Estimating Economic Capital for Private Equity Portfolios

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Today's presentation

- What is private equity and how is it different to public equity and credit?
- How much capital does it require?
- Modelling capital requirements for a diversified equity portfolio
- Estimating parameters for unlisted positions
- Results

What is Private Equity?

- Private equity investment involves taking a stake in unlisted equity; for example:
  - Leveraged Buyouts (LBO)
  - Venture Capital
  - Infrastructure Projects
  - Unlisted Managed Funds

- Significant increase in global private equity investment in recent years:
  - US$800b (2006) versus US$125b (2000) in equity and debt*

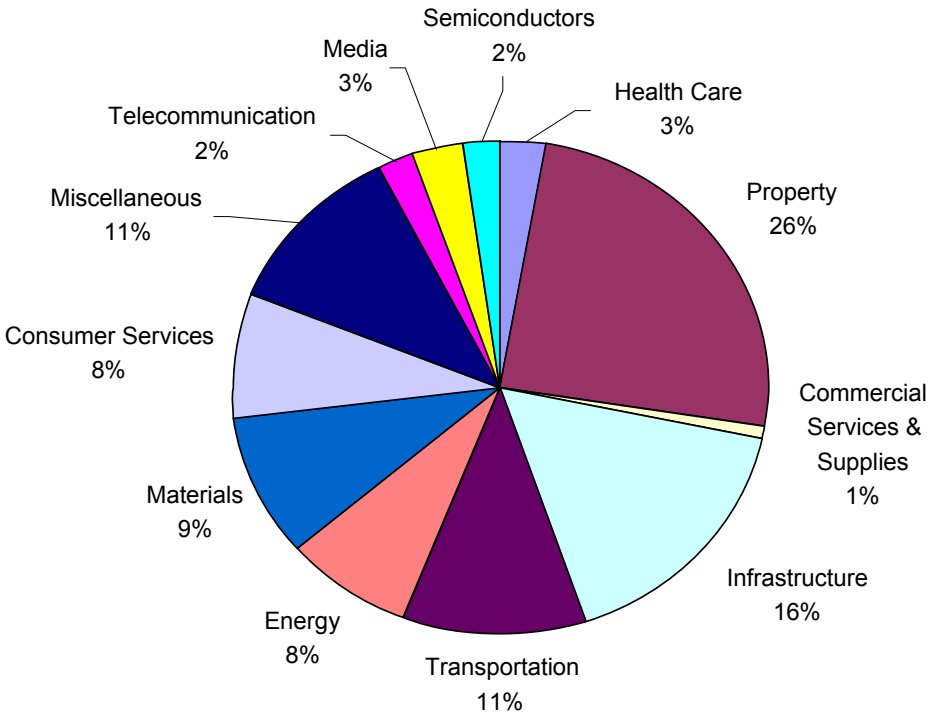
- No well-established method for estimating the capital requirement for private equity portfolios

- A variety of regulatory treatments are available under Basel 2: *Deductions, Simple RWA, internal models, PD/LGD*.

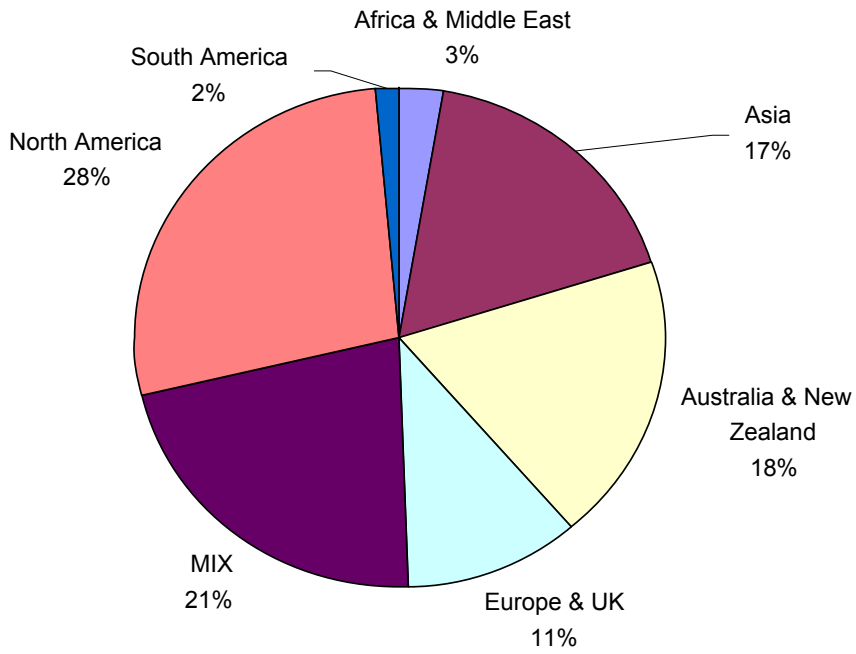
*Reserve Bank of Australia, Financial Stability Review, *Private Equity in Australia*, March 2007, p. 60.

Macquarie's equity investment portfolio

Portfolio Risk by Industry



Portfolio Risk by Region



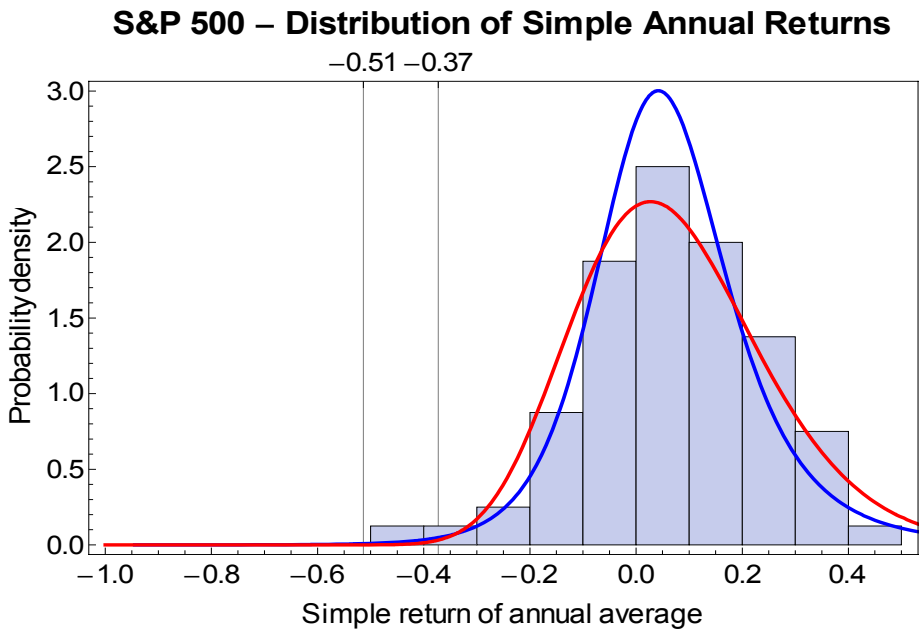
As at 30 September 2007

What is an appropriate economic capital ratio for a private equity portfolio?

What is an appropriate economic capital ratio for a private equity portfolio?

- Some benchmarks (99.9% confidence level, 1 year time horizon):
  - Basel 2 simple risk weight method: 32% for non-publicly traded equity holdings
  - Basel 2 PD/LGD approach*: 34% for a portfolio of B-rated LBO equity holdings
  - Banks (differing portfolios):31% - 68%
  - Solvency 2 standards for EU life insurers: 54%
  - Statistical analysis of annual movements in the S&P500: 40% - 55%

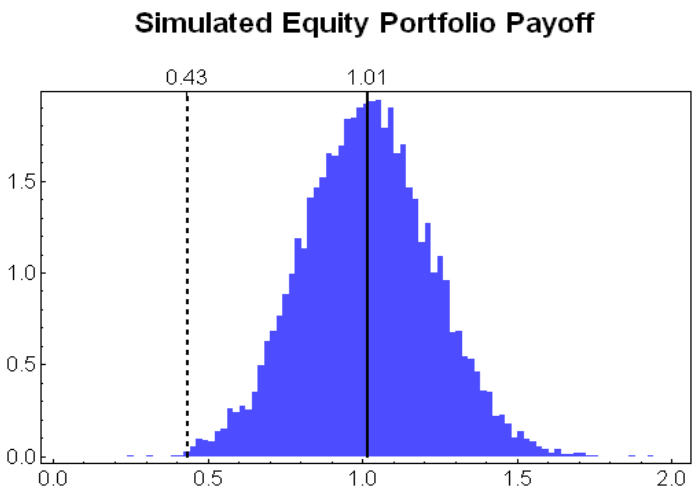
*LGD: 90%, PD: satisfy same requirements as if holding was debt, Maturity: 5 years

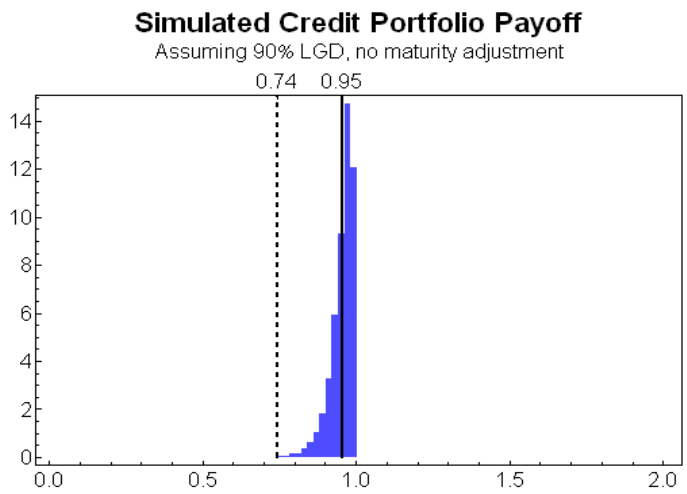


Equity Risk vs. Credit Risk

- Any decline in asset value results in a decline in equity value
- Debt value begins to decline materially only after a significant deterioration in asset value
- Question appropriateness of applying the Basel 2 credit model directly to equity portfolios

State	Credit Loss	Equity Loss
Default	Loss Given Default	Close to 100%
No Default	0%	Some





Classical Portfolio Model

$$\sigma_{portfolio} = \sqrt{\sigma^T . \Lambda . \sigma}$$

Weighted Inherent Risks, σ

Correlation Matrix, Λ

- Applying to private equity we have a couple of problems:
  - Can't observe the inherent risks
  - Can't observe the correlations
- Need to use proxy data or subjective estimates

Intuition for the large portfolio case

$$\sigma_{portfolio} \approx \sigma \cdot \sqrt{\rho}$$

- Applies to a large homogeneous portfolio of long positions
- σ is the weighted average Inherent Risk
- ρ is the average correlation between positions

Inherent Risk Factor

$$K \approx Z_{1-\alpha} \cdot \sigma \cdot \sqrt{\rho}$$

Diversification Factor

- Approximate estimate for portfolio economic capital
- $Z_{1-\alpha}$ is a distributional multiplier taking us to the α-quantile of portfolio loss (eg. for the Normal distribution $Z_{1-\alpha} = 3.09$ at 99.9% confidence)

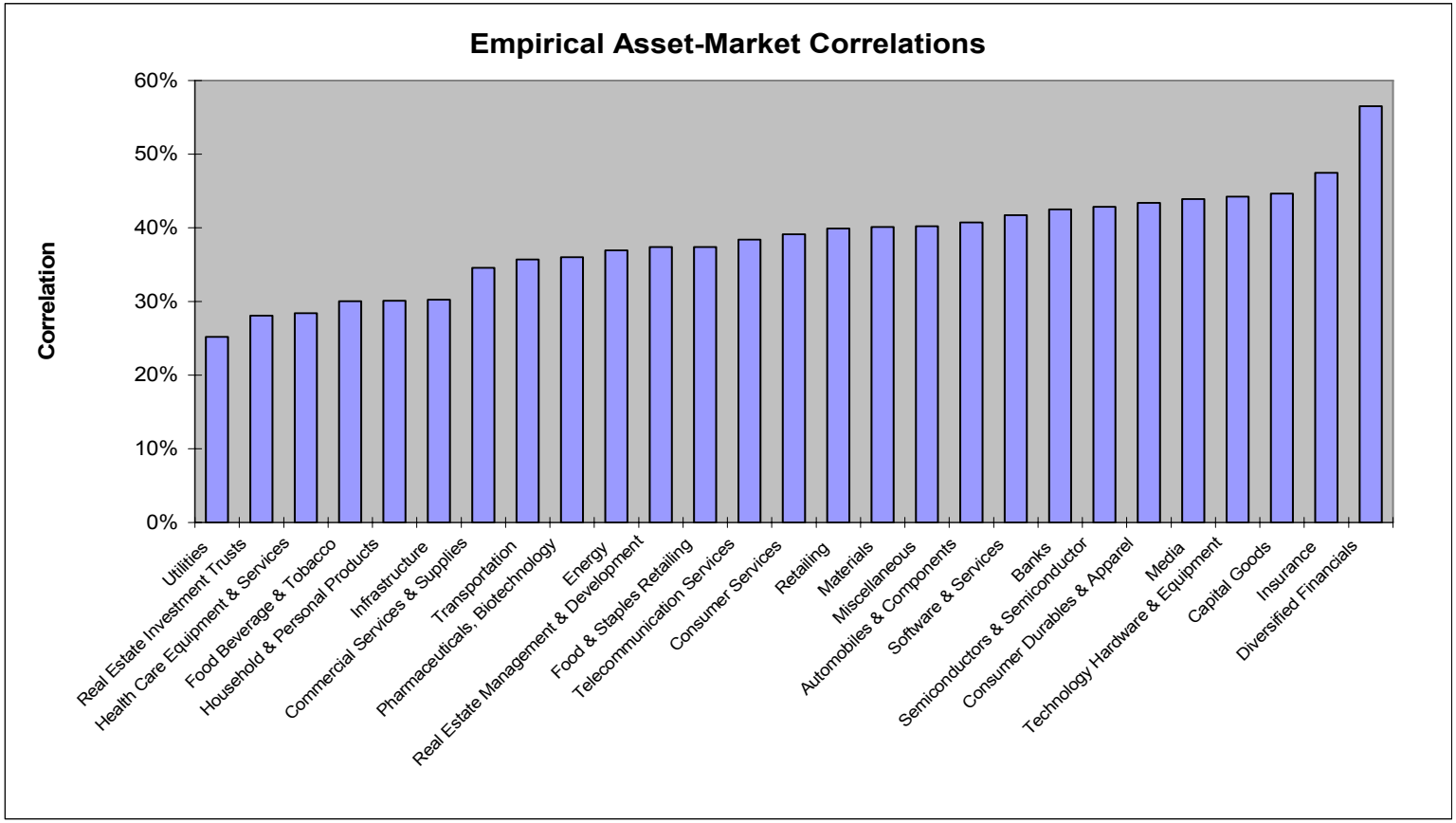
Ignores: value of the put option and discounting → see later

Ways of characterising Inherent Risk

Characterisation of Inherent Risk	Pros and Cons
Equity volatility	OK, but then need a distributional assumption to take it to the "tail" (99.9% confidence level)
Reasonable Maximum Loss	Intuitive, and already a "tail" figure, but: • Confidence level not explicit • Loses discriminatory power at high confidence levels (at 99.9% confidence, Reasonable Maximum Loss should be 100% for most equity positions)
Probability of Total Loss	Already a "tail" figure, and retains discriminatory power, but not intuitive so would need to be implemented via a "ratings scale"

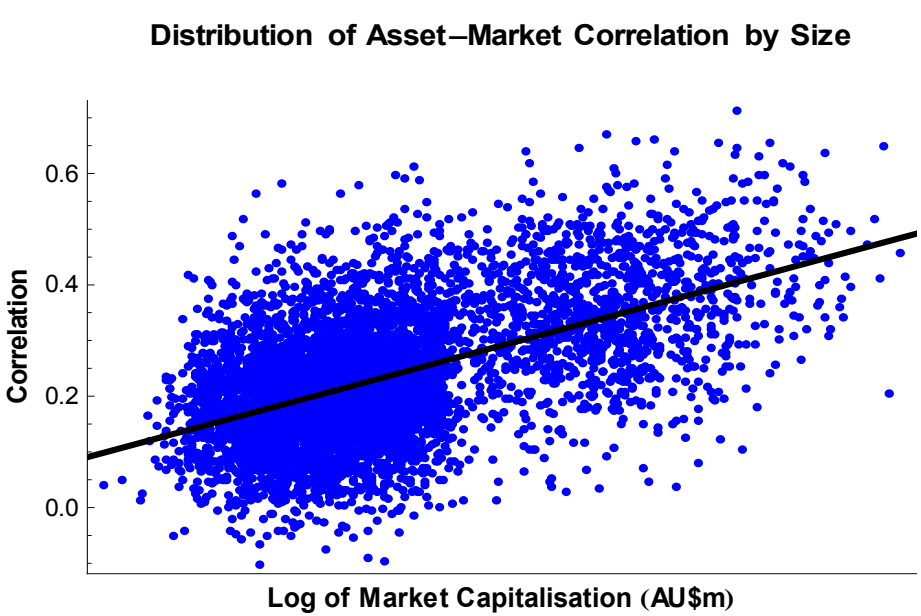
- By Inherent Risk we mean the risk of an individual position on a stand-alone basis
- We will focus on the Probability of Total Loss, which is defined as the probability of losing the entire equity stake in a position
- Probability of Total Loss can be assigned via a rating scale, for example a credit rating scale (for today's presentation we will use the S&P credit ratings scale with idealised default probabilities)

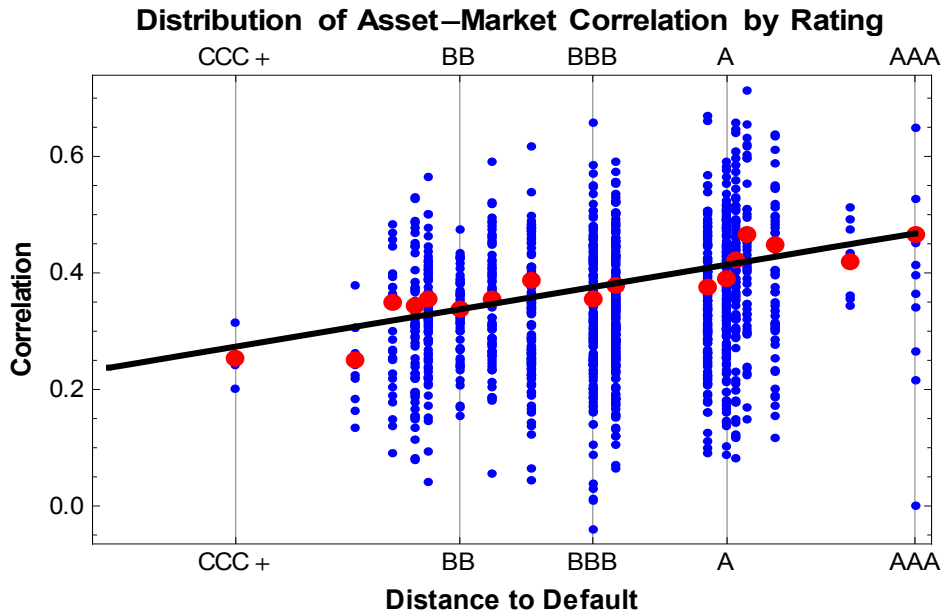
Variation of correlations with industry



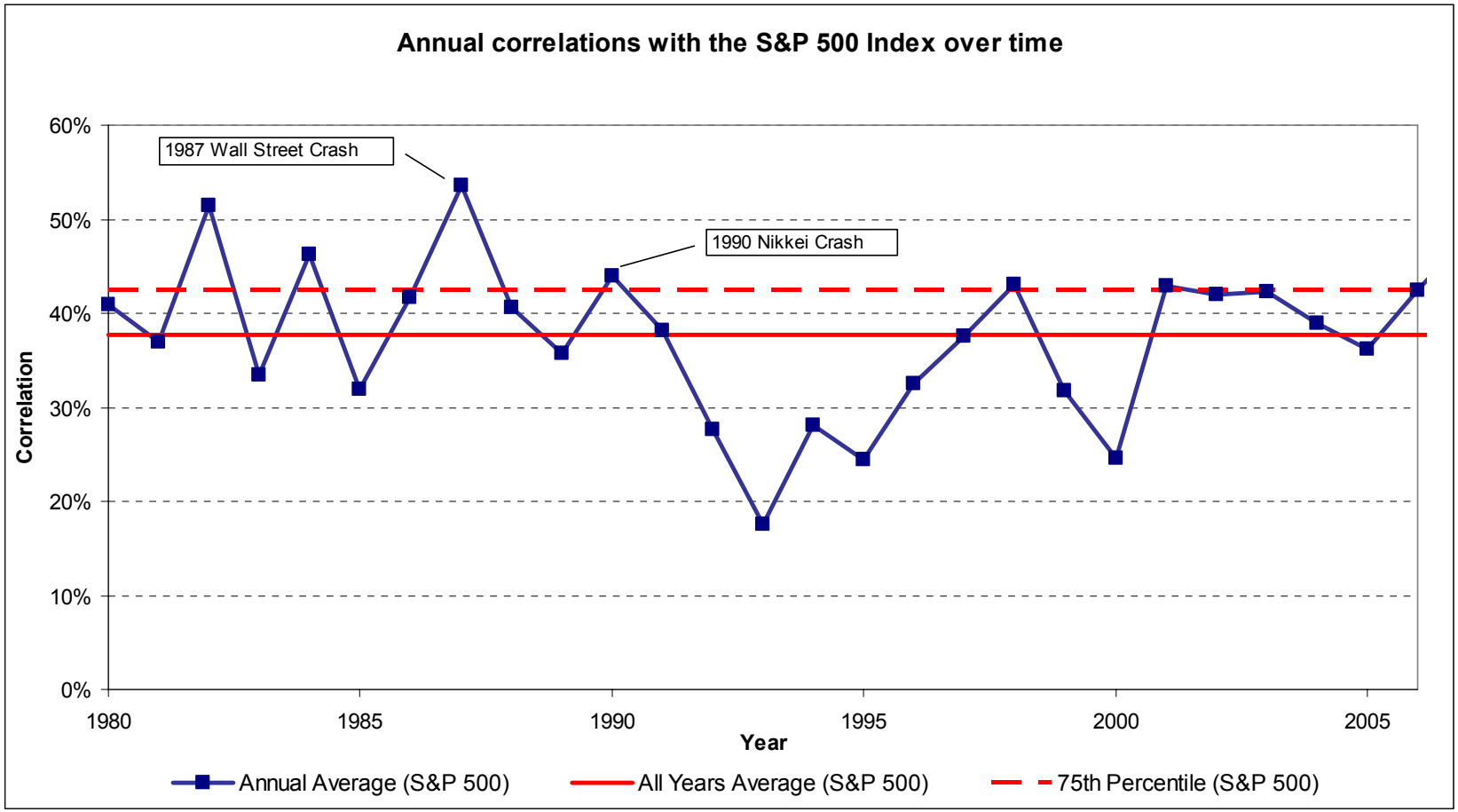
Correlation of 1200+ individual listed and rated equity positions with a broad market index (S&P Global 1200) over an 18 year period (Source: Bloomberg, Macquarie analysis)

Variation of correlations with size & rating





Variation of correlations with time



- Correlations vary with time, however even in periods of stress remain below 100%

Correlation of 5000+ individual global large and small cap equities with the S&P 500 Index

The story so far: rough answer

- Approximate capital ratio for an equity portfolio (e.g. S&P 500):

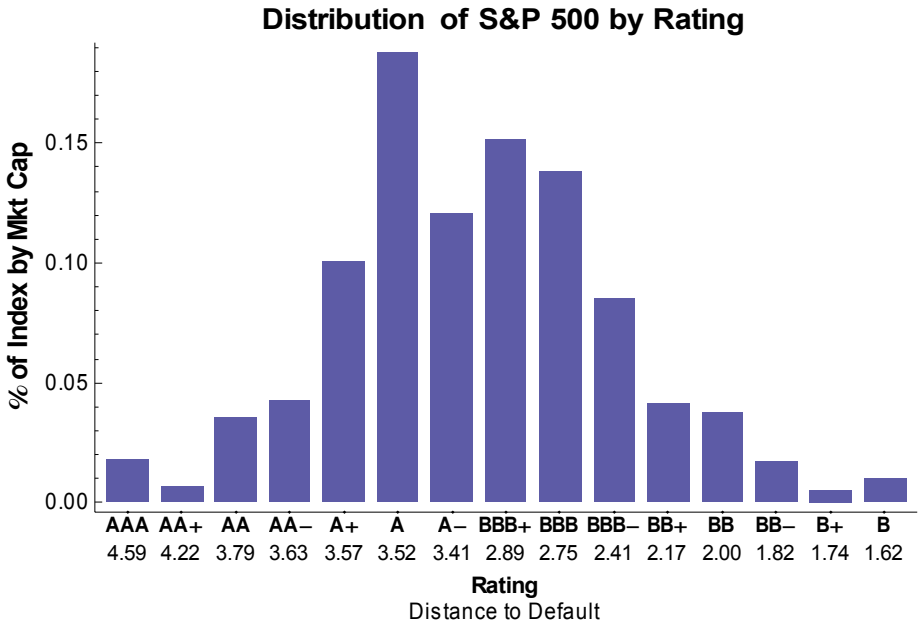
$$K \approx Z_\alpha \cdot \sigma \cdot \sqrt{\rho}$$

$$\approx \frac{Z_\alpha}{DD} \cdot \sqrt{\rho}$$

$$\approx \frac{3.09}{3.28} \cdot 0.48$$

$$\approx 0.45$$

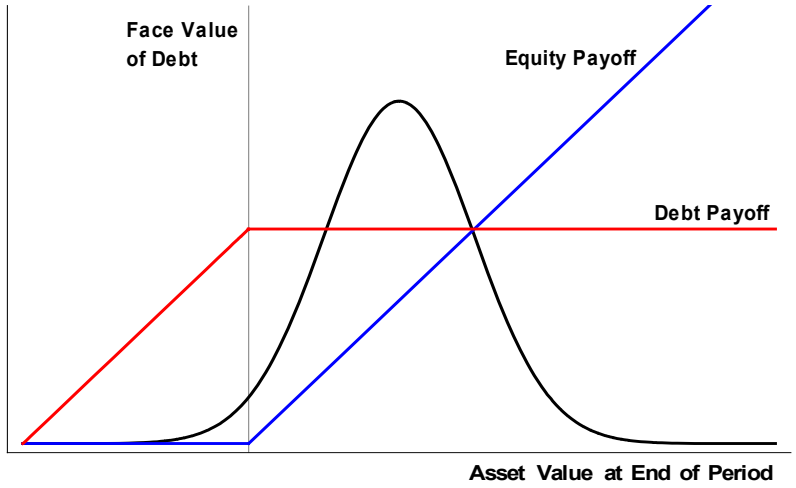
Distance to Default

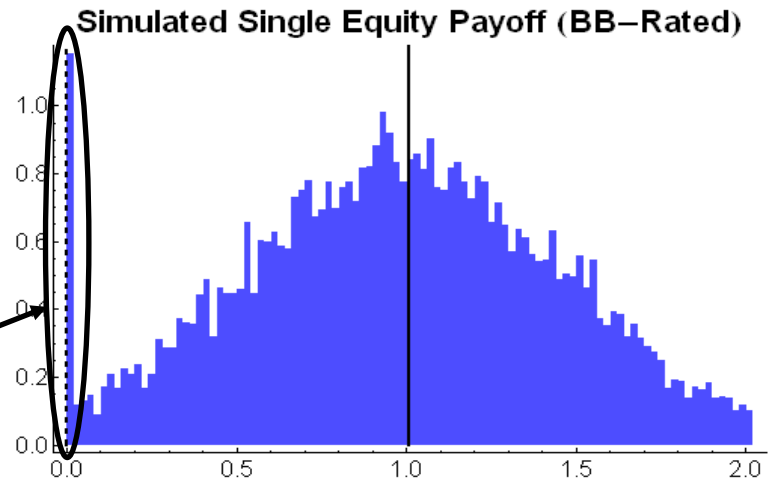


Ignores: value of the put option, discounting & equity recovery at default → see later

Modelling the "insolvency put option"

- Merton Model: equity is a geared asset position plus an 'insolvency put option'
- Put option ensures that equity holders can't lose more than they put in
- Loss on any equity exposure is capped at 100%
  - …but the probability of losing 100% is greater for more volatile assets
  - More volatile assets make a bigger contribution to portfolio risk
- Measure Inherent Risk by Probability of Total Loss

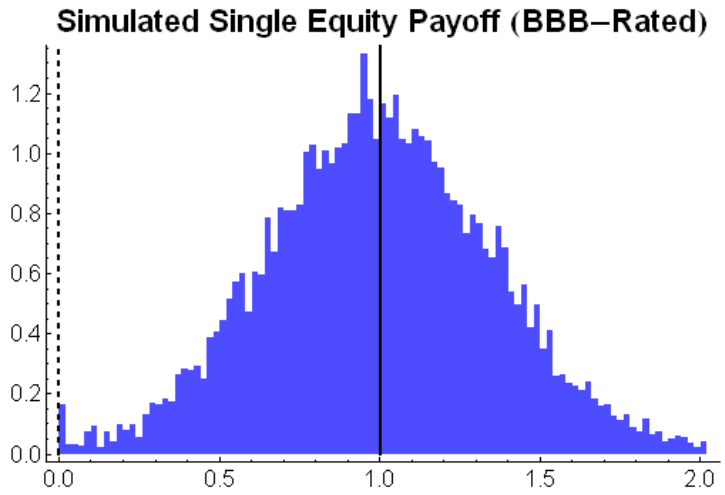


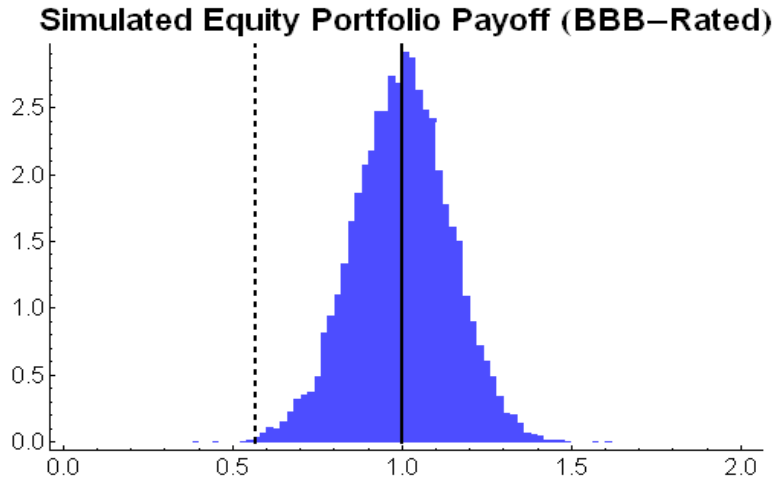


BB-Rated
S&P Idealised PD = 2.30%

More volatile assets make a bigger contribution to portfolio risk, despite loss being capped

BBB





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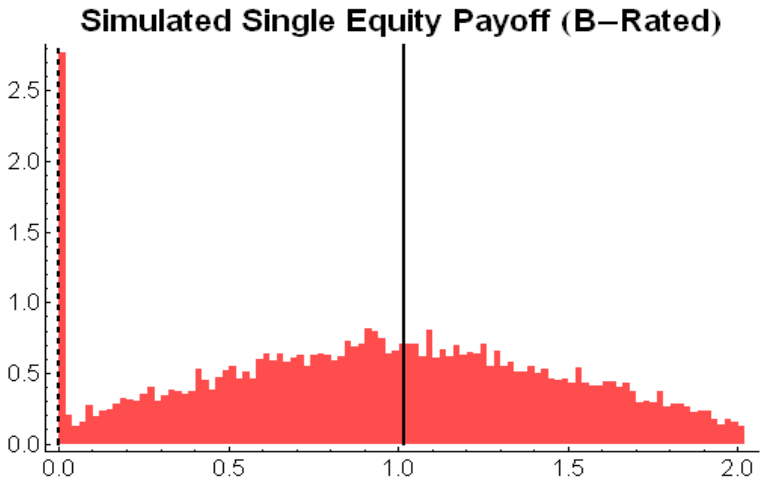
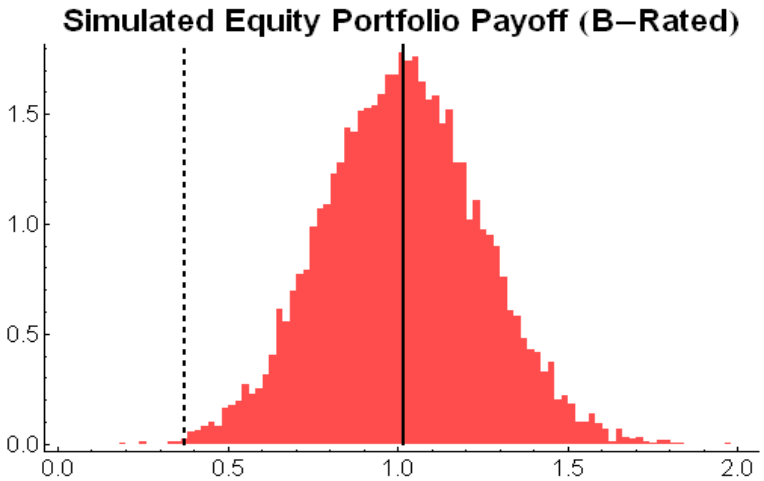
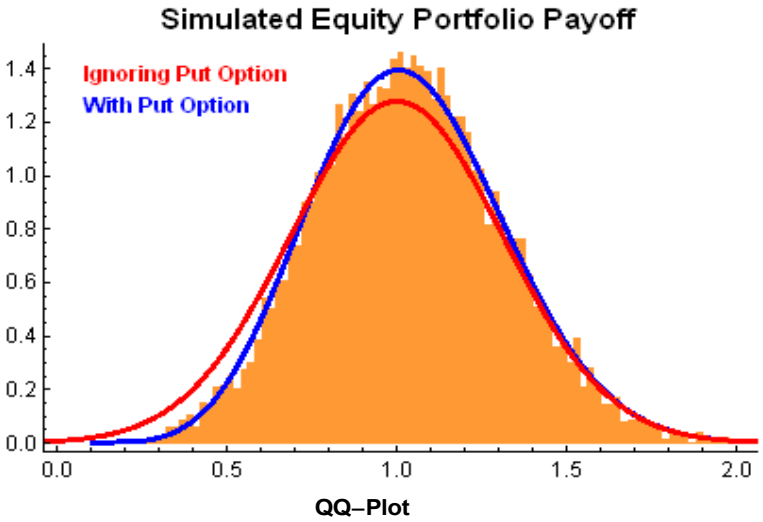
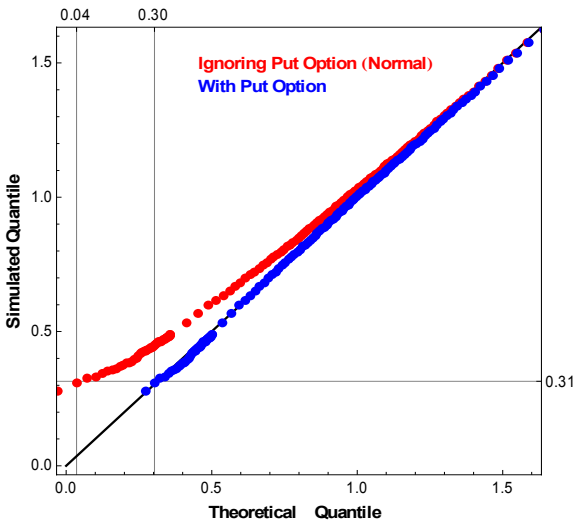




Under Basel 2 assumptions we derive an analytical formula for the equity portfolio loss





- Single Factor model

$$Y_j = \sqrt{\rho_j} \cdot X + \sqrt{1-\rho_j} \cdot U_j$$

- Portfolio risk contribution of an equity position at α-quantile

$$E_{j,\alpha} = 1 + \frac{\sqrt{\rho_j}}{d_j} X_\alpha + \frac{1}{d_j} E\left[\mathrm{Max}\left(0, \left[-d_j - \sqrt{\rho_j} X_\alpha - \sqrt{1-\rho_j} U_j\right]\right)\right]$$

- From this we can compute the unexpected loss ratio
- Combine with valuation model to produce a current capital requirement

Capital ratio by industry and rating

- Applying the analytical formula to the S&P500 gives a capital ratio of 42% (cf. 45% under classical portfolio model approximation)

BBB infrastructure investment

LBO Portfolio

	AAA	AA	A	BBB	BB	B	CCC
Utilities	0.19	0.27	0.28	0.32	0.37	0.41	0.54
Infrastructure	0.23	0.31	0.32	0.37	0.43	0.47	0.60
Transportation	0.27	0.37	0.38	0.44	0.51	0.54	0.68
Materials	0.30	0.42	0.43	0.49	0.57	0.61	0.74
Miscellaneous	0.30	0.40	0.42	0.48	0.55	0.59	0.72
Banks	0.32	0.42	0.44	0.50	0.57	0.61	0.74
Media	0.33	0.46	0.48	0.55	0.63	0.67	0.78
Diversified Financials	0.43	0.57	0.59	0.66	0.74	0.78	0.87
95% Asset-Asset Correlation	0.63	0.78	0.84	0.99	1.00	1.00	1.00

B-rated media firm

First-loss piece of securitisation

Using S&P idealised PD's; assuming no equity recovery at default

Summary and further issues

- Equity risk and credit risk require different economic capital treatments
- An analytical formula for the equity portfolio distribution can be derived under Basel 2 assumptions
- Inherent Risk can be characterised by Probability of Total Loss, mapped from a rating scale
- Correlations exhibit variation by industry, rating and over time
- Equity positions require more capital than credit positions, but substantially less than 100%
- Further Issues
  - Unrealised gains / 'latent gains'
  - Economic Capital Ratio vs. Unexpected Loss Ratio
  - Required Capital vs. Required Return
  - Equity recovered at default
  - Single-name and sector concentration
  - Non-normal distributions / non-normal dependence
  - Inter-risk diversification (or lack thereof)
  - Time Horizon