How profitable is capital structure arbitrage?

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Fresh off the press...

"The most significant development since the invention of the credit default swap itself nearly 10 years ago."

"Trading default protection versus equity is going to become the hottest strategy in the arbitrage community next year."

"For bank prop desks, it's the next big thing, a handy strategy to replace the riches several garnered from playing the interest rate and forex markets."

—Euromoney, December 2002

"During May and June, capital structure arbitrage was one of the few hedge fund techniques in positive territory."

—Financial Times, July 21, 2004

What is a credit default swap?

- A credit default swap (CDS) is an insurance contract against credit events such as the default on a bond by a specific issuer (the obligor).
- The buyer pays a premium to the seller once a quarter until the maturity of the contract or the credit event, whichever occurs first.
- The seller is obligated to take delivery of the underlying bond from the buyer for face value should a credit event take place.
- The definition of the credit event can include bankruptcy, failure to pay, or restructuring.

What is capital structure arbitrage?

- The capital structure arbitrageur uses a structural model to gauge the richness/cheapness of the CDS spread.
- The model, typically a variant of Merton (1974), predicts spreads based on a company's liability structure and its market value of equities.
- When the arbitrageur finds that the market spread is substantially larger than the predicted spread, he sells CDS and sells equity.
- When the arbitrageur finds that the market spread is substantially smaller than the predicted spread, he buys CDS and buys equity.

If market disagrees with model...

- The equity market may be more objective, and the CDS market may be gripped by fear.
- Or, it may be the other way around. The CDS market is correct, and the equity market is slow to react.
- The equity position is determined by delta-hedging, lest the arbitrageur guessed wrong.
- Caveats:
  - The model itself can be misspecified.
  - Inputs to the model can be mis-measured.

Possible scenarios when shorting

1. $c_t \downarrow$, $S_t \downarrow$. The arbitrageur profits from both positions.
2. $c_t \downarrow$, $S_t \uparrow$. The arbitrageur loses from equity but profits from CDS.
3. $c_t \uparrow$, $S_t \downarrow$. The arbitrageur loses from CDS but the equity position acts as a hedge against this loss.
4. $c_t \uparrow$, $S_t \uparrow$. The arbitrageur suffers losses from both positions regardless of the size of the equity hedge.

Research questions

- Apparently, this is no textbook arbitrage.
- If this is merely taking risk, what is the risk involved?
- What is the risk and return of this strategy? Any abnormal return after adjusting for risk?
- Does this constitute "statistical arbitrage"?

Related literature

- The performance of structural models for pricing CDS.
  - Jones, Mason, and Rosenfeld (1984), Eom, Helwege, and Huang (2004), and Ericsson, Reneby, and Wang (2004).
- The methodology is similar to Duarte, Longstaff, and Yu (2005) on fixed income arbitrage, and Mitchell and Pulvino (2001) on merger arbitrage.

- Capital structure arbitrage started with trading bonds against CDS, or bonds against equities.
  - Bond spread vs. CDS spread. Duffie (1999), Hull, Predescu, and White (2003), Houweling and Vorst (2003), Blanco, Brennan, and Marsh (2003).
  - Bonds versus equities. Schaefer and Strebulaev (2004), Chatiras and Mukherjee (2004).
  - Lead-lag relations. Longstaff, Mithal, and Neis (2003), Berndt and de Melo (2003), Zhu (2004).

CDS pricing

- First, the present value of the premium payments is equal to

$$E\left(c\int_0^T \exp\left(-\int_0^s r_u du\right) 1_{\{\tau>s\}} ds\right).$$

- Second, the present value of the credit protection is equal to

$$E\left((1-R)\exp\left(-\int_0^\tau r_u du\right) 1_{\{\tau<T\}}\right).$$

- The CDS spread is then determined by setting the initial value of the contract to zero:

$$c = -\frac{(1-R)\int_0^T P(0,s)\, q_0'(s)\, ds}{\int_0^T P(0,s)\, q_0(s)\, ds}.$$

- The preceding derives the CDS spread on a newly minted contract. If it is subsequently held, the relevant issue is the value of the contract as market conditions change.
- To someone who holds a long position from time 0 to t, this is equal to

$$\pi(t,T) = (c(t,T) - c(0,T)) \int_t^T P(t,s)\, q_t(s)\, ds.$$

- The equity delta is defined as

$$\delta(t,T) = \frac{\partial \pi(t,T)}{\partial S_t}.$$

CreditGrades

- CreditGrades (CG) is a simple structural model developed by RiskMetrics, JP Morgan, Goldman Sachs, and Deutsche Bank.
- It is based on the model of Black and Cox (1976), and contains the additional element of uncertain recovery.
- This latter feature helps to increase the short-term default probability, which is needed to produce realistic levels of CDS spreads.
- It is also reputed as the model used by most capital structure arbitrage professionals.

- CG assumes that the firm's value per share is given by

$$\frac{dV_t}{V_t} = \sigma dW_t.$$

- Debt per share is D and the default threshold is

$$LD = \overline{L}De^{\lambda Z - \lambda^2/2},$$

where $Z \sim N(0,1)$.

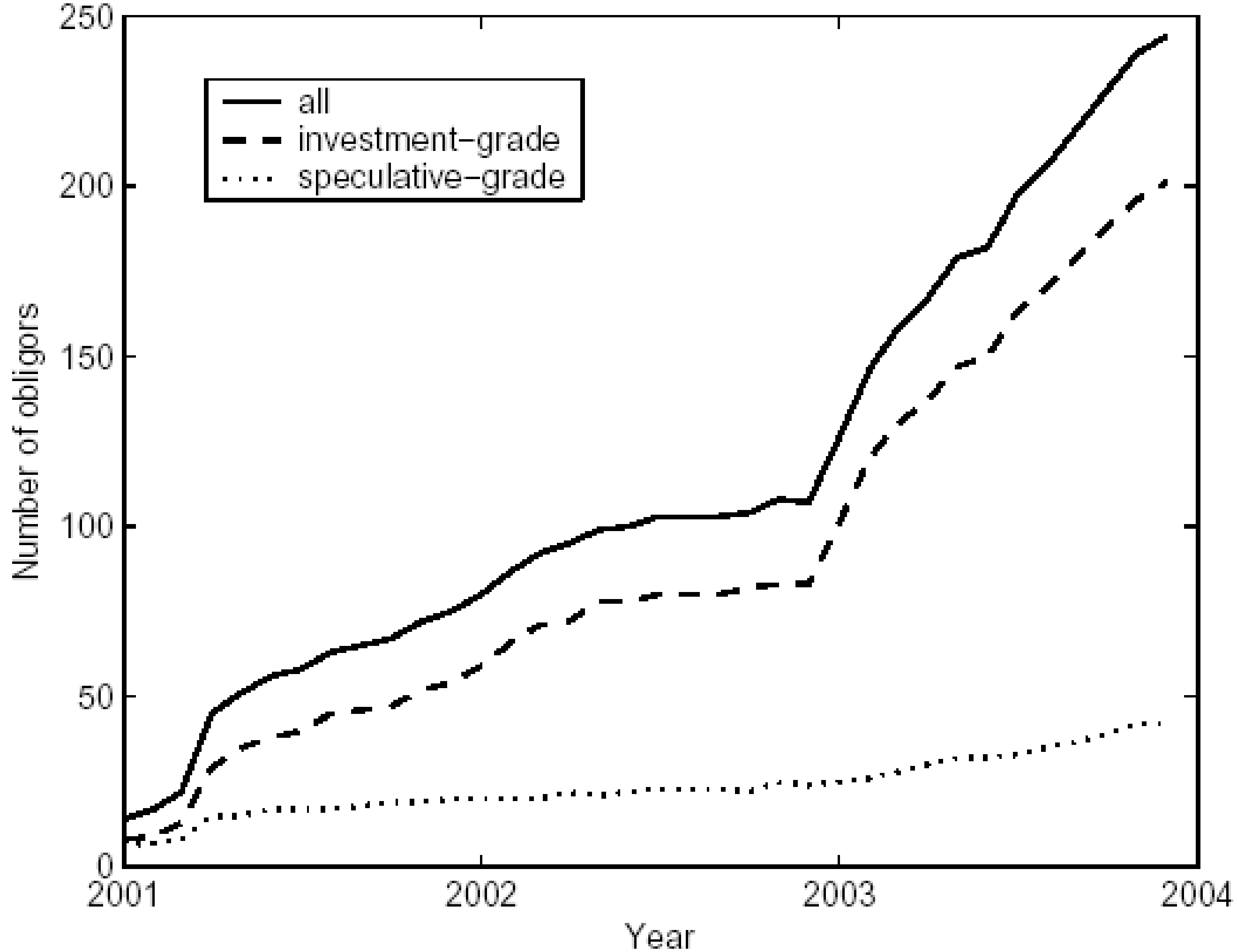
- Asset volatility and equity volatility are related by

$$\sigma = \sigma_S \frac{S}{S + \overline{L}D}.$$

- Survival probabilities and CDS spreads can be computed analytically with these inputs: $\left(S, D, \sigma_S, \overline{L}, \lambda, r, R\right)$.

Data

- CDS data obtained from Markit Group:
  - 5-yr CDS on North American obligors, 2001-2004.
- Two step procedure to get to the final sample:
  - Merging with Compustat and CRSP data.
  - Continuous daily coverage with no more than a 2-wk break.
- Final sample: 135,759 daily spreads on 261 obligors.


all
investment−grade
speculative−grade
Number of obligors
0
50
100
150
200
250
2001
2002
2003
2004
Year

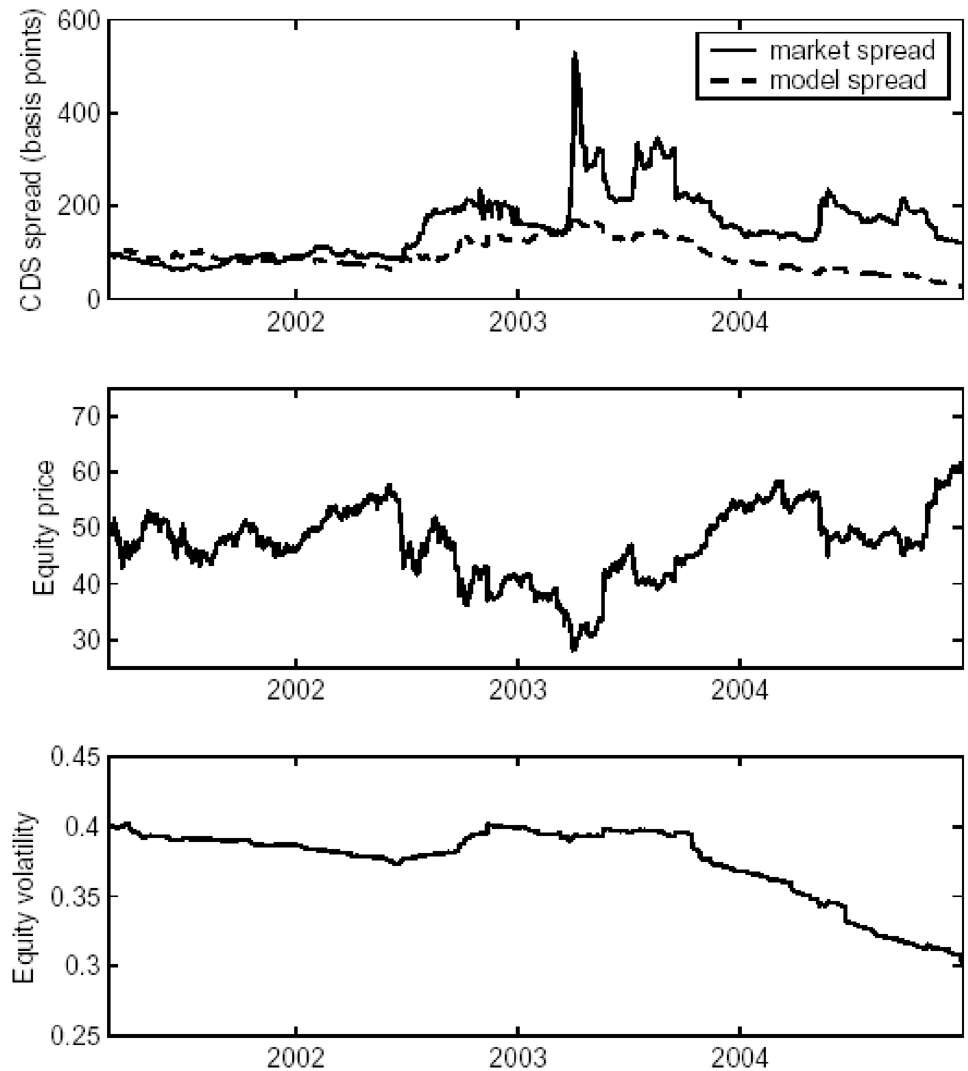
Category	N	SPD	VOL	LEV	SIZE	CORR
AAA	4	13	0.30	0.29	257,415	0.01
AA	12	16	0.32	0.20	81,306	-0.06
A	68	37	0.37	0.32	30,123	-0.04
BBB	126	84	0.39	0.46	9,381	-0.05
BB	35	247	0.51	0.56	7,162	-0.07
B	11	444	0.65	0.66	3,627	-0.12
CCC	3	627	0.56	0.82	3,949	-0.23
NR	2	388	0.73	0.68	22,858	-0.16
Comm. and Tech.	35	153	0.51	0.42	32,373	-0.07
Consumer Cyclical	56	134	0.43	0.45	15,850	-0.07
Consumer Stable	49	75	0.36	0.34	34,926	-0.07
Diversified	1	81	0.29	0.40	8,057	-0.02
Energy	30	96	0.39	0.46	20,142	-0.03
Industrial	52	102	0.42	0.46	18,542	-0.05
Materials	38	126	0.39	0.50	7,224	-0.04

Case study of Altria Group

- Altria (aka Philip Morris) has been mired in tobacco-related legal problems since the early nineties.
- In March 2003, a circuit court Judge in Illinois ordered Altria to post a $12 billion bond to appeal a class action lawsuit.
- This news led to worries that Altria may have had to file for bankruptcy, triggering Moody's to downgrade Altria from A2 to Baa1 on March 31, 2003.
- The trading analysis uses the period from February 28, 2001 to December 31, 2004, which consists of 962 daily observations of CDS market spreads.

Estimation procedure

- Following the CreditGrades Technical Document (2002), I set λ to 0.3 and σ_S to the 1,000 day historical equity volatility.
- Debt per share is total liabilities divided by shares outstanding.
- Bond recovery rate R is set to 0.5.
- For the risk-free rate I use the five-year CMT yield.
- I calibrate the default threshold $\overline{L}$ by fitting the first ten market spreads to the model spreads.
- I find $\overline{L} = 0.62$.



CDS spread (basis points)
600
400
200
0
market spread
model spread
2002
2003
2004
Equity price
70
60
50
40
30
2002
2003
2004
Equity volatility
0.45
0.4
0.35
0.3
0.25
2002
2003
2004

Trading strategy

- For each of the 962 days in the sample period, I check whether the market spread and the predicted spread differ by more than a threshold value:

$$c_t > (1+\alpha)\, c'_t \text{ or } c'_t > (1+\alpha)\, c_t.$$

- If so, then a CDS position is entered into along with its equity hedge using the hedge ratio from the CG model.
- This position is held for a fixed number of days or until convergence, where convergence is defined as $c_t = c'_t$.
- The positions are liquidated when their value goes to zero.

Returns, once again

- Value of the contract is

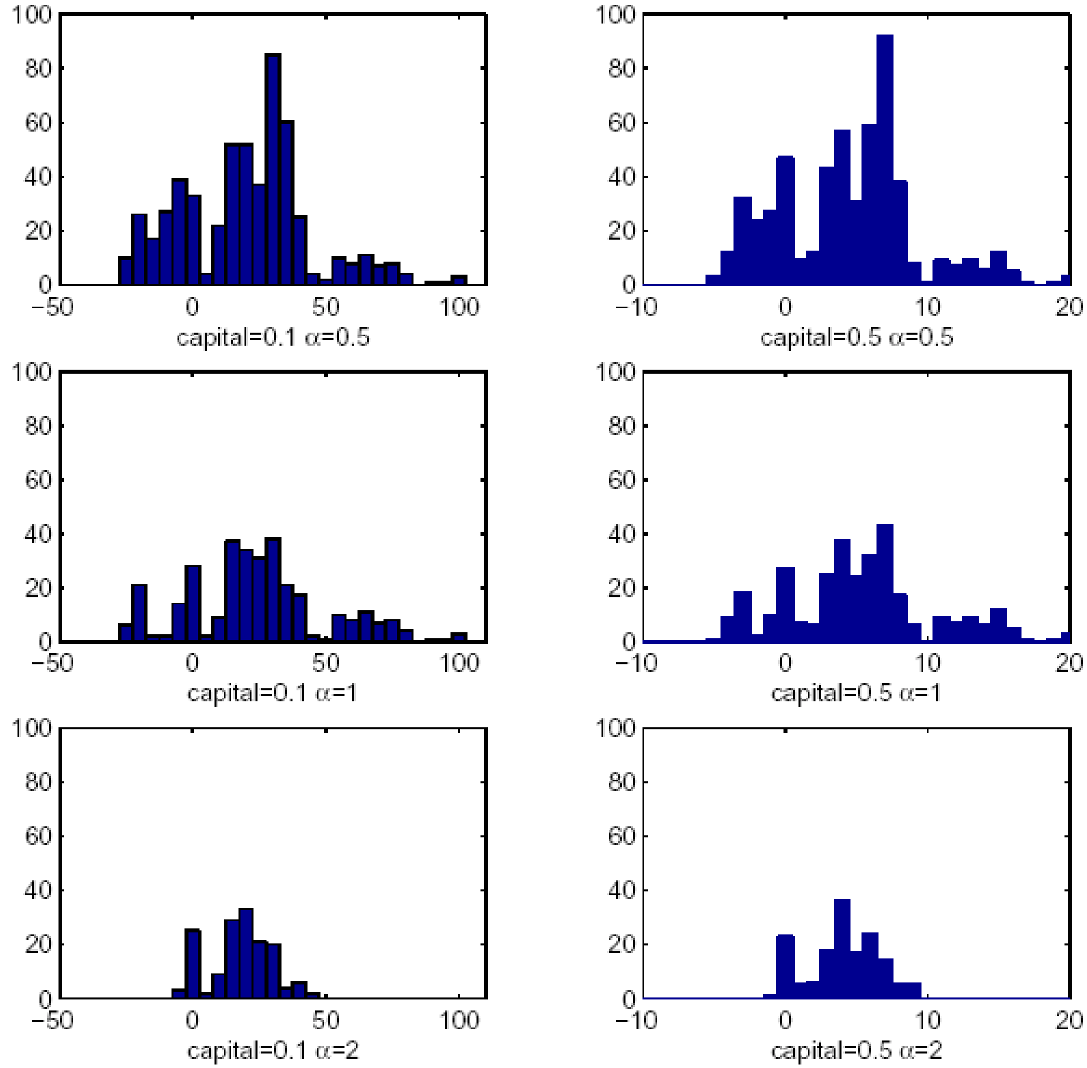
$$\pi(t,T) = (c(t,T) - c(0,T)) \int_t^T P(t,s)\, q_t(s)\, ds.$$

- $c(t,T)$ is approximated by $c(t,T+t)$—spread of "fresh" contracts.
- $q_t(s)$ is computed from the CG model.

Summary of the Altria case

- Returns are on average positive but highly volatile.
  - Risk is about ten times larger than Duarte, Longstaff, and Yu (2005)'s swap spread arbitrage.
- Large negative returns occurred because the arbitrageur traded "too early."
  - The equity hedge can be totally ineffective at times.
- When the threshold is raised, the likelihood for negative returns declines.
- With a larger holding period, more trades converge.

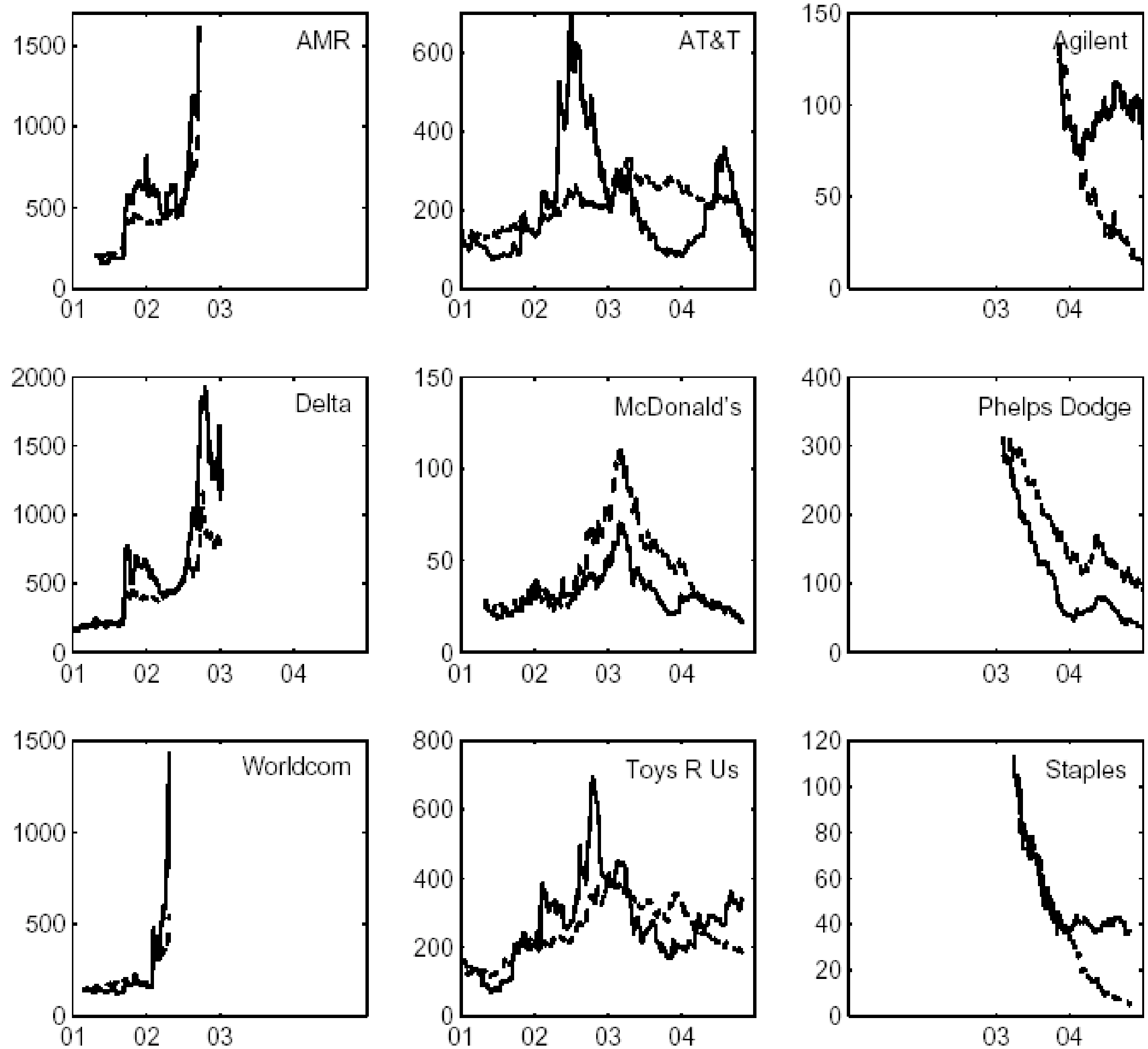
Capital	HP	α	N	N_1	N_2	N_3	Mean	Min	Max
0.1	30	0.5	550	0	104	260	0.10	-104.56	94.24
		1	319	0	53	142	2.46	-44.66	94.24
		2	154	0	14	56	2.22	-20.08	18.04
	180	0.5	550	76	235	140	20.20	-104.56	113.37
		1	319	8	96	61	24.68	-25.10	113.37
		2	154	0	25	19	18.03	-2.68	43.46
0.5	30	0.5	550	0	1	252	0.14	-10.68	18.92
		1	319	0	0	138	0.58	-8.87	18.92
		2	154	0	0	54	0.55	-3.91	3.75
	180	0.5	550	76	1	134	4.50	-4.63	23.06
		1	319	8	0	60	5.37	-4.52	23.06
		2	154	0	0	18	4.04	-5.32	9.30



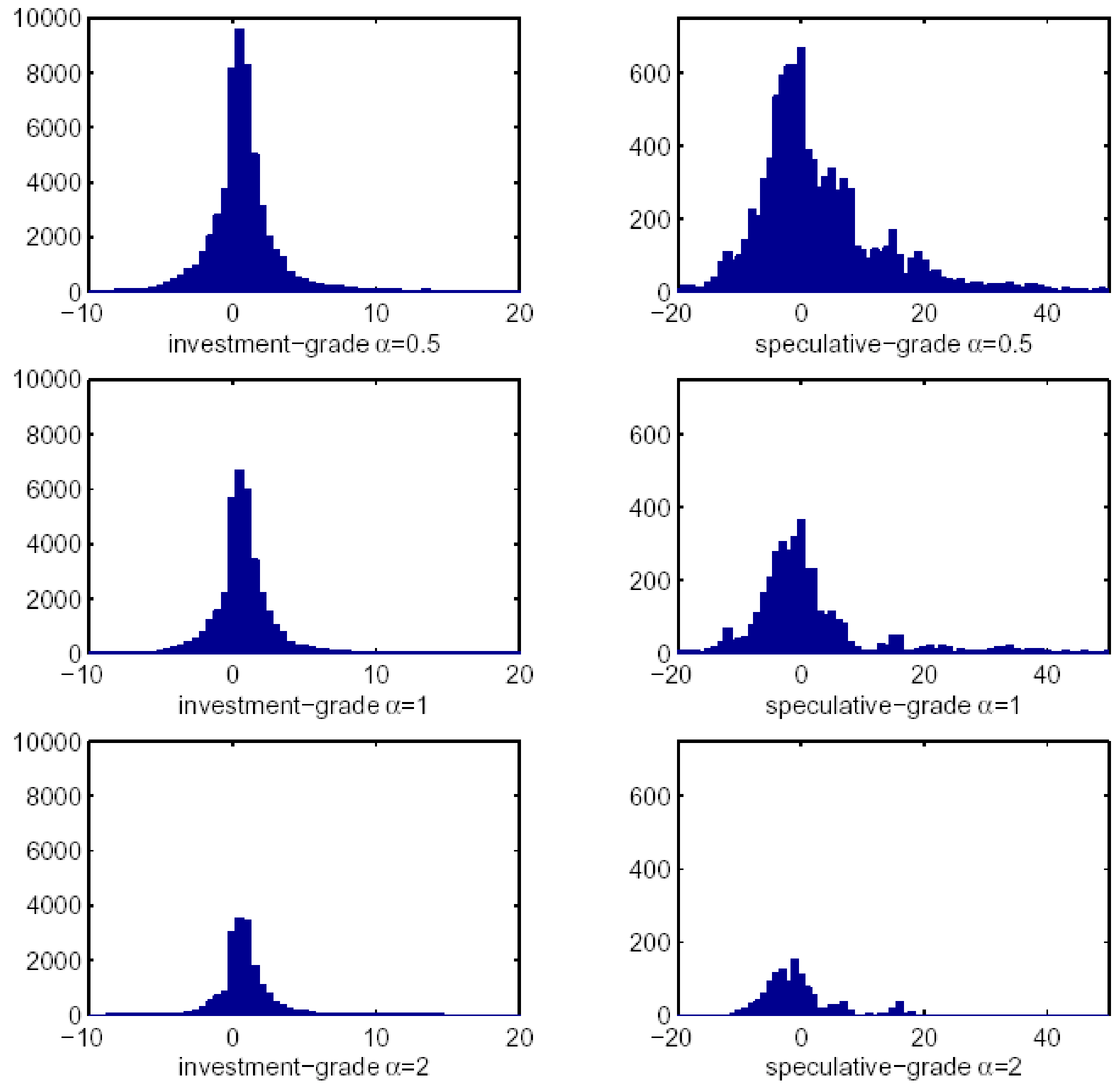
100
80
60
40
20
0
−50
0
50
100
capital=0.1 α=0.5
−10
0
10
20
capital=0.5 α=0.5
capital=0.1 α=1
capital=0.5 α=1
capital=0.1 α=2
capital=0.5 α=2

Summary for all obligors

- The obligors can be roughly separated into three groups.
  - Category 1: Market and predicted spreads are closely related.
  - Category 2: Market and predicted spreads are closely related up to a point.
  - Category 3: Market and predicted spreads are slowly drifting apart.
- The properties of the holding period returns are similar to those of the Altria Group.


AMR
AT&T
Agilent
Delta
McDonald's
Phelps Dodge
Worldcom
Toys R Us
Staples

Rating	HP	α	N	N_1	N_2	N_3	Mean	Min	Max
INV	30	0.5	57,621	372	70	28,512	-0.03	-75.16	50.97
		1	37,125	25	50	17,387	0.03	-75.16	50.97
		2	18,173	0	13	7,453	0.13	-8.50	50.97
	180	0.5	57,621	5,615	215	17,872	0.84	-88.71	104.41
		1	37,125	1,235	83	10,140	0.96	-45.69	104.41
		2	18,173	142	25	4,140	1.02	-13.37	104.41
SPEC	30	0.5	9,315	111	204	5,503	-0.52	-49.75	45.60
		1	3,912	0	49	2,302	-0.12	-49.75	31.91
		2	1,191	0	0	746	-0.31	-7.41	29.31
	180	0.5	9,315	1,883	480	4,610	2.78	-54.60	70.29
		1	3,912	367	94	2,238	1.95	-31.63	70.29
		2	1,191	85	0	795	0.05	-11.32	68.72


10000
8000
6000
4000
2000
0
−10
0
10
20
investment−grade α=0.5
600
400
200
0
−20
0
20
40
speculative−grade α=0.5
investment−grade α=1
speculative−grade α=1
investment−grade α=2
speculative−grade α=2

Capital structure arbitrage index returns

- Monthly returns are constructed as follows:
  - Compute daily excess returns for individual trades.
  - Compute an equally weighted average return across all open trades for each day.
  - Aggregate the daily returns into monthly returns.
- These are the returns from an equally weighted portfolio of all available "hedge funds", where each fund is an individual trade.

	α	N	Mean	Med	Min	Max	Std	Corr	Neg	Sharpe
Inv	0.5	48	0.13	0.05	-3.20	3.05	1.13	0.04	0.48	0.39
	1	46	0.13	0.01	-4.37	3.86	1.33	-0.10	0.44	0.35
	2	45	0.30	0.11	-2.60	4.92	1.27	0.09	0.38	0.80
Spec	0.5	45	0.67	0.30	-9.37	13.04	3.16	0.20	0.40	0.74
	1	42	1.01	0.00	-9.87	14.18	4.63	-0.20	0.40	0.76
	2	25	0.93	0.00	-2.62	21.87	4.32	0.49	0.29	0.74

Test for statistical arbitrage

- A statistical arbitrage is a zero initial cost self-financing trading strategy with positive expected discounted profits, a probability of a loss converging to zero, and a time-averaged variance converging to zero.
- Each month, borrow $1 at the risk-free rate to invest in cap arb. The profits are then re-invested at the risk-free rate.
- Use maximum likelihood to estimate the mean of the discounted profit and the rate of decay of its variance (Hogan, Jarrow, Teo, and Warachka 2004).

	α	μ	σ	λ
Inv	0.5	0.17	1.2	-0.56
		0.15	0.2	0.19
	1	0.16	1.4	-0.56
		0.17	0.2	0.16
	2	0.23	1.4	-0.42
		0.24	0.2	0.17
Spec	0.5	0.60	2.7	0.22
		0.46	0.3	0.17
	1	0.45	5.5	-0.63
		0.65	0.6	0.16

Regression of the monthly returns

- Regress monthly returns on market-wide risk factors.
  - Equity market factor proxied by S&P Industrial Index.
  - Bond market factors proxied by Lehman Baa and Ba Intermediate Index.
  - Returns benchmarked against the CSFB/Tremont Fixed Income Arbitrage Index.
- Low R^2 and none of the included factors are significant.
- Duarte, Longstaff, and Yu (2005) find returns on the short-side are negatively related to economy-wide default risk.

	α	Int.	S&PINDS	LHIBAAI	LHHYBBI	CSTINFA	R^2
Inv	0.5	0.22	0.026	-0.19	-0.04	-0.18	0.11
		0.17	0.037	0.13	0.10	0.17	
	1	0.15	-0.014	-0.19	-0.02	-0.04	0.05
		0.21	0.045	0.16	0.12	0.21	
	2	0.27	-0.01	-0.14	-0.01	0.13	0.03
		0.20	0.04	0.16	0.11	0.20	
Spec	0.5	0.44	0.06	0.22	-0.06	0.94	0.12
		0.48	0.10	0.37	0.27	0.47	
	1	0.81	0.08	0.37	-0.41	1.02	0.07
		0.72	0.15	0.55	0.40	0.71	
	2	1.03	0.04	0.38	-0.14	-0.23	0.02
		0.69	0.15	0.53	0.39	0.68	

Robustness checks

- Compute the marked-to-market value of CDS using a different methodology.
- Update the hedge ratio daily.
- Increase the CDS market bid/ask spread.
- Option-implied volatility vs. historical volatility.

	α	N	Mean	Med	Min	Max	Std	Corr	Neg	Sharpe
All	0.5	48	0.27	0.13	-3.20	5.05	1.27	0.21	0.40	0.72
	1	46	0.25	0.05	-4.37	4.87	1.50	0.06	0.40	0.57
	2	45	0.32	0.08	-2.60	5.16	1.29	0.14	0.38	0.87
Value	0.5	48	0.16	0.06	-3.43	4.52	1.26	0.21	0.42	0.45
	1	46	0.19	0.03	-4.50	4.58	1.39	0.09	0.40	0.48
	2	45	0.33	0.08	-2.45	5.13	1.26	0.12	0.35	0.89
Hedge	0.5	48	0.22	0.09	-3.27	5.27	1.31	0.23	0.40	0.58
	1	46	0.23	0.06	-4.54	5.03	1.53	0.06	0.35	0.52
	2	45	0.32	0.08	-2.45	5.31	1.31	0.15	0.35	0.84
Trans	0.5	48	0.17	-0.01	-5.31	5.82	1.69	0.20	0.52	0.36
	1	46	0.07	0.00	-5.66	4.98	1.58	0.19	0.47	0.15
	2	45	0.19	0.04	-4.46	5.39	1.40	0.16	0.42	0.47

Summary

- Capital structure arbitrage is a bet on convergence.
- However, convergence is not the norm, and large losses can occur when the market spread continues to diverge from the model spread.
- A return index constructed from a large cross-section of obligors exhibits attractive Sharpe ratios.
- Some evidence that the strategies produce positive risk-adjusted alphas, and give rise to statistical arbitrage.

The saga continues...

- WSJ (05/11/2005) reported that banks and hedge funds suffered losses on credit derivatives because of declining credit quality.
- WSJ (05/18/2005) reported that many hedge funds lost money on GM when S&P downgraded GM's debt and Kirk Kerkorian put in a $31-per-share acquisition of GM shares.