Risk and return in fixed income arbitrage: Nickels in front of a steamroller?

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Motivation

- Fixed income arbitrage is a broad set of market-neutral investment strategies intended to exploit pricing differences between various fixed income securities.
- Despite painful losses by LTCM and other hedge funds in 1998, fixed income arbitrage has been resurrected as one of the most popular hedge fund sectors in recent years.

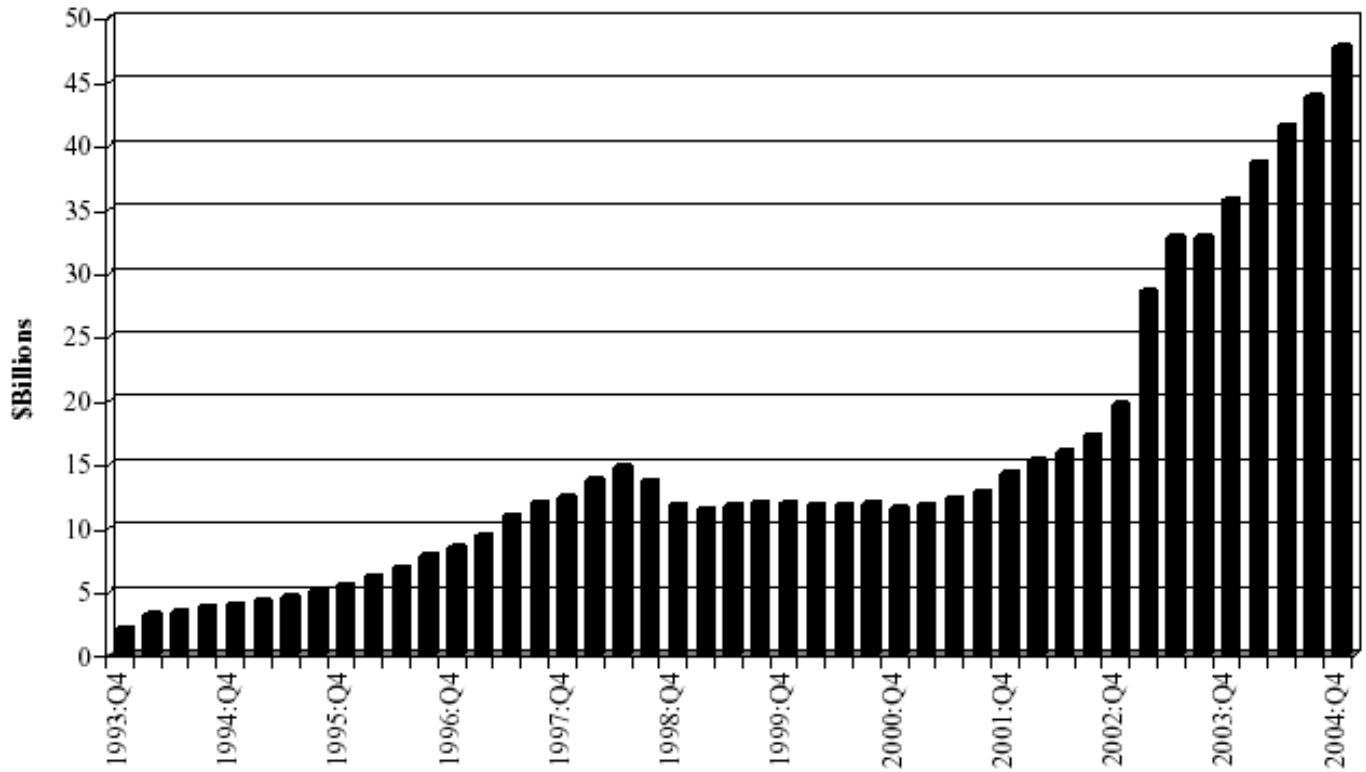


Figure 6. Total Fixed Income Arbitrage Hedge Fund Capital. This graph shows the total capital in fixed income arbitrage hedge fund strategies for the indicated dates reported in the Tremont/Tass (2004) Asset Flows Report.

Open issues

- Is fixed income arbitrage truly arbitrage?
- Is it merely a strategy that earns small positive returns most of the time, but occasionally experiences dramatic losses?
- Were the large losses during the hedge fund crisis simply due to excessive leverage, or were there deeper reasons arising from the inherent nature of these strategies?
- Is there a link between hedge fund returns and hedge fund capital?

List of strategies

- We consider five of the most popular fixed income arbitrage strategies:
  1. Swap spread arbitrage (SS).
  2. Yield curve arbitrage (YC).
  3. Mortgage arbitrage (MA).
  4. Volatility arbitrage (VA).
  5. Capital structure arbitrage (CS).

Methodology

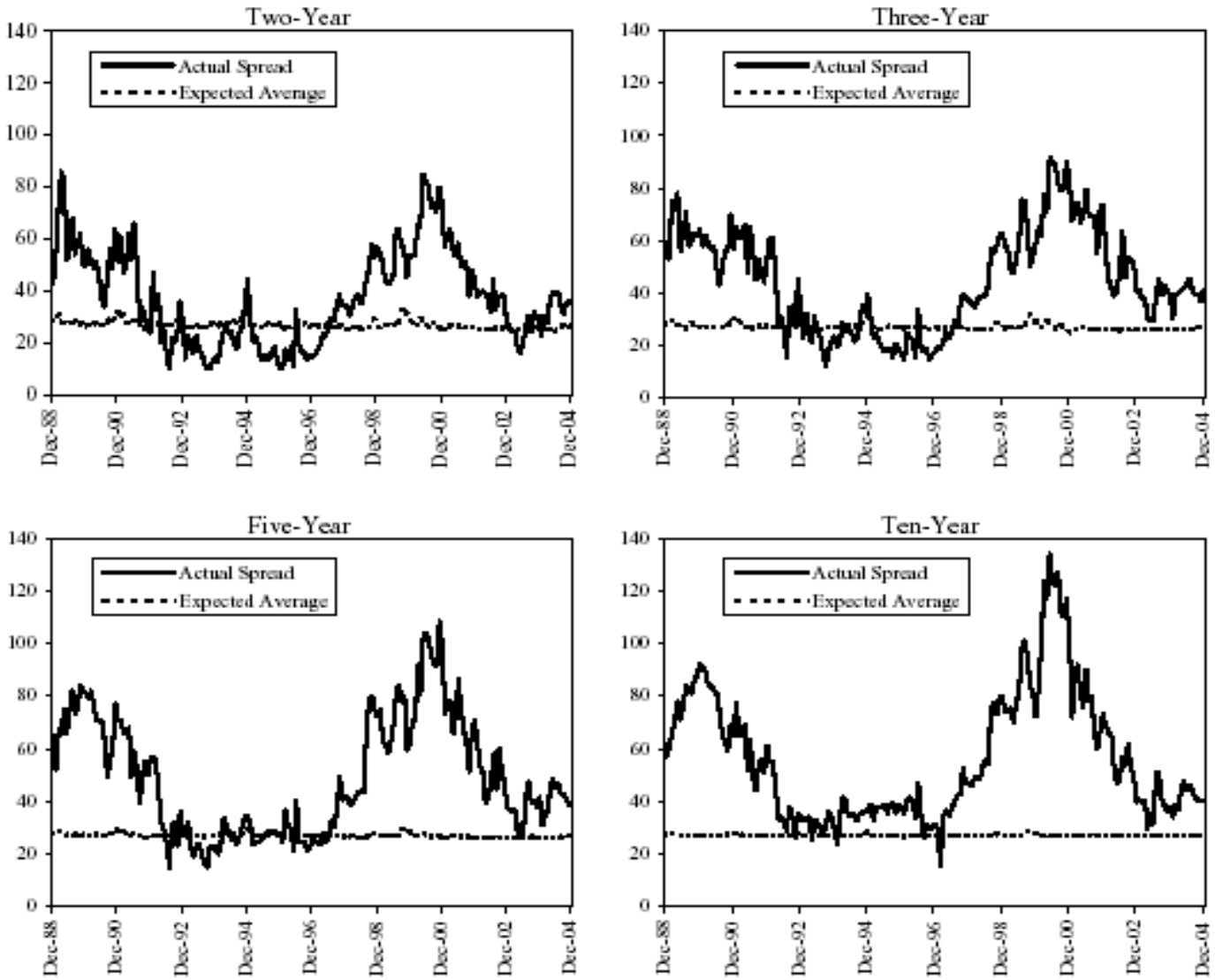
- Like Mitchell and Pulvino (2001), we construct return indexes by following these strategies through time.
- The advantages are:
  - Transaction costs can be explicitly incorporated.
  - The effects of leverage can be held fixed.
  - Returns can be studied over a longer horizon than would be possible using limited hedge fund return data.
  - Backfill and survival biases in reported hedge fund returns can be avoided.

Swap spread arbitrage - intuition

- An arbitrageur enters into a par swap and receives a fixed coupon rate CMS and pays the floating Libor rate L_t.
- He also shorts a par Treasury bond with the same maturity as the swap, paying coupon rate CMT and invests the proceeds in a margin account earning the repo rate r_t.
- Swap spread arbitrage is thus a simple bet on whether the fixed annuity of $SS = CMS - CMT$ received will be larger than the floating spread $S_t = L_t - r_t$ paid.
- Although $SS - S_t$ has been historically stable and positive, it can become negative when the banking sector has increasing default risk.

Swap spread arbitrage - implementation

- Use swap and Treasury data from November 1988 to December 2004.
- Fit an O-U process to the floating spread S_t.
- Determine each month whether SS differs from the expected average value of S_t over the life of the strategy.
- Enter a trade if this difference exceeds 10 or 20 basis points.
- Close out the trade if the swap spread and the expected average value of the floating spread become equal, or until the maturity of the swap.


Two-Year
Three-Year
Five-Year
Ten-Year
Actual Spread
Expected Average
140
120
100
80
60
40
20
0
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04

Swap spread arbitrage - index construction

- Each month, there could be multiple open trades entered into at different points in the past.
- Compute an equally-weighted average of the monthly return on all open trades.
- Realistic swap, Treasury, and repo transaction costs are applied.
- Initial capital is adjusted to achieve an annualized volatility of ten percent.

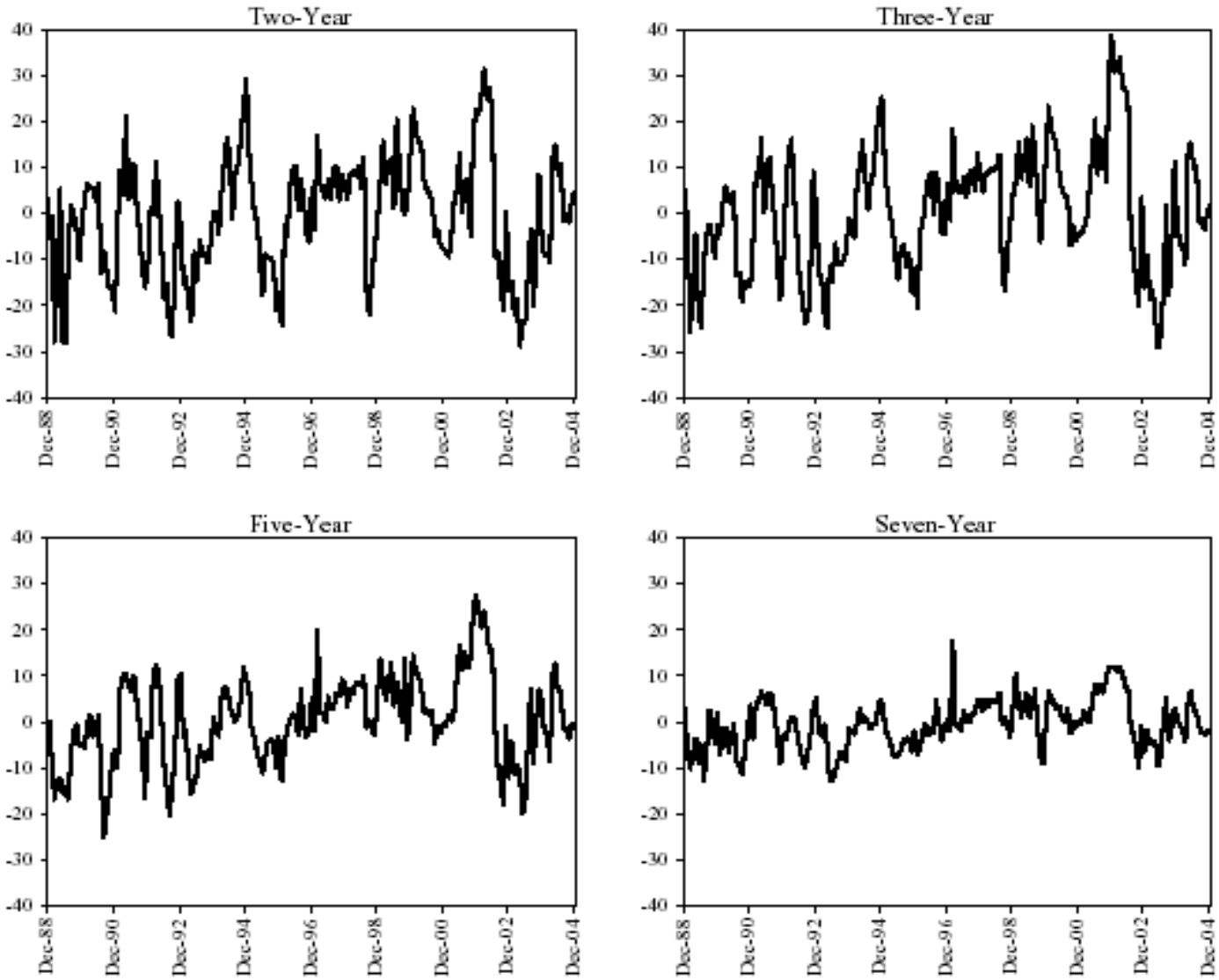
Strategy	Trigger	Swap	N	Capital	Mean	t-Stat	Min.	Med.	Max.	Skew.	Kurt.	Ratio Neg.	Serial Corr.	Sharpe Ratio
SS1	10 bp	2 yr	193	3.453	0.548	2.66	−12.549	0.000	10.610	−0.025	2.722	0.342	−0.010	0.657
SS2		3 yr	193	4.755	0.601	3.57	−9.389	0.151	13.827	0.580	3.072	0.316	−0.208	0.722
SS3		5 yr	193	7.462	0.418	2.16	−13.263	0.000	8.275	−0.491	3.030	0.285	−0.073	0.501
SS4		10 yr	193	15.063	0.297	1.66	−10.626	0.122	10.526	−0.157	2.791	0.394	−0.152	0.356
SS5	20 bp	2 yr	193	2.959	0.318	1.47	−15.063	0.000	12.352	0.005	6.392	0.181	0.038	0.381
SS6		3 yr	193	4.110	0.461	2.75	−10.825	0.000	16.174	0.491	6.595	0.155	−0.211	0.554
SS7		5 yr	193	7.164	0.325	1.75	−11.312	0.000	9.320	−0.415	2.459	0.275	−0.111	0.390
SS8		10 yr	193	14.642	0.323	1.75	−11.064	0.000	11.229	−0.094	3.687	0.295	−0.118	0.388

Yield curve arbitrage - intuition

- Some type of analysis is applied to identify points along the yield curve that are either "rich" or "cheap."
- The investor enters into a portfolio that exploits these perceived misvaluations by going long and short bonds in a way that minimizes the risk of the portfolio.
- The portfolio is held until the trade converges and the relative values of the bonds come back into line.

Yield curve arbitrage - implementation

- Fit a two-factor Vasicek model to the swap curve each month by matching exactly the one-year and ten-year swap yields.
- Identify how far off the fitted curve the other swap rates are.
- For example, for a particular month the two-year swap rate is more than five or ten basis points above the fitted two-year swap rate.
- Enter into a trade by receiving fixed on $100 notional of a two-year swap and shorting one-year and ten-year swaps to neutralize the two affine factors.
- Once this butterfly trade was put on, it would be held for 12 months, or until the market two-year swap rate converged to the model value.


Two-Year
Three-Year
Five-Year
Seven-Year
40
30
20
10
0
-10
-20
-30
-40
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04

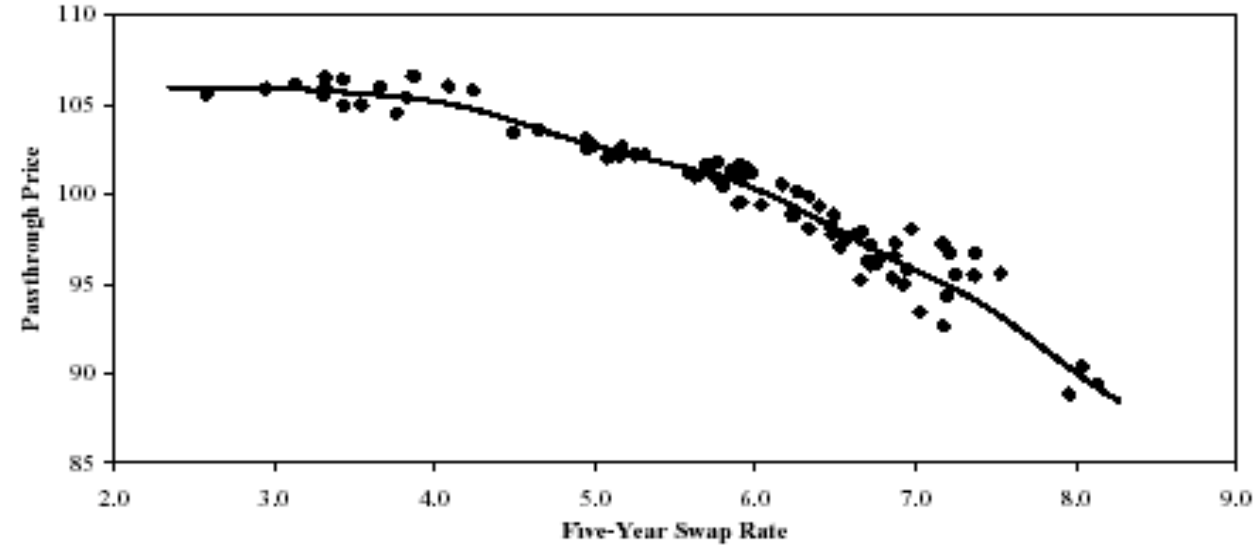
Strategy	Trigger	Swap	N	Capital	Mean	t-Stat	Min.	Med.	Max.	Skew.	Kurt.	Ratio Neg.	Serial Corr.	Sharpe Ratio
YC1	5 bp	2 yr	193	5.476	0.460	2.38	−6.072	0.000	10.099	0.521	0.469	0.394	−0.075	0.552
YC2		3 yr	193	8.499	0.509	2.38	−5.895	0.000	10.724	0.532	0.469	0.420	0.029	0.610
YC3		5 yr	193	9.244	0.580	2.90	−7.348	0.000	9.771	0.422	1.099	0.321	−0.039	0.696
YC4		7 yr	193	6.345	0.631	3.42	−7.431	0.000	14.287	0.631	3.615	0.202	−0.119	0.757
YC5	10 bp	2 yr	193	4.847	0.540	2.76	−6.878	0.000	10.056	0.569	0.902	0.301	−0.059	0.648
YC6		3 yr	193	7.891	0.486	2.31	−6.365	0.000	11.558	0.591	1.172	0.337	0.014	0.583
YC7		5 yr	193	7.794	0.615	3.29	−8.307	0.000	11.464	0.592	2.366	0.212	−0.108	0.738
YC8		7 yr	193	4.546	0.437	2.46	−10.306	0.000	20.032	2.156	14.953	0.088	−0.158	0.524

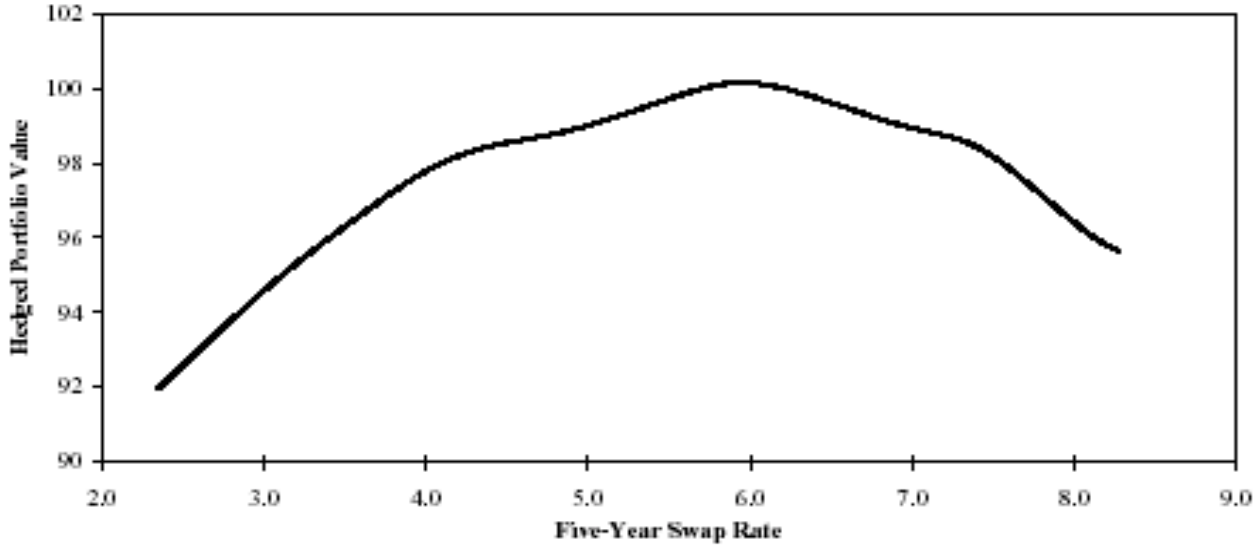
Mortgage arbitrage - intuition

- This strategy consists of buying MBS pass-throughs and hedging their interest rate exposure with swaps.
- Long positions in pass-throughs are financed with a form of repurchase agreement called a dollar roll.
- Negative convexity of the positions suggests that the investor would suffer losses under a large change in the swap rate.

Mortgage arbitrage - implementation

- We use GNMA pass-throughs with coupons closest to the current coupon, hedged with five-year swaps, from December 1996 to December 2004.
- Hedge ratios are determined using nonparametric estimation, constraining the pass-through price to be nonincreasing in the five-year swap rate.
- The positions are held as long as a discount/par/premium pass-through remains a discount/par/premium pass-through.
- To avoid dependence on a specific prepayment model, we do not use the OAS as a trade trigger.


110
105
100
95
90
85
Passthrough Price
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Five-Year Swap Rate


102
100
98
96
94
92
90
Hedged Portfolio Value
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Five-Year Swap Rate

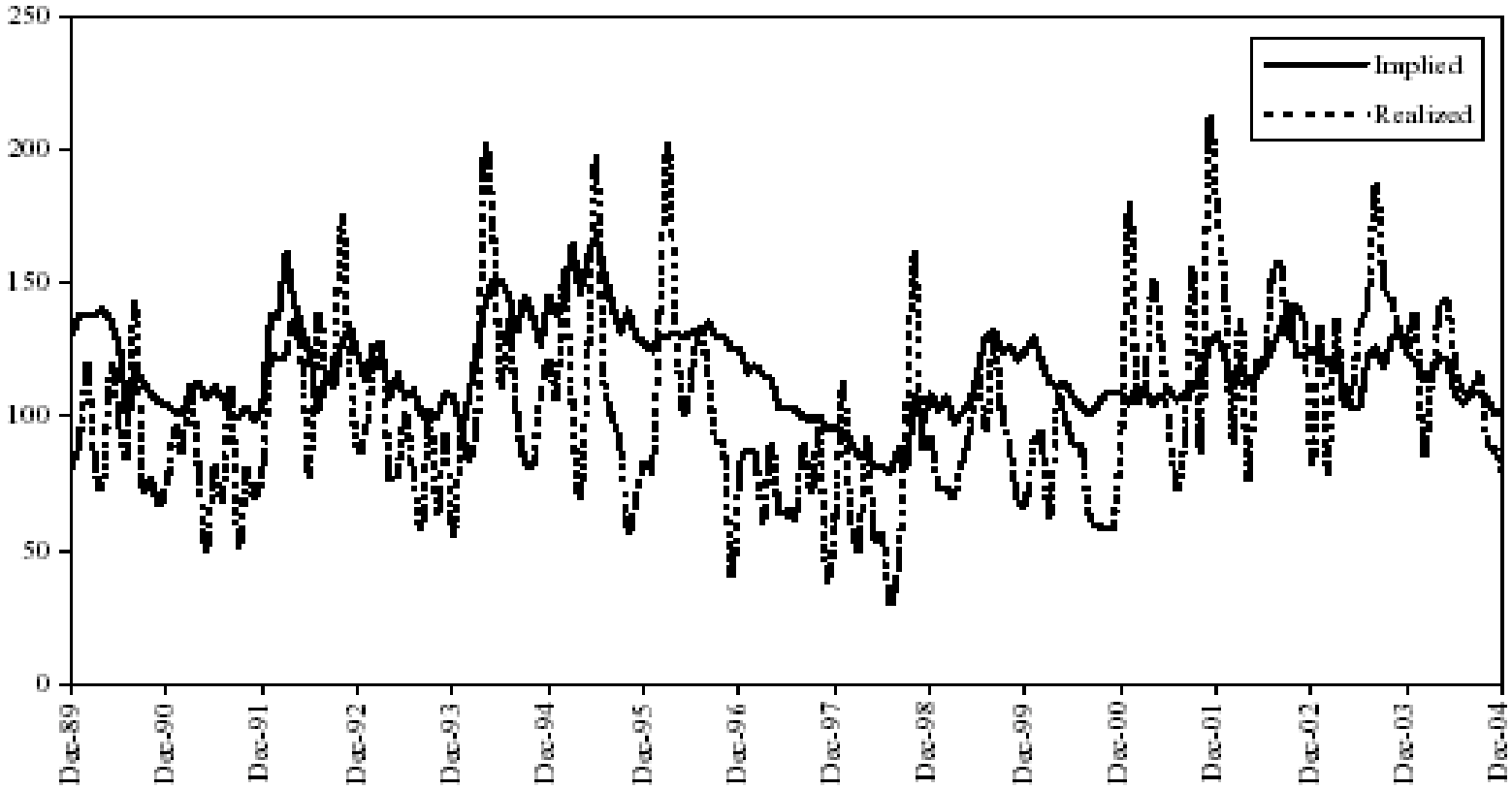
Strategy	Mortgage	N	Capital	Mean	t-Stat	Min.	Med.	Max.	Skew.	Kurt.	Ratio Neg.	Serial Corr.	Sharpe Ratio
MA1	Discount	97	21.724	0.691	2.08	−6.794	0.592	11.683	0.882	2.929	0.383	0.128	0.830
MA2	Par	97	19.779	0.466	1.50	−7.600	0.478	11.676	0.330	2.263	0.402	0.059	0.560
MA3	Premium	97	16.910	0.065	0.23	−8.274	0.311	9.844	−0.274	1.452	0.402	−0.052	0.078

Volatility arbitrage - intuition

- In its simplest form, volatility arbitrage is often implemented by selling options and then delta-hedging the exposure to the underlying asset.
- This produces an excess return proportional to the gamma of the option times the difference between the implied variance and the realized variance of the underlying asset.

Volatility arbitrage - implementation

- Short interest rate caps and hedge with Eurodollar futures from October 1989 to December 2004.
- This is equivalent to selling cap/floor straddles, or a portfolio of volatility swaps.
- Because of this, the strategy is essentially model-independent.
- The bid-ask spread for interest rate caps is assumed to be one vega.


250
200
150
100
50
0
Implied
Realized
Dec-89
Dec-90
Dec-91
Dec-92
Dec-93
Dec-94
Dec-95
Dec-96
Dec-97
Dec-98
Dec-99
Dec-00
Dec-01
Dec-02
Dec-03
Dec-04

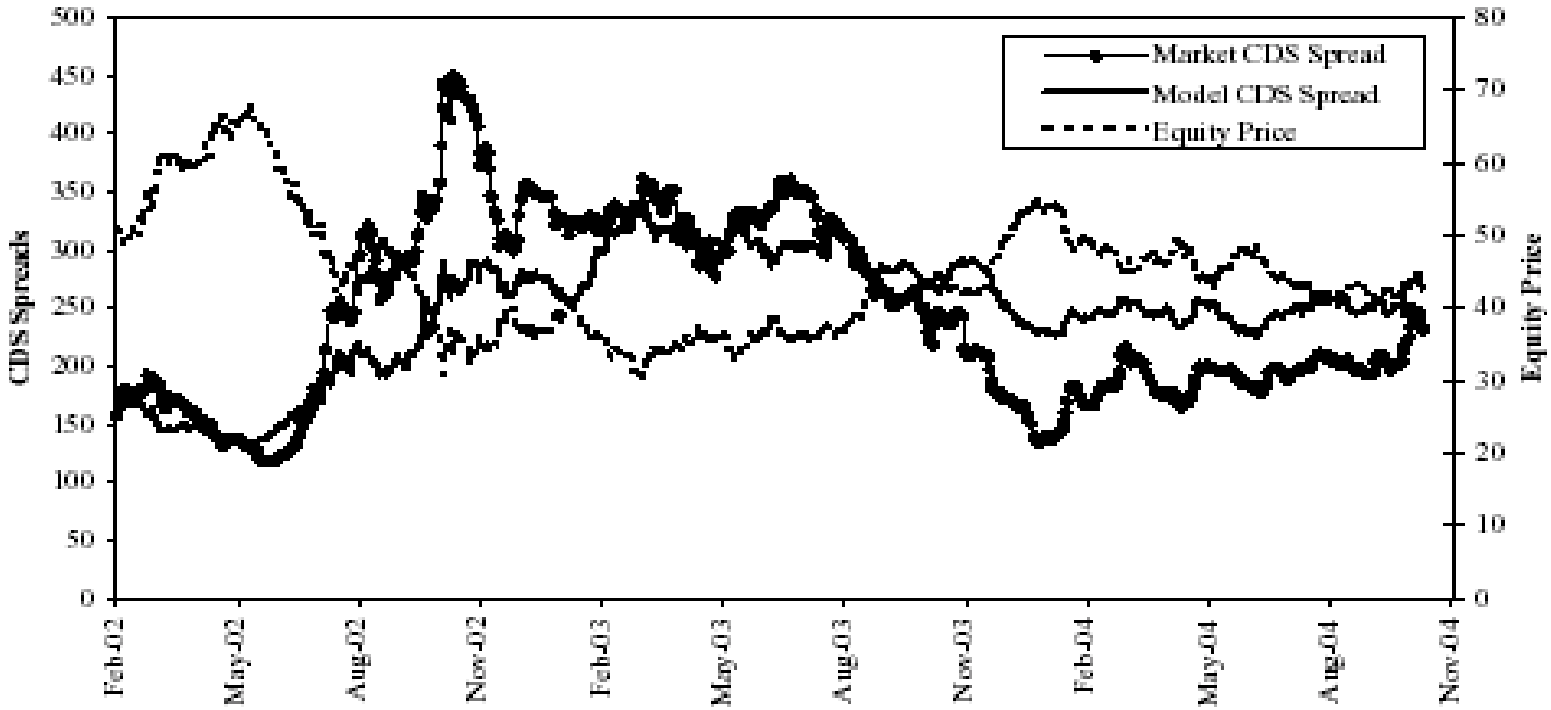
Strategy	Position	Cap	N	Capital	Mean	t-Stat	Min.	Med.	Max.	Skew.	Kurt.	Ratio Neg.	Serial Corr.	Sharpe Ratio
VA1	Short	1 yr	183	0.463	0.268	0.78	−9.833	0.448	7.745	−0.950	1.488	0.383	0.465	0.332
VA2		2 yr	183	0.734	0.389	1.11	−9.720	0.893	6.550	−0.962	1.579	0.383	0.465	0.467
VA3		3 yr	183	0.863	0.609	1.77	−9.675	1.092	6.851	−0.909	1.332	0.355	0.445	0.731
VA4		4 yr	183	0.953	0.682	2.08	−10.295	1.106	7.087	−0.989	1.644	0.311	0.409	0.819
VA5		5 yr	150	1.082	0.488	1.32	−9.997	0.912	6.654	−0.988	1.772	0.347	0.423	0.586
VA6		7 yr	135	1.279	0.270	0.72	−10.513	0.919	5.811	−1.221	2.331	0.393	0.398	0.324
VA7		10 yr	132	1.474	−0.068	−0.19	−12.819	0.400	5.072	−1.487	3.501	0.417	0.362	−0.082

Capital structure arbitrage - intuition

- Capital structure arbitrage refers to a class of fixed income trading strategies that exploit mispricing between a company's debt and its other securities (e.g. equity).
- Using the information on the equity price and the capital structure of an obligor, the arbitrageur computes its theoretical CDS spread.
- If the market spread is higher than the theoretical spread, he shorts the CDS contract, while shorting an equity hedge.
- Strategy will be profitable if the market spread converges to the theoretical spread.

Capital structure arbitrage - implementation

- We use CDS, equity, and balance sheet data from January 2001 to December 2004, with 261 obligors and 135,759 daily spreads.
- We compute the theoretical CDS spread and equity delta using the CreditGrades model.
- Positions are initiated when the market spread is more than $1 + \alpha$ times the model spread, where $\alpha = 1$, 1.5, or 2.
- Value of CDS positions is marked to the CG model daily.
- The CDS bid-ask spread is assumed to be five percent.


Market CDS Spread
Model CDS Spread
Equity Price
CDS Spreads
Equity Price
500
450
400
350
300
250
200
150
100
50
0
80
70
60
50
40
30
20
10
0
Feb-02
May-02
Aug-02
Nov-02
Feb-03
May-03
Aug-03
Nov-03
Feb-04
May-04
Aug-04
Nov-04

Strategy	Rating	Trigger	N	Capital	Mean	t-Stat	Min.	Med.	Max.	Skew.	Kurt.	Ratio Neg.	Serial Corr.	Sharpe Ratio
CS1	Invst.	1.00	48	47.000	0.768	1.95	−8.160	0.285	10.570	0.223	5.337	0.271	−0.055	0.922
CS2		1.50	48	52.300	0.613	1.25	−8.020	0.053	12.770	0.266	8.682	0.375	0.162	0.735
CS3		2.00	48	44.900	0.731	1.30	−4.640	0.000	13.790	0.342	10.075	0.417	0.296	0.877
CS4	Spec.	1.00	48	86.900	0.709	2.30	−8.680	0.000	7.680	0.331	2.646	0.167	−0.298	0.851
CS5		1.50	48	90.500	0.669	2.17	−7.250	0.000	10.920	0.358	4.661	0.146	−0.306	0.802
CS6		2.00	48	75.900	0.740	1.03	−1.730	0.000	15.210	0.448	15.889	0.104	0.505	0.887

Systematic risks of the strategies

- Though often described as "market-neutral," these strategies often have residual market risk exposure.
  - SS and the banking sector.
  - YC and the swap term structure.
  - MA and the risk of prepayment.
  - VA and the volatility risk premium.
  - CS and economy-wide default risk.

Systematic risks of the strategies (cont.)

- We attempt to "flush out" the influence of the following risk factors:
  - Fama-French market, SMB, HML, UMD, and the S&P bank stock index.
  - CRSP Fama two-year, five-year, ten-year Treasury portfolios.
  - Portfolios of A/BBB-rated industrial bonds, and A/BBB-rated bank sector bonds.
- We also use the CSFB/Tremont and the HFRI hedge fund index return series for comparison purposes.

		t Statistics											
Strategy	Alpha	Alpha	R_M	SMB	HML	UMD	R_S	R_2	R_5	R_{10}	R_I	R_B	R^2
SS1	0.207	0.86	1.41	−0.41	0.38	0.61	−1.10	1.95	−1.02	−0.55	−0.48	2.70	0.094
SS2	0.257	1.08	1.84	−0.84	1.25	1.23	−2.20	0.40	−0.42	−1.28	0.68	2.75	0.118
SS3	0.111	0.49	1.80	−2.29	0.37	0.73	−1.83	1.55	0.14	−4.14	2.30	2.74	0.216
SS4	−0.189	−0.86	2.88	−1.77	1.65	2.23	−1.98	2.28	1.40	−5.63	2.28	2.11	0.250
SS5	−0.076	−0.33	1.57	0.46	0.51	0.66	−1.93	2.90	−2.24	0.96	−1.96	4.05	0.159
SS6	0.118	0.49	1.99	−0.79	0.90	0.79	−2.34	1.58	−1.69	0.11	−0.28	3.05	0.105
SS7	−0.068	−0.30	2.55	−1.79	1.09	1.34	−2.42	1.61	0.01	−3.88	1.92	3.14	0.225
SS8	−0.172	−0.78	2.79	−1.86	1.63	2.19	−1.94	1.99	1.28	−5.38	2.54	1.98	0.241
YC1	0.365	1.48	0.44	0.49	0.08	0.31	0.14	2.16	−0.62	0.69	−1.74	0.27	0.043
YC2	0.409	1.68	0.09	0.84	0.55	0.82	0.22	2.22	−0.07	0.04	−2.22	0.77	0.071
YC3	0.535	2.19	−0.47	1.38	0.71	0.76	0.57	1.35	−1.45	1.96	−2.58	1.57	0.068
YC4	0.818	3.38	−1.15	1.96	0.26	0.86	1.04	−0.37	−0.44	1.81	−2.32	0.26	0.089
YC5	0.582	2.36	−0.81	1.25	−0.25	−0.16	1.03	1.44	0.10	0.23	−1.86	0.27	0.057
YC6	0.521	2.14	−1.04	0.93	−0.22	−0.14	0.88	1.98	−0.09	−0.00	−2.02	0.76	0.075
YC7	0.638	2.64	−0.85	1.78	0.33	0.86	0.62	0.84	−1.57	2.28	−3.10	2.31	0.094
YC8	0.653	2.74	−0.48	−0.56	−0.07	0.21	−0.27	1.27	−1.33	1.11	−2.30	1.44	0.117
MA1	0.725	2.12	−1.42	−1.46	−1.33	−0.87	1.05	−0.74	−0.24	−0.39	2.52	−0.61	0.160
MA2	0.555	1.61	−1.64	−1.20	−1.68	−1.23	0.72	−0.23	−1.74	1.07	1.82	0.02	0.142
MA3	0.157	0.47	−2.08	−1.45	−1.61	−0.91	1.00	0.51	−2.68	1.18	2.41	−0.15	0.191

		t Statistics										
Strategy	Alpha	Alpha	R_M	SMB	HML	UMD	R_S	R_2	R_5	R_{10}	R_I	R_B	R^2
VA1	−0.062	−0.24	0.02	−0.07	0.35	0.76	−0.75	1.90	−0.99	−0.86	1.47	0.53	0.061
VA2	0.074	0.29	0.60	−0.71	0.39	0.92	−1.27	1.44	−0.78	−0.85	1.42	0.56	0.056
VA3	0.305	1.21	0.67	−1.29	0.22	0.93	−1.43	1.06	−1.01	−0.41	1.21	0.57	0.064
VA4	0.415	1.65	0.53	−1.56	0.03	0.95	−1.34	0.71	−0.93	−0.23	1.65	0.53	0.066
VA5	0.228	0.83	0.37	−1.59	0.06	1.09	−1.11	0.80	−0.97	−0.24	0.83	0.55	0.081
VA6	0.069	0.24	0.23	−1.87	−0.05	1.09	−0.99	0.42	−0.85	−0.02	1.22	0.21	0.098
VA7	−0.278	−0.97	0.36	−2.10	0.12	1.42	−1.02	0.19	−0.81	0.21	1.11	0.17	0.127
CS1	1.073	1.66	0.58	−1.94	0.55	−0.59	0.59	0.52	−1.04	1.05	−0.30	−0.12	0.252
CS2	0.803	1.34	1.55	−2.06	0.85	−0.32	−0.73	0.32	−1.01	0.96	0.66	−0.68	0.352
CS3	1.076	1.70	1.45	−1.78	0.50	−0.38	−1.64	0.11	−0.48	0.44	0.98	−0.91	0.280
CS4	0.432	0.69	−0.61	−0.71	−1.23	−0.53	0.38	−0.35	−0.40	−0.70	1.80	0.43	0.303
CS5	1.150	1.67	−1.47	−0.38	−1.64	−1.46	0.48	−1.08	−0.35	0.11	0.96	−0.11	0.149
CS6	1.235	1.95	−0.72	−0.40	−0.50	−0.96	−1.36	−2.14	1.61	−1.03	2.50	−2.03	0.282
CSFB	0.412	3.87	−0.80	0.79	−0.09	0.71	0.32	1.06	−2.30	0.17	−0.06	2.69	0.159
HFRI	0.479	4.22	−1.70	0.73	−0.59	−0.44	0.81	0.20	0.84	−2.76	1.52	0.40	0.139

Excess returns and hedge fund capital

- Intuition suggests that as more capital is directed towards fixed income arbitrage, any excess returns should dissipate.
- However, increased capital can improve the liquidity of the market for the underlying securities, leading to more rapid convergence.
- We regress the risk-adjusted excess returns on annual changes in a measure of the total amount of capital devoted to fixed income arbitrage.

Strategy	Slope Coefficient	t-Statistic	R^2
SS1	−0.02765	−0.74	0.005
SS2	−0.04245	−1.08	0.010
SS3	−0.05442	−1.20	0.012
SS4	−0.06964	−1.40	0.017
SS5	−0.01686	−0.49	0.002
SS6	−0.03647	−0.91	0.007
SS7	−0.05395	−1.17	0.011
SS8	−0.07728	−1.53	0.020
YC1	0.02061	0.43	0.002
YC2	0.09093	1.83	0.028
YC3	0.11140	2.13	0.037
YC4	0.03317	0.61	0.003
YC5	−0.00309	−0.06	0.000
YC6	0.09812	1.97	0.032
YC7	0.01343	0.26	0.001
YC8	0.00887	0.16	0.000
MA1	0.15615	3.26	0.101
MA2	0.16879	3.52	0.116
MA3	0.10148	2.10	0.044
VA1	−0.04887	−0.95	0.008
VA2	−0.10111	−1.90	0.030
VA3	−0.13628	−2.56	0.053
VA4	−0.13923	−2.59	0.054
VA5	−0.13299	−2.69	0.054
VA6	−0.10814	−2.21	0.040
VA7	−0.08555	−1.76	0.026
CS1	−0.06655	−1.08	0.024
CS2	−0.08342	−1.46	0.044
CS3	−0.08987	−1.50	0.046
CS4	−0.06396	−1.07	0.024
CS5	−0.07963	−1.21	0.031
CS6	−0.11067	−1.87	0.071
CSFB	−0.01487	−0.79	0.005
HFRI	0.01298	0.63	0.003

Summary

- A majority of the strategies produce significant excess returns.
- The annualized Sharpe ratio lies between 0.3 and 0.9.
- Most of the monthly returns are positively skewed.
- Fat tails are the norm.
- No significant autocorrelation.
- The amount of capital required to obtain an annual volatility of ten percent varies across strategies.

Summary (cont.)

- Returns on many of the strategies are sensitive to equity, bond, and credit market risk factors.
- However, strategies that require a high degree of intellectual capital to implement (YC, MA, and CS) command positive excess returns even after adjusting for market risks.
- The link between returns and hedge fund capital may be more complex than previously believed.