PRACTICAL METHODS OF HANDLING DEFAULT RISK

MR. NICHOLAS BAUER:

I. BACKGROUND

A. Models

There are a few early references to C-1 risk in discussions published in the Record. These are largely associated with the work of Donald Cody and the Society Committee on Valuation and Related Problems. I refer to RSA Vol. 3, No. 1, P. 27, RSA Vol. 7, No. 4, p. 1379 and RSA Vol. 8, No. 2, p. 697, this last one having been published in 1982.

The Committee defined C-1 risk to be "asset default and related loss of income and loss of market values of common stocks and related reductions of stock dividends."

In these discussions, the creation of deterministic and stochastic models for C-1 and other risks are alluded to, while at the same time it is suggested that the required C-1 equity be estimated from the consideration of a carefully constructed worst-case scenario, taking full advantage of the professional judgment of an investment researcher, an economist and an actuary.

The challenge of developing models for C-1 risk was taken up by only a few actuaries. In 1987, Joseph Buff made a presentation at the Spring Meeting in Colorado of a model designed to test the effects on surplus needs of various diversification rules and market-wide default rates and salvage values in connection with corporate bonds. To oversimplify, his results showed that portfolio diversification will reduce C-1 equity requirements substantially.

Several years earlier, in 1974, a gentleman named Gordon Pye published a paper in the Financial Analysts Journal in which he described a method for computing the difference between the return promised on a bond and the return expected. The difference he called the "default premium."

Pye's objective was to describe a method, also based on anticipated default rates and salvage values, by which it would be possible to decompose the premium yield on a risky bond between the default premium and the risk averseness premium.

In 1986, Richard Sega brought together the objectives of measuring the default premium on the one hand and the C-1 equity requirement on the other in a seminal paper entitled "A Practical C-1" published in TSA 38 at p. 243. While we have a critical difference of opinion with him -- in that he calculates the sum of the risk-free rate and default premium and calls it, wrongly, the expected yield -- the paper nevertheless serves as an important reference for any actuary seriously concerned with measuring C-1 risk.

B. Data

To this point, much of the talk about C-1 risk and corporate bonds was pretty cheerful. The original issue junk bond market was a recent phenomenon although growing very rapidly, and Wall Street reports were bullish. In any case, most insurers were investing only in governments and high quality corporate bonds where the risk of default is considered to be virtually nil. Gordon Pye, for example, estimated an annual default rate of only .001 for BBB bonds, with a resulting default premium of only 6 basis points.

But things were beginning to change. Life insurers, encouraged by favorable estimates of the returns to be expected on low quality bonds, saw them as an opportunity to compete effectively on savings instruments with other financial institutions. As this occurred more attention was being paid to empirical measures of default rates on risky bonds.

The Society's C-1 Task Force, under the chairmanship of Irwin Vanderhoof, last year published a report on bond defaults. For statistics on bond defaults the Task Force drew on the very extensive pre-war study by the National Bureau of Economic Research, conveniently referred to as the Hickman study, and on some recent work on junk bonds by Edward Altman, among other sources.

Vanderhoof makes a number of interesting observations about bond defaults. Aggregate bond default rates in the pre-war era were very high relative to the post-war era. He cites an average annual default rate over the years 1900-1944 of 1.65 percent while the average for the years 1945-1985 he gives as .078 percent. Reasoning that the credit-worthiness of bonds cannot be assumed to have improved, he argues that the sharp decline in default levels is the result of a more stable economy in the post-war period.

Vanderhoof also discusses the question of whether default rates would change over the lifetime of a bond. Observing that arguments can be made for more complex patterns, he concludes that the date do not support them and prefers the simple assumption that default rates are constant within a given agency rating class.

He goes on to make the following important point:

> If the default rate for a particular rating of bond is reasonably constant over the life span of the bond but bonds can change rating classes, then this last one is the most important one for understanding default experience.

I heartily concur.

Fans of Ravi Batra will have noted with some interest another of Vanderhoof's observations which was that "there was a high proportion of junk bonds issued during the late twenties, and they were almost immediately exposed to the chilling economy of the thirties." I might add that prior to the 1980s this was the only time in the twentieth century when noninvestment grade bonds were issued in any volume.

While the Altman studies and similar efforts emanating from Wall Street painted a rosy picture of the junk bond market, a more recent study by Paul Asquith, David Mullins and Eric Wolff of Harvard observed that cumulative default rates on junk bonds that were tracked from issue were quite alarming and that this trend was obscured by the so-called traditional approach of dividing the defaults in a given year by the total outstanding in that year.

Other recent studies, e.g., by Fridson, Wahl and Jones, have also cautioned that since the junk bond market is relatively immature, it is too early to be drawing conclusions.

Moody's recently published default study by rating at the beginning of a study year also gives much food for sober reflection.

Regrettably, the various studies have used different methodologies and are thus difficult to reconcile. In any event, it is important to point out that historical default experience is not a necessary guide to future experience.

II. ECKLER MODEL

A. Model

Meanwhile, we at Eckler have been busy, too. Building on concepts suggested by Cody, Pye and Sega, we have developed a model that measures default premiums and required C-1 equity for corporate bonds based on the usual parameters -- alpha, the probability of default, and Lambda, the salvage value -- plus one more, the transitional probability of a change in rating class.

All parameters are permitted to vary by economic scenario, which can be selected by a random process or prespecified. The model also permits the use of different default probabilities at maturity for each class.

B. Empirical Research

Fully cognizant of the fact that a model is only as good as the assumptions you use, we have conducted our own empirical research on bond defaults. In order to do so, we have succeeded in restoring -- at least in part -- the original database of the Corporate Bond

Project that was used by Hickman. We have also established a modern database for current and future study, that will become increasingly useful in the measurement of default experience and rating changes.

In conducting our own study, we have measured annual default rates by class, not just for the whole universe or junk universe, thus avoiding erroneous conclusions that might be caused by unobserved changes in the composition of the universe.

We have measured default rates by class at the beginning of the exposure year, not cumulative rates by original class, thus ensuring that the exposures properly reflect prior extinguishments.

We have measured default rates at maturity as distinct from nonmaturity default rates.

We have measured annual transition rates from each rating class at the beginning of a year to each of the other classes at the end of the year.

We have measured exposures, defaults and rating changes in a consistent manner.

Before describing the model and the results of our research, I would like to begin with some basic concepts.

(Note: The following slides, which were used at the seminar, are sufficiently self-explanatory that no additional text has been developed.)

NOTES ON SLIDES:

1. Slide comparing interest rates with default rates:

   "DEFAULT" = market rate of default, all bonds
   "DEFAULT (5-9) = market rate of default, junk bonds
   "INTEREST" = prevailing yields, railroad bonds

   Conclusion: poor correlation between interest rates and default rates.

   Note: different scales are abscissa for each variable

2. Slide comparing GNP with default rates:

   "DEFAULT" and "DEFAULT (5-9)" plotted against " GNP"
   where " GNP" = change in real GNP

   Conclusion: reasonable, though not perfect, correlation of defaults with economic conditions. Correlation is better for below-investment grade bonds.

3. Slide comparing interest rates with default rates and call rates, i.e., proportion of bonds called in year, all grades:

   Conclusions: 1) calls are strongly but inversely correlated with interest rates

   2) defaults are not really correlated with either calls or interest rates

4. Slide comparing GNP with call rates:

   Conclusion: calls are not really correlated with economic conditions.

5. Slide comparing GNP with transition rates, i.e., probability of not being downgraded in a year:

   Conclusion: there is a strong correlation between economic conditions and bond rating changes.

6. Slide showing pre-war default probabilities, with and without the inclusion of railroad bond experience, under economic conditions (based on GNP) characterized as "best," "good," "average," and "worst."

7. Slide showing current default experience.

8. Slide showing assumptions used in our model runs.

9. Slide showing results of our model runs.

SLIDE 1

Year	Default	Default 5-9	Interest
16	0.016	0.115	4.468
17	0.012	0.063	4.367
18	0.011	0.017	5.202
19	0.025	0.153	5.070
20	0.007	0.062	5.506
21	0.005	0.053	5.573
22	0.008	0.044	5.002
23	0.007	0.038	4.853
24	0.011	0.084	4.945
25	0.011	0.105	4.774
26	0.002	0.022	4.643
27	0.004	0.041	4.451
28	0.006	0.051	4.184
29	0.002	0.022	4.500
30	0.008	0.047	4.503
31	0.028	0.139	4.315
32	0.051	0.163	5.591
33	0.060	0.160	5.222
34	0.027	0.077	4.944
35	0.039	0.103	4.171
36	0.016	0.045	4.008
37	0.016	0.036	-
38	0.022	0.056	-
39	0.020	0.043	-
40	0.020	0.047	-
41	0.001	0.004	-
42	0.004	0.012	-
43	0.001	0.004	-

SLIDE 2

Year	Default	Default 5-9	GNP
16	0.016	0.115	1.076
17	0.012	0.063	1.017
18	0.011	0.017	1.186
19	0.025	0.153	0.927
20	0.007	0.062	0.922
21	0.005	0.053	0.930
22	0.008	0.044	1.148
23	0.007	0.038	1.110
24	0.011	0.084	1.010
25	0.011	0.105	1.073
26	0.002	0.022	1.060
27	0.004	0.041	0.998
28	0.006	0.051	1.010
29	0.002	0.022	1.063
30	0.008	0.047	0.907
31	0.028	0.139	0.914
32	0.051	0.163	0.866
33	0.060	0.160	0.979
34	0.027	0.077	1.077
35	0.039	0.103	1.081
36	0.016	0.045	1.141
37	0.016	0.036	1.050
38	0.022	0.057	0.955
39	0.020	0.043	1.079
40	0.020	0.047	1.079
41	0.001	0.004	1.177
42	0.004	0.012	1.188
43	0.001	0.004	1.181

SLIDE 3

Year	Default	Called	Interest
16	0.016	0.018	4.468
17	0.012	0.002	4.367
18	0.011	0.002	5.202
19	0.025	0.003	5.070
20	0.007	0.001	5.506
21	0.005	0.011	5.573
22	0.008	0.008	5.002
23	0.007	0.026	4.853
24	0.011	0.034	4.945
25	0.011	0.036	4.774
26	0.002	0.045	4.643
27	0.004	0.052	4.451
28	0.006	0.046	4.184
29	0.002	0	4.500
30	0.008	0.034	4.503
31	0.028	0.004	4.315
32	0.051	0.006	5.591
33	0.060	0.014	5.222
34	0.027	0.090	4.944
35	0.039	0.124	4.171
36	0.016	0.087	4.008
37	0.016	0.067	-
38	0.022	0.073	-
39	0.020	0.083	-
40	0.020	0.099	-
41	0.001	0.054	-
42	0.004	0.057	-
43	0.001	0.001	-
10	0.000	0.000	4.108
11	0.003	0.002	4.167
12	0.006	0.009	4.179
13	0.013	0.001	4.269
14	0.022	0.001	4.442
15	0.015	0.011	4.586

SLIDE 4

Year	Called	GNP
16	0.018	1.076
17	0.002	1.017
18	0.002	1.186
19	0.003	0.927
20	0.001	0.922
21	0.011	0.930
22	0.008	1.148
23	0.026	1.110
24	0.034	1.010
25	0.036	1.073
26	0.045	1.060
27	0.052	0.998
28	0.046	1.010
29	0.027	1.063
30	0.034	0.907
31	0.004	0.914
32	0.006	0.866
33	0.014	0.979
34	0.090	1.077
35	0.124	1.081
36	0.087	1.141
37	0.067	1.050
38	0.073	0.955
39	0.083	1.079
40	0.099	1.079
41	0.054	1.177
42	0.056	1.188
43	0.001	1.181

SLIDE 5

Year	Transition	GNP
16	0.98	1.076
17	0.94	1.017
18	0.89	1.186
19	0.93	0.927
20	0.94	0.922
21	0.67	0.930
22	0.98	1.148
23	0.95	1.110
24	0.92	1.010
25	0.96	1.073
26	0.95	1.060
27	0.95	0.998
28	0.94	1.010
29	0.94	1.063
30	0.86	0.907
31	0.57	0.914
32	0.60	0.866
33	0.88	0.979
34	0.93	1.077
35	0.93	1.081
36	0.95	1.141
37	0.78	1.050
38	0.84	1.079
39	0.92	1.079
40	0.94	1.079
41	0.98	1.177
42	0.99	1.188
43	0.99	1.181

SLIDE 6

DEFAULT RATES BY NO. OF BONDS
(Non-maturity)

CLASS	BEST		GOOD		BAD		WORST	
	ALL	-RR	ALL	-RR	ALL	-RR	ALL	-RR
1	–	–	–	0.002	–	–	–	–
2	–	–	0.001	0.001	–	–	–	–
3	–	–	–	–	0.001	–	0.002	0.002
4	0.010	0.013	0.008	0.004	0.006	0.002	0.011	0.013
5	0.002	–	0.014	0.008	0.023	0.004	0.030	0.035
6	0.003	0.004	0.046	0.035	0.047	0.026	0.152	0.142
7	0.031	0.025	0.248	0.168	0.289	0.204	0.445	0.407
1–4	0.003	0.004	0.003	0.002	0.002	0.001	0.003	0.005
5–9	0.007	0.006	0.050	0.034	0.076	0.048	0.120	0.117

SLIDE 7

HARVARD STUDY

- Includes distress exchanges
- Based on original volume (exposure not reduced for calls)

	'77	'78	'79	'80	'81	'82
Defaults	34%	34	25	28	21	26
Exchange o/s	-	9	1	4	19	10
Calls/Mat'y	42%	26	33	30	30	58
o/s 31/12/88	24%	31	41	38	30	16

ALTMAN BOND MORTALITY STUDY

- Excludes distress exchanges
- Based on current exposures (to 1986)

Original Issue Rating	Default in Year 1	2	3	4	5	6
4	.06%	.35	.22	-	.6	-
5	-	.93	.75	.50	.5	3.8
6	.82%	1.8	.48	.64	2.4	3.5
7	7.7%	6.2	8.5	-	1.7	N/A

OURS

- 1 year of experience
- based on rating at beg. of year

Class	1-5	6	7
Default	-	2%	8%

SLIDE 8

ASSUMPTIONS USED

Transition probabilities:

- smoothed Hickman data, excluding railroads

Base default

	Best	Good	Bad	Worst
1 & 2	-	-	-	-
3	.01%	.01%	.01%	.01%
4	.02%	.02%	.02%	.01%
5	.2%	1.0%	1.0%	3.0%
6	.3%	2.5%	3.0%	10.0%
7	3.0%	8.0%	10.0%	40.0%

Maturity default -- same as base

Salvage Value ( )

3 & 4	55%
5	40%
6	35%
7	30%

SLIDE 9

SAMPLE RESULTS

PORTFOLIO		D	E-1 EQUITY	DEFAULT SHAVE (H-R=8%)
Quality at Start	No. of bonds			
6	5	2.4%	18.0%	3.9%
	10	2.4%	12.7%	3.4%
	20	2.4%	8.7%	3.1%
	50	2.4%	5.3%	2.8%
75% Inv. Grade 25% Junk	80	0.9%	2.5%	1.1%
100% Inv. Grade	80	0.3%	1.5%	0.4%
100% Junk	20	2.7%	8.0%	3.3%
	20	8.3%	5.8%	8.8%

Economic scenario
- Simulated, normal
- 2 bad years
  3 worst years
  3 bad years
  then simulated

ANALYSIS OF THE C-1 RISK ON BONDS

X59NB01

FIXED INCOME ASSET

A *Fixed Income Asset* is a stream of promised cash flows at predefined times and in predetermined amounts.

RISK

Risk is the possibility of experiencing deviation from promised flows.

Risks of Fixed Income Assets

- *Default*
- *Inherent C–3*
  - full or partial redemption due to antiselective action of issuer
- *Liquidity*
  - liquidity preference
  - financial illiquidity
- *Taxation*

X59NB06

DEFAULT

Default is the loss of *promised* cash flow.

Default can be due to:

- *Bankruptcy*
- *Distress exchange*
- *Inability to meet scheduled interest or principal payments*

DECOMPOSITION OF YIELD

$$Y = R + D + C + \Pi$$

Y = Promised yield

R = Risk–free rate (for comparable maturity).

D = Default premium – portion of Y expected to be lost through default.

C = Inherent C–3 risk premium – portion of Y expected to be lost through financial anti–selective action of issuers

Π = Market risk–averseness premium.

Other considerations

- *Liquidity*
- *Taxation*

X59NB04

DECOMPOSITION OF YIELD
INVESTOR VIEW

$$Y = R + D + C + \Pi' + \Pi^M$$

Π^M Represents the difference between the perception of the market and the requirement of the investor.

$\Pi' = \Pi^D + \Pi^C$ Usually, for institutional investors.

X59NB05

VALIDATION

$$Y - R = C + D + \Pi$$

- Key is Independence of "C" and "D"
- Π is Residual and Not Considered an Independent Variable

X59NB07

EMPIRICAL EVIDENCE

D	Correleted with	– *Quality*
		– *Economic conditions*
	Not Correlated with	– *R (level or slope)*
C	Correlated with	– *R (level and slope)*
	Not or Mildly Correlated with	– *Quality*
		– *Economic conditions*

X59NB08

CONCLUSION

C and D are either independent or tend toward mutually exclusive. Therefore, assumption of indepen– dence is reasonable, perhaps slightly conservative.

X59NB09

LIABILITY–DRIVEN PORTFOLIO

- Call–adjusted Duration Match
- Buy–and–Hold Strategy

(Assumes any required rebalancing can be accomplished through current cash flow.)

MODELING THE DEFAULT RISK

Key Parameters

1. Default probabilities per year per bond class
   - *Non-maturity year "α_i"*
   - *Maturity year "α_i^m"*

   Varying by economic scenario
2. Salvage values by bond class "λ_i"
3. Transitional probabilities
   - *Probability of changing from class "i" to class "j" in one year*

   Varying by economic scenario
4. Economic scenario

X59NB11

PROCESS

- Model Can be Applied to Any Stipulated Portfolio
- Key Output
  - *Default premium*
  - *C–1 equity at stipulated protection level*

X59NB12

PROCESS
DEFAULT PREMIUM

1) Develop expected cash flows

   a) From each given starting rating, calculate probability of falling into each rating class at the end of year 1, 2 . . . (depending on economic scenario)

   b) Calculate weighted average probability of default in year 1, 2 . . .

      – *before maturity*

      – *at maturity*

   c) Calculate weighted average salvage value on default in year 1, 2 . . .

   d) Apply to promised cash flows to derive expected cash flows

X59NB13

PROCESS
DEFAULT PREMIUM

2) Calculate default premium from relationship

$$D = Y - Y^E$$

where Y^E is determined from the equation

PV (@ Y^E) expected flows = PV (@ Y) promised flows

X59NB14

PROCESS

C–1 equity = the amount that must be set aside to ensure that the value of the portfolio will not fall below a stipulated minimum (the threshold) within a stipulated probability (the protection level).

The need for C–1 equity is determined by the <u>scatter</u> of portfolio default losses compared to expected. The scatter is estimated by stochastic simulation.

X59NB15

PROCESS
C–1 EQUITY

- Decide threshold and protection level
- Expose portfolio N times and schedule present value of realized flows at Y^E.

$$E_{C1} = \text{threshold} - \text{realized portfolio value @ protection level}$$

X59NB16

MORTALITY ANALOGY FOR DEFAULTS

- Consider "Class" (Quality) as Underwriting Class
- $\alpha_i \Rightarrow q_x$
- $D \Rightarrow$ Whole Life Premium
- Model can easily be adapted to derive the one–period expected default loss (D_p) for each period. This is equivalent to one–period term for the portfolio.

Analogy can be extended to cover calls (a second decrement).

X59NB17

DEFAULT SHAVE

The total reduction in promised yield needed to be made on account of default

$$D^T = D + \frac{E_{C1}}{A}(H - R)$$

Where: E_{C1} = C-1 equity
A = Assets in portfolio
H = Hurdle rate required by company

The default shave is a reasonable approach to the compensation for risk taking demanded by a prudent risk-taker.

The second term of the RHS is the measure of the risk-averseness compensation required by the investor.

X59NB18

CAUTION

How applicable are historical non–investment grade default/recovery rates to the new universe of junk bonds?

- LBO, Management Buyout are New Phenomena
- Leverage Ratios Much Higher
- Used to be Fallen Angels or Smaller/Weaker Companies
- Market Less than 3 Years Old on Average – Not Enough Time for Seasoning
- New Universe Not Yet Tested by Adverse Market Conditions Yet Default Rates Quite High

Event risk for investment grades.

Sectorial influence ignored – but may be important for concentrated portfolios.

X59NB19

PARAMETER VALUES

Value of model is determined by soundness of input parameters;

therefore

we spent much time and effort on empirical research.

PARAMETER VALUES

Sources used: NBES Bond Study, Hickman, Altman, Atkinson, Compu-stat, Myriad, Investment Houses, etc.

Data not easily available, inconsistent in definition, frequently scanty or nonexistent;

therefore

our suggested values are tentative, much research remains to be done.

X59NB21

RESULTS

Default Premiums

- Increase steeply with worsening economic conditions

<u>but</u>

- The poor conditions must persist to have a significant impact
- Tend to increase by increasing term to maturity for investment grades, but de–crease for junks. If crisis at maturity is less pervasive than previously, this result for junks is mitigated.

RESULTS

C–1 Equity

- Decreases dramatically with increasing diversification
- Is only vaguely related to the size of the default premium. Low "D" may be accompanied by high E_{C1} or vice versa. The key is scatter.

X59NB23

POTENTIAL USES

Valuation

- Default Deduction from Promised Flows (Plus MAD)

MARGIN FOR ADVERSE DEVIATION

Pricing

- Default Shaves by Class
- Optimal Pricing Mix of Assets

Investment Management

- Identification of Relative Value and Consequent Trading Opportunities
- Quantify Value of Credit Research

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POTENTIAL USES

Senior Management

- Investment Policy Guidelines
  - *Minimum diversification*
  - *Overall "junk" limit*
  - *Hurdle rate for C–1 equity*
  - *Surplus available for C–1 equity*

Management of Default Risk

- By SBU? By Line? By Segment?
- Reinsurance of Default Risk by Corporate Line

X59NB25

PRELIMINARY OBSERVATIONS ON MORTGAGES

X59NB26

CLASSIFICATION OF FIRST MORTGAGES BY UNDERLYING ASSET

- Farm
- Non-farm Residential
  - *Single family*
  - *Multi-unit*
- Non-farm Non-residential
  - *Office buildings*
  - *Industrial*
    - single user
    - multi-user
  - *Commercial*
    - regional (3 or more anchors)
    - local (1 or 2 anchors)

X59NB27

	Bonds	First Mortgages
Security	Good Faith of Issuer Depends on Seniority	General Credit of Borrower Plus Specific Pledge of Asset Possible Insurance FHA (CMHC), VA or Private
Periodic Payment	Interest Only, Unless Sinking Fund Stipulated	Blended Payments of Principal and Interest

RISK OF DEFAULT RELATED TO

- Loan to Value Ratio
- Economic Conditions (General and Local)
- Nature of Underlying Property (Cash Flow)
- Defaults are Rare while Mortgagor has Net Equity

X59NB29

SALVAGE VALUE RELATED TO

- Nature of Property
- Variability of Market
- Economic Conditions (General & Local)
- The Higher the Risk of Default, the Greater the Risk of Low Salvage Value
- Interest Rates (λ Expressed as % of Expected Cash Flows)

X59NB30

PARALLEL WITH BOND MODEL

Rating	Loan to Value Ratio
"α" "λ" Vary by Rating	α Varies by Loan to Value Ratio λ Varies by LVR, Type of Property
Transition Probabilities Vary by General Economic Conditions	LVR Varies by General AND Local Conditions (V) and by Capital Repayments to Date (L)

X59NB31

DIFFERENCES WITH BOND MODEL

- Sectoral Contagion Important
- Drop in Interest Rates in Bad Economic Times Results in Default Losses for Non-residential, Non-prepayable Mortgages of Even High Quality: This is a C-3 Risk as Much as a C-1 Risk, but on Bonds it Appears as Calls
- Default Risk Concentrated in Early Years

X59NB32