



C e n t r e
E m i l e
B e r n h e i m

Can a mimicking synthetic equity structure dominate the risk return profile of corporate bonds?

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Outline

- Introduction
- Research question
- Equity derivative structure and pricing model
- Data
- Results
- Conclusion

Introduction

- Link between traditional asset classes, bonds and stocks
 - Portfolio management : Markowitz framework (1972)
 - Corporate finance : Merton's structural model of the firm (1973)
 - Financial stability and market continuum: Hass (2003)
- Bonds and stocks are often analysed separately
 - Bonds : interest rate and credit spread dynamics, links with probability of default
 - Stocks : equity risk premium, factor investing

Introduction

- New academic literature since Black & Scholes (1973) on the use of derivatives and links with traditional assets
 - Merton (78) : derivatives as alternatives to equity underlying for portfolio managers
 - Koski & Pontif (1995) : how mutual funds use derivatives and **their** impact on performances' s distribution
 - Derivatives and **h**edge funds : Chen & Tech (2008)

Research question

- **Goal:** Replicate the corporate bond asset class with an equity derivative structure and compare them empirically
 - How far do we obtain a similar or different investment profile for the corporate bond asset class?
- **In short:**
 - Does the strategy offer a better yield with a lower probability of default?
 - Does a continuity between bonds portfolio's risk profile and equity risk portfolio exist?

Equity derivative structure and pricing model

- The proposed equity structure is very close to the corporate bond in terms of expected payoff
- 5 years maturity with annual coupon
- Coupon and principal payments conditional on an equity index (Eurostoxx50) barrier level
 - On an annual basis, if the equity index level is above the pre-fixed barrier level, the coupon is paid and the structure continues
 - If the equity index level falls below the barrier, the coupon is not paid and investors receive 40% (standard recovery rate)
 - Same at the maturity date, investors receive 100% + coupon or 40%

Equity derivative structure and pricing model

- Pricing model
 - Monte Carlo simulations with varying volatility

$$S(T) = S(0)e^{\left(\mu - \frac{\sigma^2}{2}\right)T + \sigma\epsilon\sqrt{T}}$$

$$\begin{aligned}T &= 1 \\ \mu &= r - d \\ \epsilon &\sim N(0,1)\end{aligned}$$

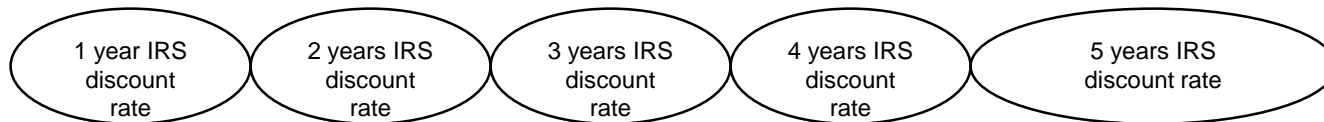
$$S(j, m, n) = S(j - 1) e^{(r_j - d) - \frac{\sigma_{j,m}^2}{2} + \sigma_{j,m} * N(0,1)_{n,j}}$$

j from 1 to 5 years
m from - 50% to 60% by 5%
n from 1 to 2000

Equity derivative structure and pricing model

- Possible payoffs
 - SL = simulated level
 - BL = barrier level

Years	1		2		3		4		5		6	
	SL vs BL	Payoff	SL vs BL	Payoff	SL vs BL	Payoff	SL vs BL	Payoff	SL vs BL	Payoff	SL vs BL	Payoff
1	SL < BL	40	SL > BL	Coupon	SL > BL	Coupon	SL > BL	Coupon	SL > BL	Coupon	SL > BL	Coupon
2		0	SL < BL	40	SL > BL	Coupon	SL > BL	Coupon	SL > BL	Coupon	SL > BL	Coupon
3		0		0	SL < BL	40	SL > BL	Coupon	SL > BL	Coupon	SL > BL	Coupon
4		0		0		0	SL < BL	40	SL > BL	Coupon	SL > BL	Coupon
5		0		0		0		0	SL < BL	40	SL > BL	100



Data

- Equity Index : Eurostoxx50
- Daily data from 04/02/11 to 27/01/2015 (source Bloomberg)
- Interest rate : EUR swap rate curve (source Bloomberg)
- Dividend yield : reflects the average anticipated level of the market (source Bloomberg)

- Volatility

- 3-dimensional data matrix taking into account the skew and tenor effects
- Volatility surface for each observation day

Maturity	Moneyess																	
	-50%	-40%	-30%	-25%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%	25%	30%	40%	50%	60%
1 year	36,84%	32,71%	29,18%	27,59%	26,10%	24,71%	23,40%	22,18%	21,05%	20,02%	19,11%	18,32%	17,67%	17,17%	16,80%	16,46%	16,49%	16,72%
2 years	31,87%	29,05%	26,63%	25,54%	24,52%	23,57%	22,69%	21,88%	21,13%	20,44%	19,82%	19,27%	18,77%	18,34%	17,97%	17,40%	17,06%	16,90%
3 years	29,62%	27,41%	25,48%	24,62%	23,82%	23,08%	22,39%	21,75%	21,17%	20,64%	20,15%	19,71%	19,31%	18,95%	18,63%	18,09%	17,69%	17,41%
4 years	28,38%	26,50%	24,86%	24,13%	23,45%	22,82%	22,25%	21,71%	21,22%	20,77%	20,36%	19,99%	19,65%	19,34%	19,06%	18,57%	18,18%	17,88%
5 years	27,62%	25,96%	24,50%	23,85%	23,25%	22,70%	22,19%	21,72%	21,29%	20,90%	20,54%	20,21%	19,92%	19,64%	19,39%	18,96%	18,60%	18,31%

- Corporate bond spreads
 - Merrill Lynch corporate bond spreads vs IRS (source Bloomberg)
 - Rating class sub-indexes : AAA - AA - A- BBB

	AAA	AA	A	BBB	BB
Mean	0,429	0,644	1,082	2,076	3,970
Minimum	0,140	0,180	0,390	0,950	2,160
Maximum	0,820	1,850	2,850	4,020	7,060
Median	0,450	0,490	0,820	1,890	3,600

- Average Modified Duration

AAA	AA	A	BBB	BB
5,74	5,10	5,28	5,57	5,74

Results

Yield differences

AA		Average	Minimum	Maximum	Median	% of difference > 0
	35%	0,2192	-0,3225	1,552	0,131	66,92%
	40%	0,6819	-0,1355	2,352	0,5745	95,70%
	45%	1,2657	0,2285	3,3565	1,1545	100,00%
	50%	1,9807	0,6915	4,272	1,7775	100,00%
	55%	2,8160	1,3495	5,073	2,636	100,00%
	60%	3,9201	2,0915	7,072	3,776	100,00%
	65%	5,2118	3,1895	8,3165	4,982	100,00%

In more than 95% of cases, equity structure with 40% barrier offers a better yield than AA corporate bond index

A		Average	Minimum	Maximum	Median	% of difference > 0
	35%	-0,2195	-0,7725	0,8085	-0,243	13,53%
	40%	0,2431	-0,3655	1,6085	0,216	74,33%
	45%	0,8269	-0,0315	2,6937	0,8055	99,57%
	50%	1,5419	0,4515	3,5925	1,4605	100,00%
	55%	2,3772	1,0895	4,093	2,331	100,00%
	60%	3,4813	1,8515	6,2885	3,4635	100,00%
	65%	4,7730	2,9295	7,6885	4,661	100,00%

In more than 99% of cases, equity structure with 45% barrier offers a better yield than A corporate bond index

BBB		Average	Minimum	Maximum	Median	% of difference > 0
	35%	-1,2127	-2,385	-0,4245	-1,1195	0,00%
	40%	-0,7500	-1,8685	0,322	-0,7395	1,18%
	45%	-0,1662	-1,105	1,3737	-0,234	25,35%
	50%	0,5488	-0,2285	2,3025	0,4385	97,10%
	55%	1,3841	0,5015	2,894	1,3195	100,00%
	60%	2,4882	1,2615	5,042	2,4355	100,00%
	65%	3,7799	2,4095	6,3785	3,6975	100,00%

In more than 97% of cases, equity structure with 50% barrier offers a better yield than BBB corporate bond index

BB		Average	Minimum	Maximum	Median	% of difference > 0
	35%	-3,1072	-4,9755	-1,799	-2,9955	0,00%
	40%	-2,6445	-4,458	-1,3855	-2,572	0,00%
	45%	-2,0607	-3,658	-0,7455	-2,0185	0,00%
	50%	-1,3457	-2,665	-0,0535	-1,3155	0,00%
	55%	-0,5104	-1,6505	0,9065	-0,5245	12,89%
	60%	0,5936	-0,5705	2,1865	0,523	93,56%
	65%	1,8854	0,911	3,3865	1,8245	100,00%

Results

- Equivalent cumulative probability of default

Barrier level	35%	40%	45%	50%	55%	60%	65%
Cumulative probability of failure	0,014%	0,170%	1,354%	4,976%	14,557%	24,760%	34,538%

- Corporate bond S&P probability of default

Rating	Probability of default
AA	0,36%
A	0,62%
BBB	2,15%
BB	8,35%

Results

- Risk spread analysis
 - Spread and expected spread for each risk profile

	Average spread	Probability of défaut	Survival probability	Expected spread
AA	0,6437	0,36%	99,64%	0,6414
A	1,0825	0,62%	99,38%	1,0758
BBB	2,0756	2,15%	97,85%	2,0310
BB	3,9701	8,35%	91,65%	3,6386
50%	2,6221	0,014%	99,99%	2,6218
45%	1,9078	0,170%	99,83%	1,9046
40%	1,3246	1,354%	98,65%	1,3067
35%	0,8624	4,976%	95,02%	0,8195
55%	3,4566	14,557%	85,44%	2,9534
60%	4,5595	24,760%	75,24%	3,4306
65%	5,8499	34,538%	65,46%	3,8295

- Expected spread difference for each barrier level (%)

	AA	A	BBB	BB
50%	1,9804	1,5460	0,5908	-1,0169
45%	1,2632	0,8288	-0,1264	-1,7340
40%	0,6653	0,2309	-0,7243	-2,3320
35%	0,1781	-0,2563	-1,2115	-2,8191
55%	2,3120	1,8777	0,9224	-0,6852
60%	2,7892	2,3548	1,3996	-0,2080
65%	3,1881	2,7537	1,7985	0,1908

AA and A rating class offer a lower risk yield profile than the equity structure

Conclusion / Extension

- In a buy and hold framework : the use of equity derivatives can offer a better risk profile than a corporate bond index
- Expected spread is mostly better for AA and A rating class
- No duration adjustment
- Extension to a classical risk return analysis?
- Go deeper in the link analysis between credit spread and equity put option parameters (dividend yield, volatility)