's rating with the BBG implied rating.

In all cases, the closer the metric is to zero, the better the performance of the model.

One last point worth noting is that CPM apply manual overrides, adjusting ratings for some of the companies in the portfolio slightly. The analysis described in this document does not currently take these overrides into account.

Using these metrics, the performance over the entire dataset is shown in Table 1.

	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
Overall	604	0.60	0.91	0.07	0.20

Table 1: Overall model performance

Figure 1 shows the distribution of model scores for all the companies against their Market Average and Implied ratings.

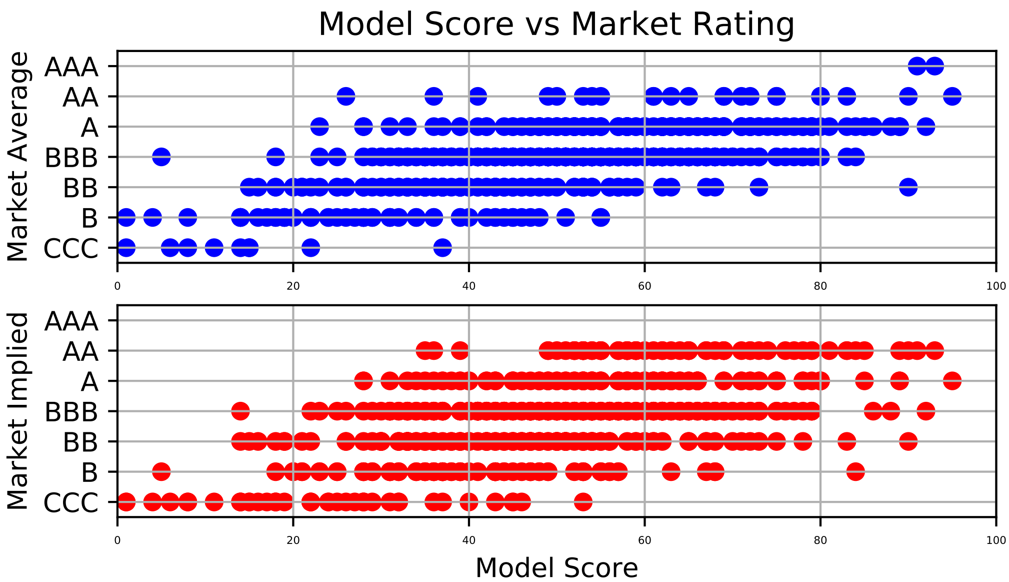

Figure 1: Distribution of model scores vs Market Average and Implied ratings

1.1 Conditioning Performance on Data Quality, Industry, Geography, Revenue and Market Ratings

Figures 2 to 7 show this performance broken down by industry type, country, revenue, the Bloomberg ratings themselves and the number of years financial history available when making the ratio calculations.The actual numbers are shown in Tables 2 to 7 in the Appendix.

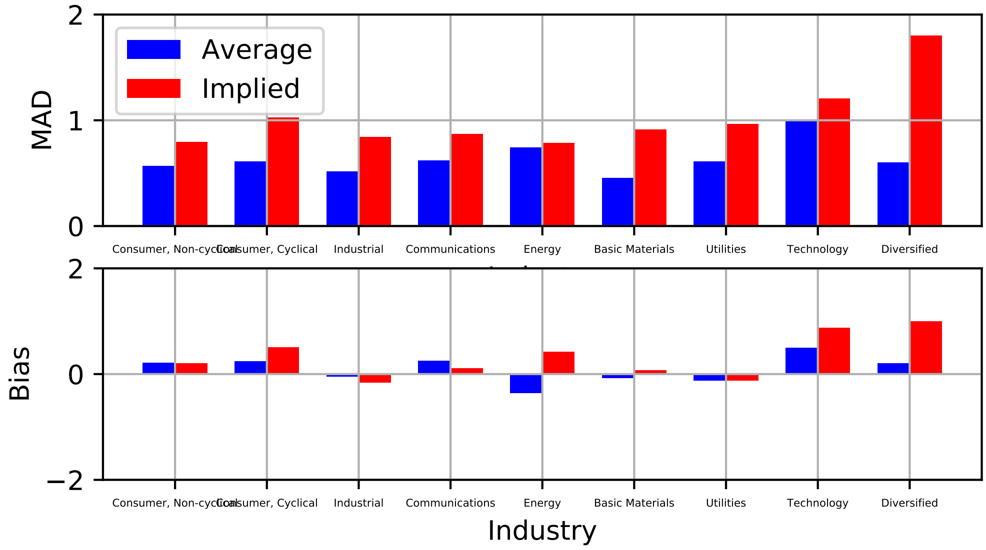

Figure 2: Model performance conditioned on the industry type

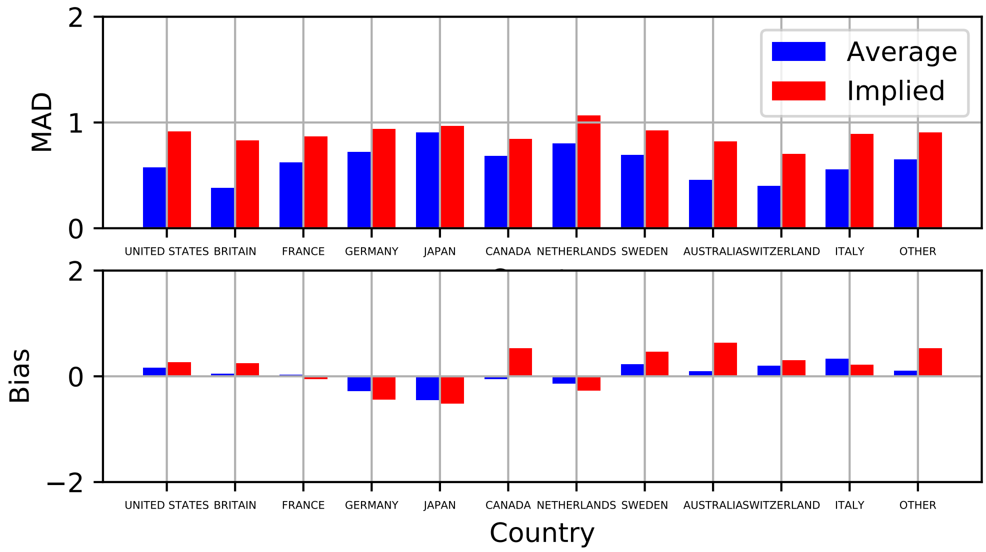

Figure 3: Model performance conditioned on the country the company is domiciled in

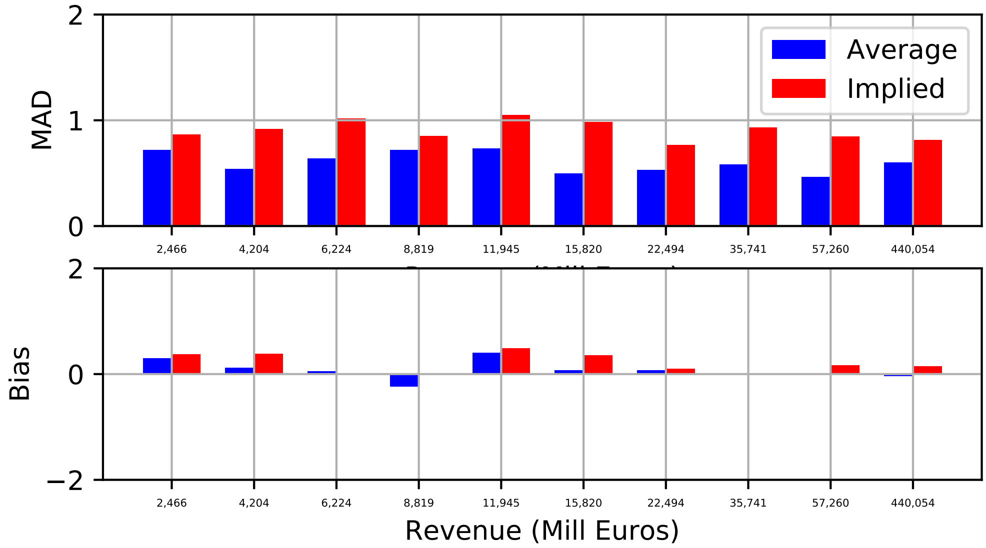

Figure 4: Model performance conditioned on revenue decile

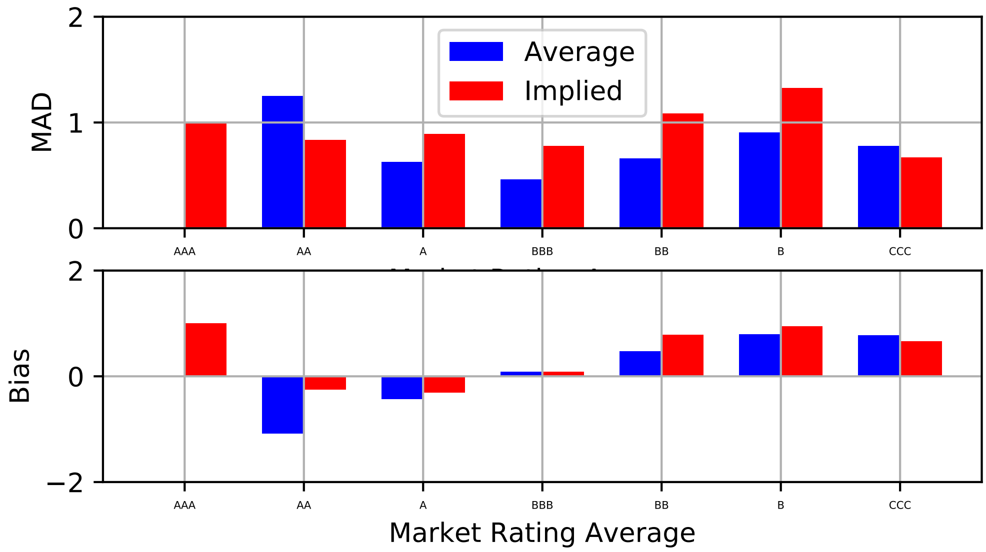

Figure 5: Model performance conditioned on Bloomberg Average Rating. This breaks down the performance of the model by what the actual rating (in this case the Bloomberg Average) was. So for example, one can see that the model shows the highest performance when predicting the rating for companies that turn out to have a BBG Average rating of *BBB*.

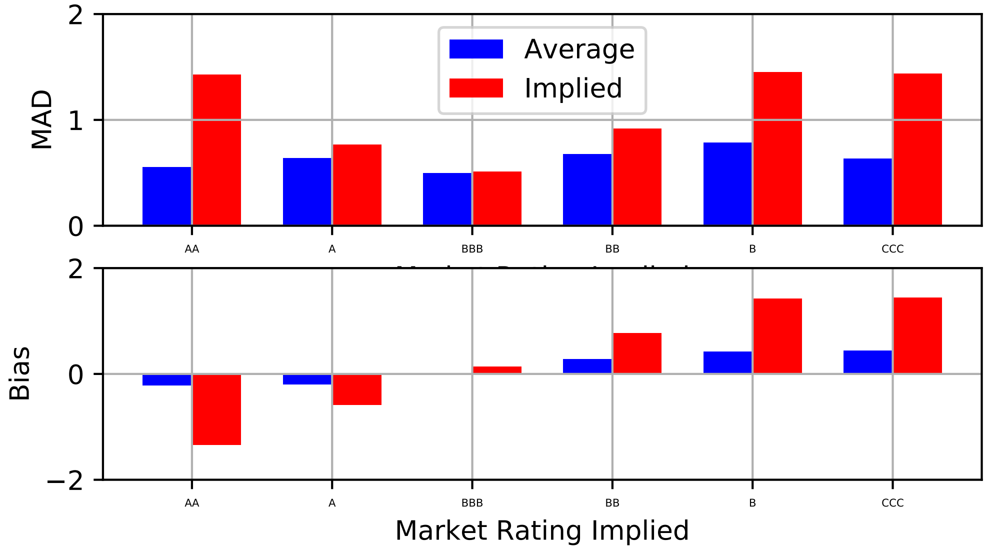

Figure 6: Model performance conditioned on Bloomberg Implied Rating. This breaks down the performance of the model by what the actual rating (in this case the Bloomberg Implied) was. So for example, one can see that the model shows the highest performance when predicting the rating for companies that turn out to have a BBG Implied rating of *BBB*.

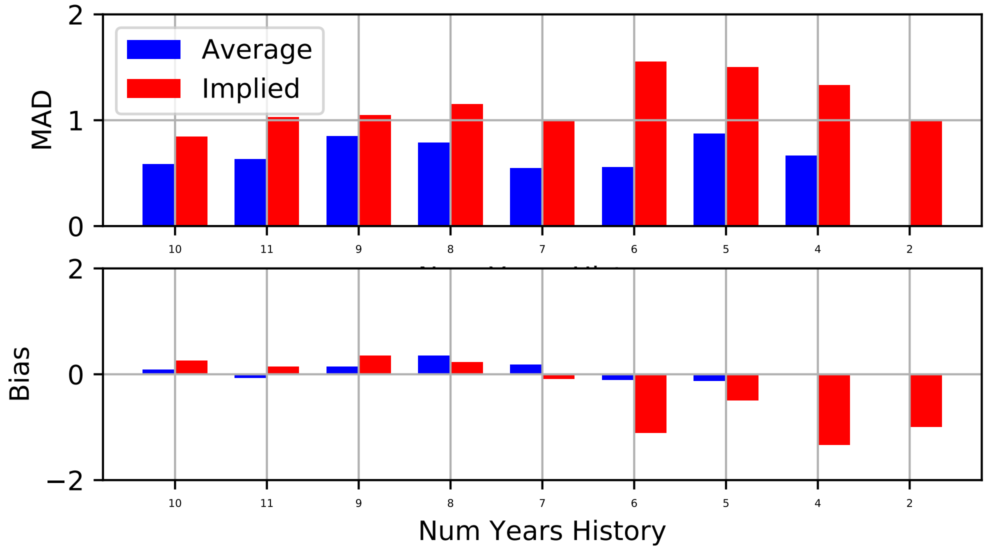

Figure 7: Model performance conditioned on number of years history available for calculations

1.2 Appendix

Industry	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
Consumer, Non-cyclical	118	0.57	0.80	0.21	0.20
Consumer, Cyclical	108	0.61	1.03	0.24	0.50
Industrial	97	0.52	0.84	-0.04	-0.16
Communications	71	0.62	0.87	0.25	0.11
Energy	67	0.75	0.79	-0.36	0.42
Basic Materials	57	0.46	0.91	-0.07	0.07
Utilities	57	0.61	0.96	-0.12	-0.12
Technology	24	1.00	1.21	0.50	0.88
Diversified	5	0.60	1.80	0.20	1.00

Table 2: Model performance conditioned on the industry type

Country	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
UNITED STATES	311	0.58	0.92	0.16	0.26
BRITAIN	42	0.38	0.83	0.05	0.24
FRANCE	37	0.62	0.86	0.03	-0.05
GERMANY	32	0.72	0.94	-0.28	-0.44
JAPAN	31	0.90	0.97	-0.45	-0.52
CANADA	19	0.68	0.84	-0.05	0.53
NETHERLANDS	15	0.80	1.07	-0.13	-0.27
SWEDEN	13	0.69	0.92	0.23	0.46
AUSTRALIA	11	0.45	0.82	0.09	0.64
SWITZERLAND	10	0.40	0.70	0.20	0.30
ITALY	9	0.56	0.89	0.33	0.22
OTHER	74	0.65	0.91	0.11	0.53

Table 3: Model performance conditioned on the country the company is domiciled in

Revenue (Mill Euros)	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
2,466	61	0.72	0.87	0.30	0.38
4,204	61	0.54	0.92	0.11	0.38
6,224	61	0.64	1.02	0.05	0.00
8,819	61	0.72	0.85	-0.23	0.00
11,945	60	0.73	1.05	0.40	0.48
15,820	60	0.50	0.98	0.07	0.35
22,494	60	0.53	0.77	0.07	0.10
35,741	60	0.58	0.93	-0.02	0.02
57,260	60	0.47	0.85	0.00	0.17
440,054	60	0.60	0.82	-0.03	0.15

Table 4: Model performance conditioned on revenue

BBG Rating (Average)	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
AAA	2	0.00	1.00	0.00	1.00
AA	24	1.25	0.83	-1.08	-0.25
A	129	0.63	0.89	-0.43	-0.30
BBB	279	0.46	0.78	0.09	0.09
BB	108	0.66	1.08	0.47	0.79
B	53	0.91	1.33	0.79	0.94
CCC	9	0.78	0.67	0.78	0.67

Table 5: Model performance conditioned on Bloomberg Average Rating

BBG Rating (Implied)	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
AA	65	0.55	1.43	-0.22	-1.34
A	108	0.64	0.77	-0.19	-0.58
BBB	207	0.50	0.51	-0.00	0.14
BB	109	0.68	0.92	0.28	0.77
B	71	0.79	1.45	0.42	1.42
CCC	41	0.63	1.44	0.44	1.44

Table 6: Model performance conditioned on Bloomberg Implied Rating. Note the absence of companies given a AAA implied rating by Bloomberg.

Num Years History	Num Companies	MAD Average	MAD Implied	Bias Average	Bias Implied
10	470	0.58	0.85	0.09	0.26
11	68	0.63	1.03	-0.07	0.15
9	20	0.85	1.05	0.15	0.35
8	14	0.79	1.15	0.36	0.23
7	11	0.55	1.00	0.18	-0.09
6	9	0.56	1.56	-0.11	-1.11
5	8	0.88	1.50	-0.12	-0.50
4	3	0.67	1.33	0.00	-1.33
2	1	0.00	1.00	0.00	-1.00

Table 7: Model performance conditioned on number of years history available for calculations