What Happened To The Quants In August 2007?

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Motivation

Quantitative Equity Funds Hit Hard In August 2007

- Specifically, August 7–9, and massive reversal on August 10
- Some of the most consistently profitable funds lost too
- Seemed to affect only quants
- No real market news

Wall Street Journal
September 7, 2007

AUGUST AMBUSH

How Market Turmoil Waylaid the 'Quants'

Morgan Stanley Star Is Among Those Battered; No Time for Music Now

By Scott Patterson And Anita Raghavan

Peter Muller, a 43-year-old trader at Morgan Stanley, is used to markets behaving more or less as he expects. But in late July, some unusual patterns perplexed him. Certain investing strategies that historically had posted steady gains started faltering for no evident reason.

Soon, the unusual trading spread from U.S. to Japanese and European

Adding Up

Estimated assets in quant hedge funds using two common strategies, 'market neutral' and 'statistical abitrage'; quarterly data

Source: Hedgefund.net

What Is The Future of Quant?

- Is "Quant Dead"?
- Can "it" happen again?
- What can be done about it?

But Lack of Transparency Is Problematic!

A New Microscope

Use Strategy As Research Tool

- Lehmann (1990) and Lo and MacKinlay (1990)
- Basic mean-reversion strategy:

$$\omega_{it} = -\frac{1}{N}(R_{it-k} - R_{mt-k}) \quad , \quad R_{mt-k} \equiv \frac{1}{N}\sum_{i=1}^{N} R_{it-k}$$

$$\sum_{i=1}^{N} \omega_{it} = 0 \quad \text{Market Neutral}$$

$$\mathrm{I}_t \equiv \frac{1}{2}\sum_{i=1}^{N} |\omega_{it}| \quad \text{Gross Long or Short Market Value}$$

$$R_{pt} \equiv \sum_{i=1}^{n} \omega_{it} R_{it}/\mathrm{I}_t \quad \text{Unleveraged Return}$$

A New Microscope

Simulated Historical Performance of Contrarian Strategy

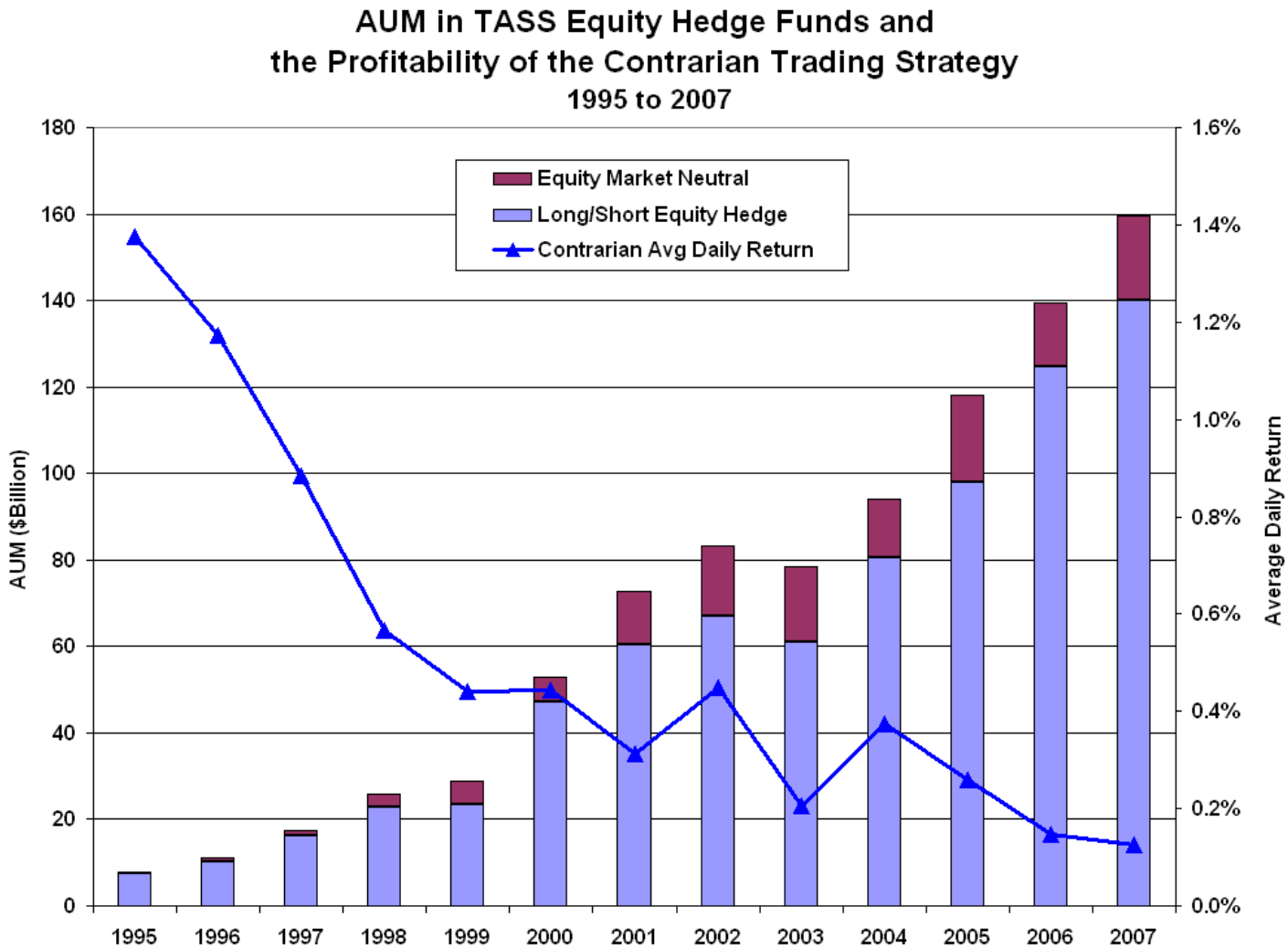
Year	Market Capitalization Deciles										All
	Smallest	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Largest	
	Average Daily Returns										
1995	3.57%	2.75%	1.94%	1.62%	1.07%	0.61%	0.21%	-0.01%	-0.02%	0.04%	1.38%
1996	3.58%	2.47%	1.82%	1.34%	0.84%	0.52%	0.19%	-0.11%	-0.04%	0.02%	1.17%
1997	2.83%	1.94%	1.34%	1.02%	0.62%	0.28%	0.04%	-0.12%	0.06%	0.14%	0.88%
1998	2.38%	1.45%	1.11%	0.62%	0.29%	0.03%	-0.04%	-0.12%	0.03%	0.10%	0.57%
1999	2.56%	1.41%	0.82%	0.38%	-0.01%	-0.11%	-0.21%	-0.35%	-0.01%	0.06%	0.44%
2000	2.58%	1.59%	0.92%	0.14%	0.03%	-0.02%	-0.14%	0.16%	0.00%	0.03%	0.44%
2001	2.15%	1.25%	0.57%	0.24%	-0.01%	0.06%	0.13%	-0.10%	-0.11%	-0.11%	0.31%
2002	1.67%	0.85%	0.53%	0.29%	0.28%	0.26%	0.28%	0.20%	0.11%	0.09%	0.45%
2003	1.00%	0.26%	-0.07%	0.04%	0.11%	0.20%	0.18%	0.15%	0.04%	0.05%	0.21%
2004	1.17%	0.48%	0.31%	0.38%	0.25%	0.29%	0.22%	0.15%	0.05%	-0.01%	0.37%
2005	1.05%	0.39%	0.13%	0.11%	0.09%	0.11%	0.05%	0.08%	0.01%	0.02%	0.26%
2006	0.86%	0.26%	0.11%	0.06%	0.05%	-0.02%	-0.02%	0.05%	0.06%	0.00%	0.15%
2007	0.57%	0.09%	0.08%	0.18%	0.16%	-0.08%	0.04%	-0.04%	0.00%	-0.04%	0.13%

A New Microscope

Simulated Historical Performance of Contrarian Strategy

Year	Market Capitalization Deciles										All
	Smallest	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Largest	
	Standard Deviation of Daily Returns										
1995	0.92%	0.88%	0.81%	0.82%	0.78%	0.77%	0.73%	0.67%	0.63%	0.65%	0.40%
1996	1.07%	1.00%	0.79%	0.81%	0.88%	0.84%	0.90%	0.90%	0.83%	0.73%	0.48%
1997	1.04%	0.98%	0.96%	0.96%	1.12%	1.00%	0.91%	0.99%	0.98%	0.77%	0.68%
1998	1.59%	1.67%	1.23%	1.22%	1.57%	1.25%	1.29%	1.43%	1.08%	1.00%	0.84%
1999	1.66%	1.82%	1.44%	1.44%	1.79%	1.57%	1.71%	1.70%	1.57%	1.07%	1.02%
2000	1.57%	1.69%	2.06%	1.89%	1.76%	2.15%	2.18%	2.29%	2.44%	2.56%	1.68%
2001	1.33%	1.26%	1.46%	1.62%	1.65%	1.64%	1.83%	1.91%	2.28%	2.29%	1.43%
2002	1.17%	0.89%	1.14%	1.07%	1.25%	1.11%	1.30%	1.42%	1.50%	1.50%	0.98%
2003	1.11%	0.81%	0.95%	0.89%	0.86%	0.81%	0.77%	0.76%	0.75%	0.56%	0.54%
2004	1.35%	1.01%	0.87%	0.76%	0.76%	0.78%	0.80%	0.74%	0.69%	0.57%	0.53%
2005	1.35%	0.80%	0.89%	0.70%	0.77%	0.77%	0.65%	0.73%	0.57%	0.56%	0.46%
2006	1.07%	0.90%	0.83%	0.84%	0.70%	1.07%	0.68%	0.68%	0.64%	0.61%	0.52%
2007	0.96%	1.02%	1.00%	0.99%	1.06%	1.44%	1.00%	0.87%	0.67%	0.56%	0.72%

Total Assets, Expected Returns, and Leverage



A New Microscope

Basic Leverage Calculations

- Regulation T leverage of 2:1 implies

$$\$100\text{MM of Capital} \;\Rightarrow\; \text{Leverage} = \frac{|100| + |-100|}{100} = 2:1$$

- More leverage is available:

$$\$100\text{MM of Capital} \;\Rightarrow\; \text{Leverage} = \frac{|500| + |-500|}{100} = 10:1$$

- Leverage magnifies risk and return:

$$\theta:1 \;\Rightarrow\; \text{Leveraged Return} \equiv \frac{\theta}{2} R_{pt}$$

Total Assets, Expected Returns, and Leverage

How Much Leverage Needed To Get 1998 Expected Return Level?

- In 2007, use 2006 multiplier of 4
- 8:1 leverage
- Compute leveraged returns
- How did the contrarian strategy perform during August 2007?
- Recall that for 8:1 leverage:
  - $E[R_{pt}] = 4 \times 0.15\% = 0.60\%$
  - $SD[R_{pt}] = 4 \times 0.52\% = 2.08\%$

$\Rightarrow$ 2007 Daily Mean: **0.60%**

$\Rightarrow$ 2007 Daily SD: **2.08%**

Required Leverage Ratios For Contrarian Strategy To Yield 1998 Level of Average Daily Return

Year	Average Daily Return	Return Multiplier	Required Leverage Ratio
1998	0.57%	1.00	2.00
1999	0.44%	1.28	2.57
2000	0.44%	1.28	2.56
2001	0.31%	1.81	3.63
2002	0.45%	1.26	2.52
2003	0.21%	2.77	5.53
2004	0.37%	1.52	3.04
2005	0.26%	2.20	4.40
2006	0.15%	3.88	7.76
2007	0.13%	4.48	8.96

What Happened In August 2007?

Daily Returns of the Contrarian Strategy In August 2007

Date	Deciles by Market Capitalization										All
	Smallest	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Largest	
7/30/2007	-0.28%	0.08%	7.85%	-1.43%	0.29%	0.91%	1.04%	1.51%	2.05%	0.71%	1.77%
7/31/2007	0.77%	4.41%	1.12%	2.20%	-2.53%	0.09%	-3.19%	1.94%	-1.23%	0.22%	1.46%
8/1/2007	6.10%	1.78%	-5.55%	1.39%	3.79%	-3.52%	-2.83%	-2.52%	-8.06%	-0.90%	0.43%
8/2/2007	3.54%	-3.04%	-0.46%	-2.68%	-3.77%	-10.79%	8.63%	6.12%	-2.97%	-0.77%	-1.22%
8/3/2007	-3.79%	-2.49%	-3.12%	0.24%	3.52%	0.05%	-2.49%	-4.35%	-2.29%	-2.74%	-0.10%
8/6/2007	-3.33%	-7.06%	-1.57%	-4.12%	5.47%	-5.47%	-4.75%	-2.86%	1.06%	3.08%	2.01%
8/7/2007	3.00%	1.03%	-6.55%	-11.65%	-6.01%	-2.79%	1.42%	-4.08%	-6.86%	-2.67%	-4.64%
8/8/2007	3.52%	-5.30%	-10.36%	-14.58%	-17.07%	-8.65%	-8.94%	-13.85%	-5.06%	-5.91%	-11.33%
8/9/2007	3.66%	-7.42%	-15.46%	-11.08%	-12.72%	-15.78%	-13.06%	-17.33%	-10.32%	-5.22%	-11.43%
8/10/2007	-1.32%	14.62%	24.32%	31.58%	35.08%	30.67%	30.07%	26.79%	18.73%	9.55%	23.67%
8/13/2007	5.42%	-1.24%	-2.53%	-4.26%	-6.20%	-0.88%	-5.15%	-8.04%	-8.58%	-4.99%	-3.05%
8/14/2007	4.65%	3.64%	-1.02%	1.35%	2.23%	-1.12%	2.74%	-1.16%	0.66%	0.67%	0.33%
8/15/2007	3.52%	4.74%	-2.42%	-2.33%	-0.69%	-3.89%	-0.97%	-5.36%	-2.29%	-4.73%	-1.53%
8/16/2007	-5.03%	-2.16%	0.59%	-2.36%	-2.39%	-3.95%	-6.94%	-5.08%	1.08%	-7.31%	-3.24%
8/17/2007	14.30%	9.94%	0.41%	5.04%	5.32%	-2.07%	0.47%	-1.56%	1.24%	0.44%	1.53%
8/20/2007	15.02%	7.02%	1.42%	5.40%	2.03%	1.74%	4.88%	2.22%	1.57%	4.67%	4.58%
8/21/2007	4.98%	0.43%	0.02%	-1.80%	0.09%	-2.54%	-0.33%	-0.20%	0.74%	0.43%	0.24%
8/22/2007	-3.39%	-1.23%	-2.07%	-2.05%	-0.67%	-3.31%	-0.74%	-2.26%	1.57%	0.37%	-1.51%
8/23/2007	-0.14%	2.79%	2.79%	-0.64%	1.51%	4.15%	1.04%	-1.33%	1.28%	1.23%	1.31%
8/24/2007	2.47%	-1.13%	-0.26%	0.92%	3.70%	-0.23%	-0.29%	0.37%	-1.42%	2.43%	1.73%
8/27/2007	4.38%	2.80%	0.46%	0.78%	5.01%	-0.63%	1.58%	2.85%	2.84%	0.10%	2.99%
8/28/2007	1.64%	1.26%	0.34%	-2.45%	-2.56%	-1.99%	-1.33%	-1.77%	-1.88%	0.99%	-3.04%
8/29/2007	5.79%	0.31%	5.07%	8.32%	7.75%	-2.14%	5.67%	6.39%	3.63%	3.94%	7.06%
8/30/2007	4.27%	0.16%	2.46%	1.61%	3.55%	0.41%	-0.11%	-0.16%	0.47%	-0.19%	2.01%
8/31/2007	6.75%	3.86%	3.80%	-2.21%	0.21%	2.08%	-0.32%	-2.68%	0.02%	0.58%	1.46%

What Happened In August 2007?

Daily Returns of Various Indexes In August 2007

Date	S&P 500	S&P Small Cap 600	MSCI Emerging Markets	MSCI World ex. US	Lehman Aggregate US Gov. Index	Lehman US Universal Corp. High-Yield Index	Goldman Sachs Commodity Index	Trade Weighted USD Index	CBOE Volatility Index (VIX) Change
7/30/2007	1.03%	0.94%	0.87%	0.14%	-0.04%	0.18%	0.11%	-0.12%	-3.30
7/31/2007	-1.26%	-0.88%	1.67%	1.36%	0.17%	0.61%	1.18%	-0.10%	2.65
8/1/2007	0.73%	0.19%	-3.42%	-1.70%	0.04%	-0.15%	-1.34%	0.13%	0.15
8/2/2007	0.46%	0.98%	0.61%	0.62%	0.04%	0.53%	0.00%	-0.20%	-2.45
8/3/2007	-2.65%	-3.48%	-0.05%	-0.37%	0.29%	0.08%	-1.10%	-0.66%	3.94
8/6/2007	2.42%	1.35%	-1.99%	-0.57%	-0.14%	-0.29%	-2.76%	0.10%	-2.56
8/7/2007	**0.62%**	**0.71%**	**0.45%**	**0.56%**	**-0.04%**	**0.38%**	**0.34%**	**0.28%**	**-1.04**
8/8/2007	**1.44%**	**1.52%**	**2.83%**	**1.88%**	**-0.48%**	**0.84%**	**-0.20%**	**-0.17%**	**-0.11**
8/9/2007	**-2.95%**	**-1.38%**	**-1.28%**	**-1.52%**	**0.31%**	**-0.07%**	**-0.37%**	**0.54%**	**5.03**
8/10/2007	**0.04%**	**1.01%**	**-3.30%**	**-2.85%**	**0.07%**	**-0.29%**	**-0.03%**	**-0.12%**	**1.82**
8/13/2007	-0.03%	-0.84%	1.01%	1.08%	0.04%	0.34%	0.27%	0.46%	-1.73
8/14/2007	-1.81%	-1.87%	-1.42%	-1.10%	0.23%	-0.10%	0.35%	0.54%	1.11
8/15/2007	-1.36%	-1.45%	-2.39%	-1.52%	0.15%	-0.56%	0.80%	0.41%	2.99
8/16/2007	0.33%	1.70%	-5.63%	-2.91%	0.58%	-0.59%	-3.01%	-0.11%	0.16
8/17/2007	2.46%	2.30%	0.12%	0.96%	-0.28%	0.24%	1.49%	-0.37%	-0.84
8/20/2007	-0.03%	0.30%	3.78%	1.23%	0.23%	0.24%	-1.65%	-0.03%	-3.66
8/21/2007	0.11%	0.21%	-0.18%	0.61%	0.24%	0.19%	-1.14%	0.11%	-1.08
8/22/2007	1.18%	1.19%	2.58%	1.27%	-0.16%	0.37%	0.04%	-0.30%	-2.36
8/23/2007	-0.11%	-1.16%	1.76%	1.16%	-0.01%	0.22%	0.96%	-0.13%	-0.27
8/24/2007	1.16%	1.44%	0.44%	0.51%	-0.10%	0.04%	1.10%	-0.59%	-1.90
8/27/2007	-0.85%	-1.07%	1.90%	0.29%	0.23%	0.17%	0.28%	0.09%	2.00
8/28/2007	-2.34%	-2.70%	-0.85%	-1.26%	0.34%	-0.07%	-0.17%	0.02%	3.58
8/29/2007	2.22%	2.28%	-0.23%	0.04%	-0.09%	-0.06%	1.40%	-0.07%	-2.49
8/30/2007	-0.41%	-0.38%	1.31%	0.80%	0.29%	0.06%	0.15%	0.12%	1.25
8/31/2007	1.12%	1.28%	2.39%	1.58%	-0.16%	0.01%	0.48%	0.00%	-1.68

Comparing August 2007 To August 1998

Daily Returns of the Contrarian Strategy In August and September 1998

Date	Deciles by Market Capitalization										All
	Smallest	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Largest	
8/3/1998	3.35%	1.75%	1.68%	0.15%	3.25%	-0.33%	0.40%	0.06%	0.62%	0.16%	1.01%
8/4/1998	-0.29%	2.16%	1.64%	-1.35%	-1.18%	-0.51%	-0.82%	-0.07%	-1.22%	-0.16%	-0.18%
8/5/1998	2.75%	1.93%	0.68%	2.60%	2.04%	0.93%	-0.57%	0.38%	-0.59%	2.56%	1.27%
8/6/1998	2.25%	1.68%	2.01%	0.36%	0.17%	-0.33%	-1.35%	0.15%	0.85%	1.34%	0.66%
8/7/1998	3.05%	2.99%	0.79%	0.26%	-0.23%	0.03%	0.12%	0.39%	2.93%	-0.10%	0.67%
8/10/1998	3.48%	1.69%	1.53%	0.91%	0.48%	2.23%	1.03%	-0.23%	0.68%	0.27%	1.27%
8/11/1998	2.34%	1.72%	0.81%	-0.24%	0.60%	1.18%	-0.36%	0.79%	-0.29%	-0.14%	0.59%
8/12/1998	4.83%	2.88%	2.71%	1.31%	0.96%	0.58%	2.01%	0.93%	1.00%	0.68%	2.04%
8/13/1998	3.74%	2.24%	0.88%	2.72%	0.37%	0.39%	1.03%	0.48%	-0.11%	0.04%	1.33%
8/14/1998	2.25%	1.64%	3.57%	1.42%	-0.46%	-0.05%	0.66%	-0.07%	0.77%	-0.42%	0.94%
8/17/1998	**2.46%**	**2.48%**	**1.81%**	**0.11%**	**-0.32%**	**1.66%**	**-0.01%**	**-0.80%**	**0.11%**	**0.49%**	**0.96%**
8/18/1998	4.31%	1.85%	1.75%	3.86%	0.35%	-0.16%	-2.12%	0.03%	0.29%	0.12%	0.87%
8/19/1998	2.60%	2.15%	1.16%	0.45%	-0.65%	-0.36%	0.34%	-0.80%	0.06%	-0.13%	0.63%
8/20/1998	1.60%	3.04%	1.49%	0.42%	-0.64%	0.55%	0.87%	-0.61%	-0.55%	-1.47%	0.46%
8/21/1998	**2.26%**	**4.06%**	**2.18%**	**1.79%**	**1.03%**	**-0.06%**	**-0.28%**	**-0.51%**	**0.06%**	**-0.36%**	**1.04%**
8/24/1998	5.35%	1.84%	4.13%	0.63%	-0.83%	0.13%	-1.57%	-1.02%	-0.68%	0.73%	0.90%
8/25/1998	2.05%	2.19%	1.76%	0.85%	-0.45%	-0.34%	0.91%	-1.46%	-0.48%	-0.56%	0.36%
8/26/1998	4.02%	1.39%	1.78%	0.81%	-0.31%	0.06%	-0.43%	1.03%	-0.65%	-0.26%	0.61%
8/27/1998	1.69%	1.15%	0.24%	-1.16%	-2.02%	-0.47%	-1.54%	-1.91%	-0.63%	-2.20%	-0.78%
8/28/1998	2.52%	2.29%	1.33%	1.35%	0.11%	1.12%	-1.29%	-1.32%	-1.18%	-0.36%	0.39%
8/31/1998	3.31%	1.79%	0.51%	-0.36%	-3.44%	-1.97%	-3.08%	-4.47%	-2.73%	-2.82%	-1.62%
9/1/1998	4.96%	4.42%	6.04%	4.67%	9.06%	6.68%	6.71%	6.67%	4.90%	6.10%	6.59%
9/2/1998	4.43%	2.74%	1.90%	0.82%	-1.33%	0.25%	0.86%	-0.39%	0.45%	0.33%	0.63%
9/3/1998	**3.89%**	**3.78%**	**2.08%**	**2.09%**	**0.23%**	**-0.03%**	**0.79%**	**0.15%**	**0.51%**	**0.76%**	**1.41%**
9/4/1998	5.10%	3.95%	2.09%	0.75%	-0.33%	-0.84%	-1.33%	-1.61%	-1.15%	-3.68%	0.26%

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Date	Deciles by Market Capitalization										All
	Smallest	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Largest	
9/8/1998	3.53%	3.40%	3.82%	0.57%	0.60%	0.82%	1.35%	1.05%	0.97%	3.73%	2.08%
9/9/1998	1.99%	3.62%	1.38%	1.15%	1.12%	1.66%	1.70%	2.10%	2.32%	2.92%	2.42%
9/10/1998	4.26%	2.68%	0.08%	2.05%	0.96%	-0.27%	0.64%	-0.86%	-0.67%	-2.16%	0.29%
9/11/1998	3.34%	3.17%	2.15%	0.77%	0.20%	0.50%	-0.95%	1.28%	-0.18%	0.15%	1.24%
9/14/1998	3.53%	3.58%	1.54%	0.83%	-0.20%	-0.42%	-0.47%	-0.50%	0.02%	-0.23%	0.33%
9/15/1998	3.62%	2.36%	1.34%	0.77%	-0.17%	-0.98%	-0.52%	-1.15%	-0.95%	-0.63%	0.14%
9/16/1998	2.71%	3.33%	0.89%	1.48%	0.58%	0.83%	0.00%	0.05%	1.53%	-0.04%	1.01%
9/17/1998	3.70%	2.24%	1.54%	1.56%	-0.95%	0.23%	1.10%	-0.40%	-0.86%	0.38%	0.79%
9/18/1998	4.01%	3.94%	2.67%	1.27%	2.55%	1.20%	-1.17%	-1.41%	-0.51%	-0.45%	1.07%
9/21/1998	3.22%	1.28%	1.86%	-0.61%	-0.87%	-0.09%	-2.22%	1.08%	-0.47%	-0.32%	0.19%
9/22/1998	3.26%	2.15%	1.68%	1.76%	-0.21%	-0.16%	-0.62%	-2.06%	-1.46%	0.16%	0.42%
9/23/1998	4.24%	2.16%	0.78%	-1.66%	-0.34%	-2.33%	-3.08%	-3.27%	-0.60%	-0.42%	-0.71%
9/24/1998	**2.54%**	**1.47%**	**3.13%**	**1.60%**	**0.63%**	**-0.38%**	**-0.06%**	**-0.27%**	**0.59%**	**1.63%**	**1.21%**
9/25/1998	2.28%	3.27%	0.16%	0.86%	0.28%	-0.90%	-0.66%	0.67%	1.16%	0.36%	0.61%
9/28/1998	4.24%	1.24%	1.81%	2.64%	0.52%	-1.30%	0.47%	-1.58%	-0.59%	0.16%	0.60%
9/29/1998	2.75%	1.48%	-0.07%	0.81%	-0.83%	-1.61%	-1.58%	-0.83%	-1.19%	-0.83%	-0.29%
9/30/1998	2.98%	0.41%	0.33%	-0.96%	0.01%	-1.00%	-1.78%	-0.41%	-0.10%	-0.74%	-0.33%

The Unwind Hypothesis

What Happened?

- Losses due to rapid and large unwind of quant fund (market-neutral)
- Liquidation is likely forced because of firesale prices (sub-prime?)
- Initial losses caused other funds to reduce risk and de-leverage
- De-leveraging caused further losses across broader set of equity funds
- Friday rebound consistent with liquidity trade, not informed trade
- Rebound due to quant funds, long/short, 130/30, long-only funds

Did Portfolio Managers Use the Same Factors?

Factor-Based Strategies

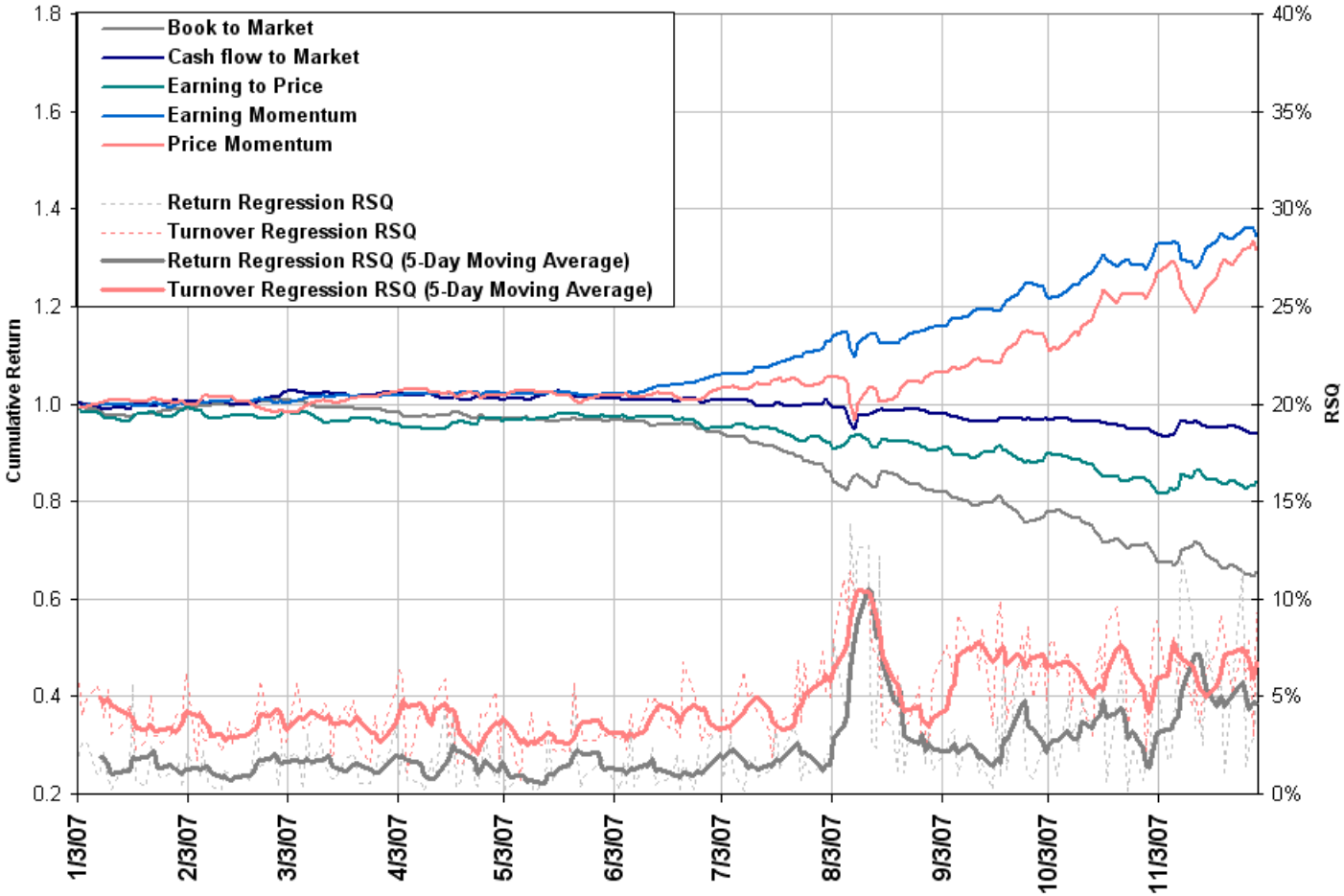
Construct Five Long/Short Factor Portfolios

- Book-to-Market
- Earnings-to-Price
- Cashflow-to-Price
- Price Momentum
- Earnings Momentum
- Rank S&P 1500 stocks monthly
- Invest $1 long in decile 10 (highest), $1 short in decile 1 (lowest)
- Equal-weighting within deciles
- Simulate daily holding-period returns

Factor-Based Strategies

Cumulative Returns of Factor-Based Portfolios

January 3, 2007 to December 31, 2007



Factor-Based Strategies

Are These Trends Due To Market Moves or Unwinding?

- Estimate daily cross-sectional regressions for returns and turnover

$$R_{i,t} = \alpha_t + \sum_{f=1}^{5} \beta_{f,t} D_{i,f} + \epsilon_{i,t}$$

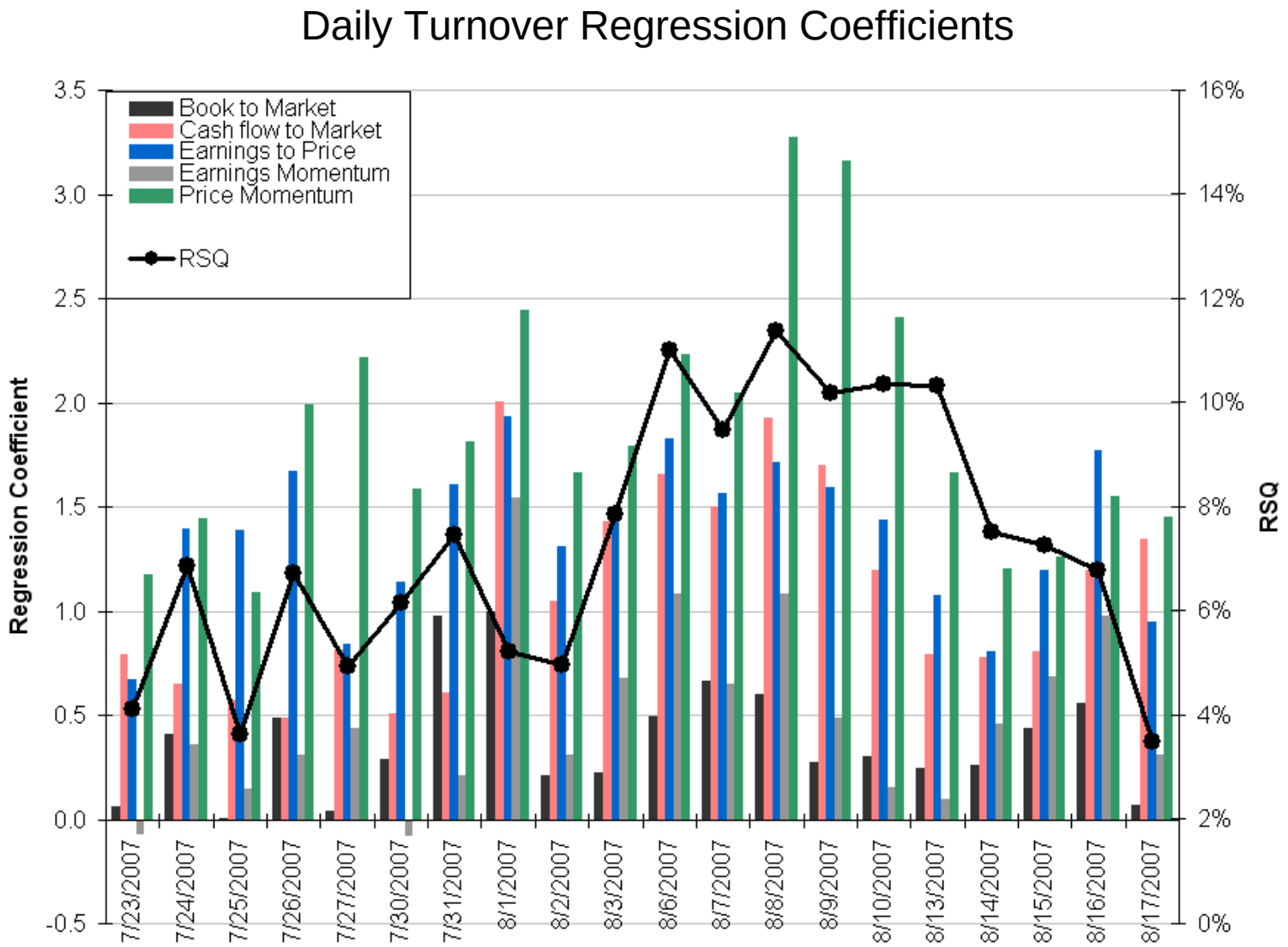
$$\text{TO}_{i,t} = \gamma_t + \sum_{f=1}^{5} \delta_{f,t} |D_{i,f} - 5.5| + \eta_{i,t}$$

$$\text{TO}_{i,t} \equiv \frac{\text{Shares Traded for Security } i \text{ on Day } t}{\text{Share Outstanding for Security } i \text{ on Day } t}$$

$$D_{i,f} \equiv \text{Decile Ranking for } i \text{ wrt Factor } f$$

- If Unwind Hypothesis is true, R^2's should be high for both regressions

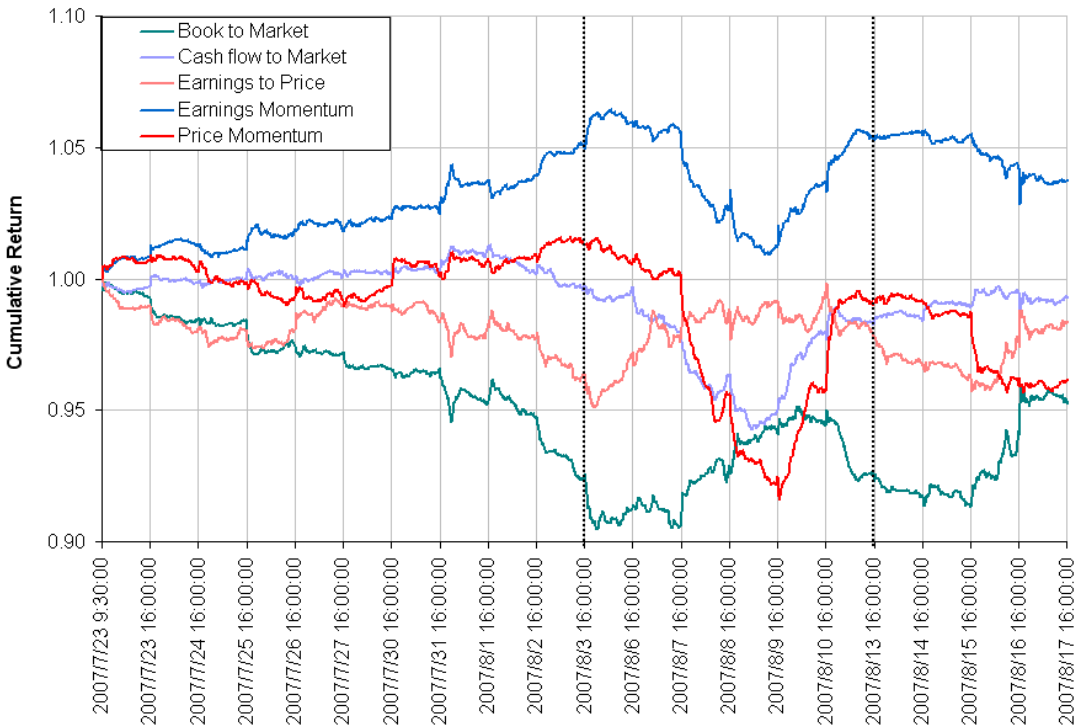
Factor-Based Strategies



Factor-Based Strategies

Using Tick Data, Construct Long/Short Factor Portfolios

- Same five factors
- Compute 5-minute returns from 9:30am to 4:00pm (no overnight returns)
- Simulate intra-day performance of five long/short portfolios



Measures of Liquidity and Price Impact

- Kyle (1985) price-impact model

Liquidity Measure

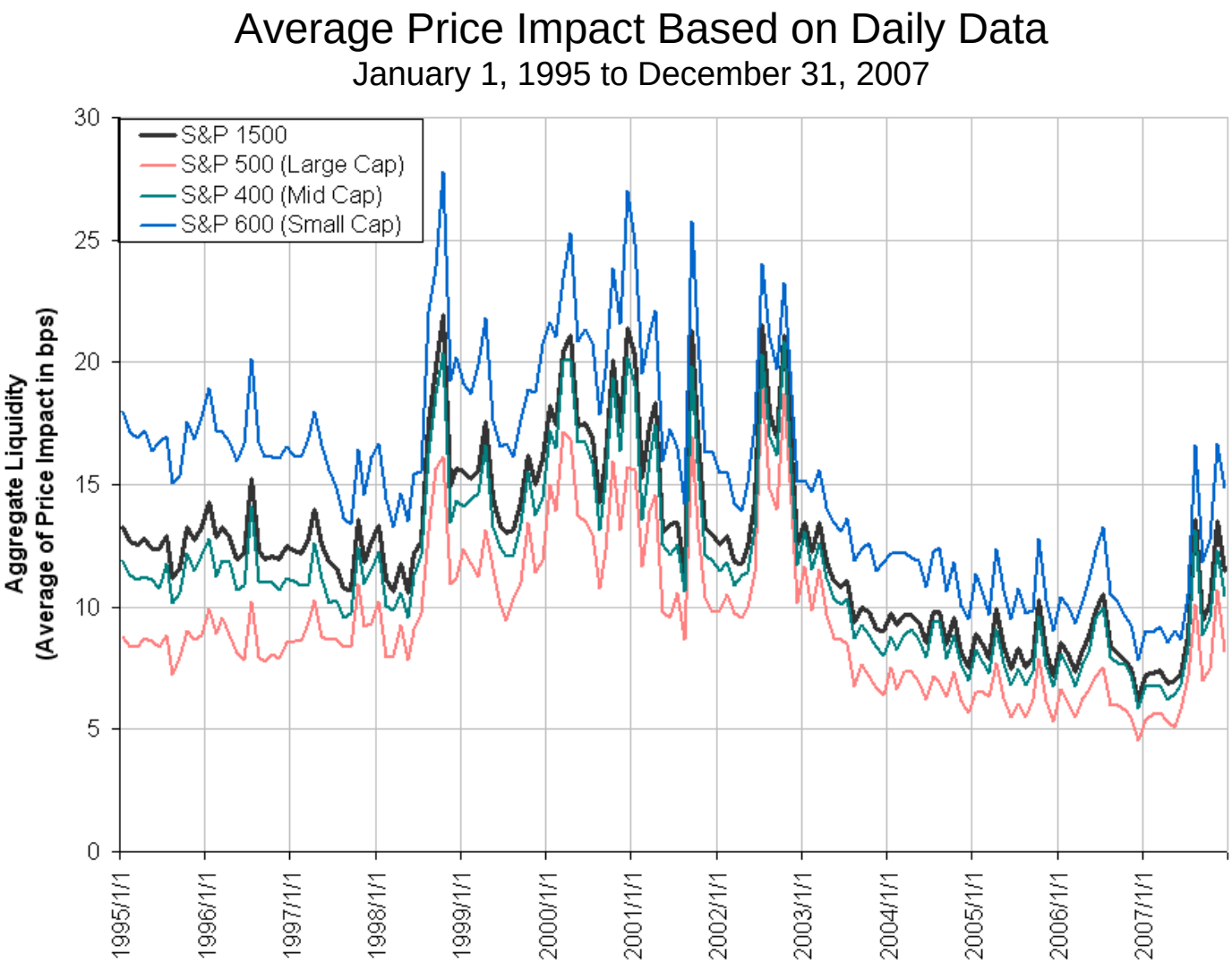
$$R_{i,t} = \hat{c}_i + \hat{\lambda}_i \cdot \text{Sgn}(t) \log(v_{i,t} p_{i,t}) + \hat{\epsilon}_{i,t}$$

- Use "tick test" to determine sign of daily volume

$$\text{Sgn}(t) = \begin{cases} +1 & \text{if } R_{i,t} > 0 \\ -1 & \text{if } R_{i,t} \leq 0 \end{cases}$$

- Larger values of $\hat{\lambda}_i \Rightarrow$ less liquidity

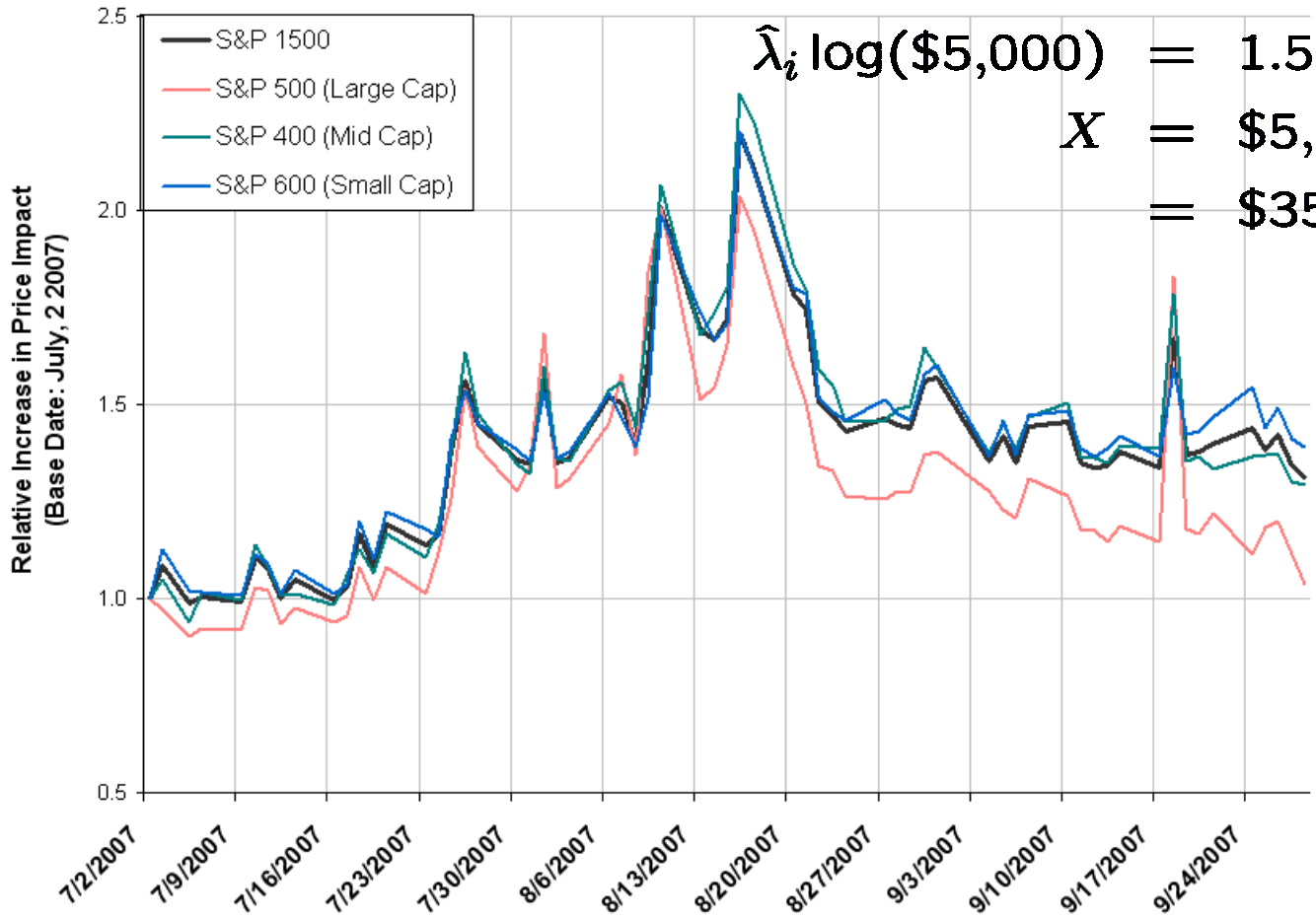
Measures of Liquidity and Price Impact



Measures of Liquidity and Price Impact

Relative Price Impact Based on Transactions Data

July to September 2007, Base Date: July 2, 2007



$$\hat{\lambda}_i \log(\$5{,}000) = 1.5 \times \hat{\lambda}_i \log(X)$$

$$X = \$5{,}000^{1.5}$$

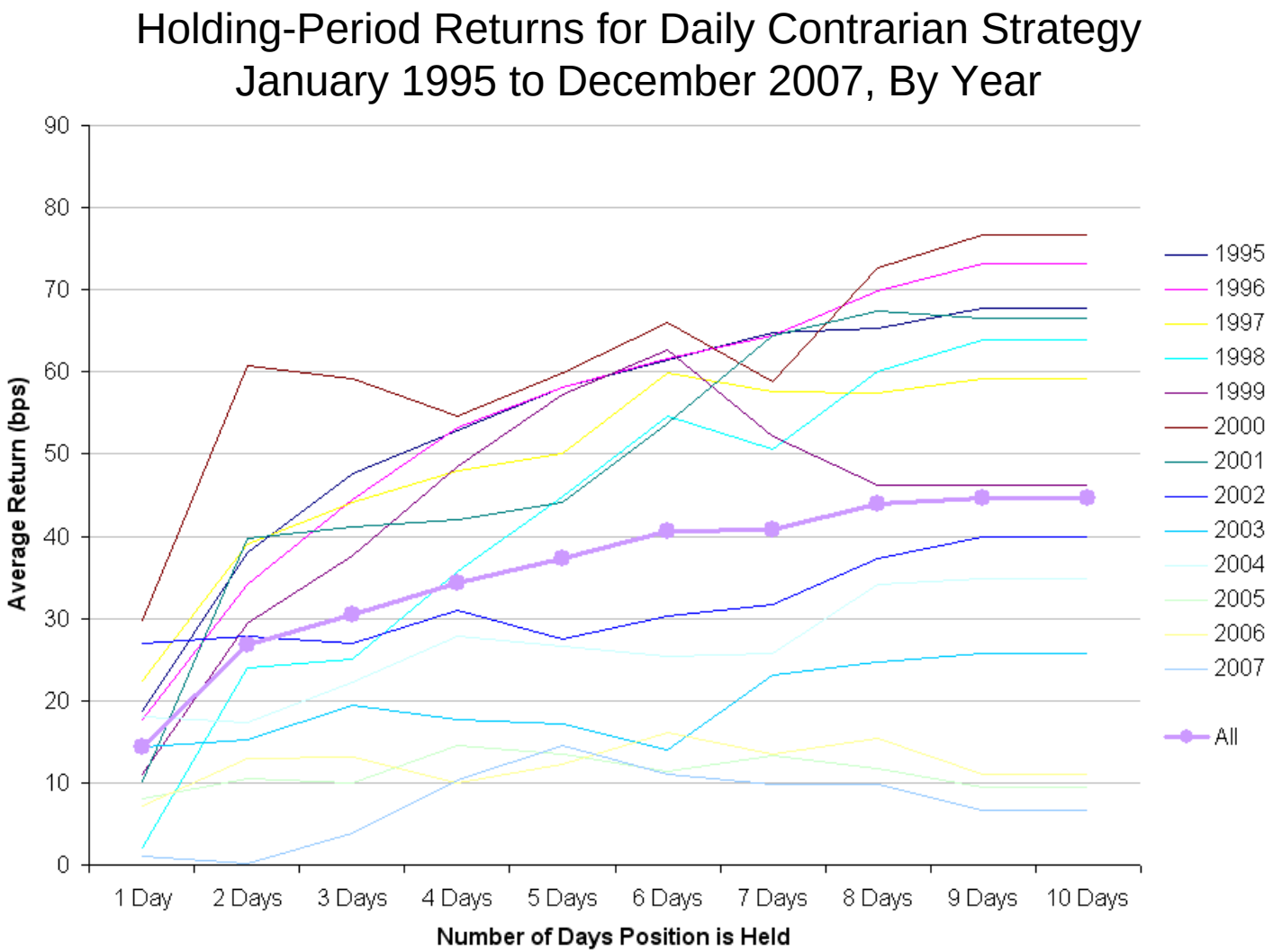
$$= \$353{,}553$$

Proxies for Marketmaking Profits

What Happened To Market-Makers During August 2007?

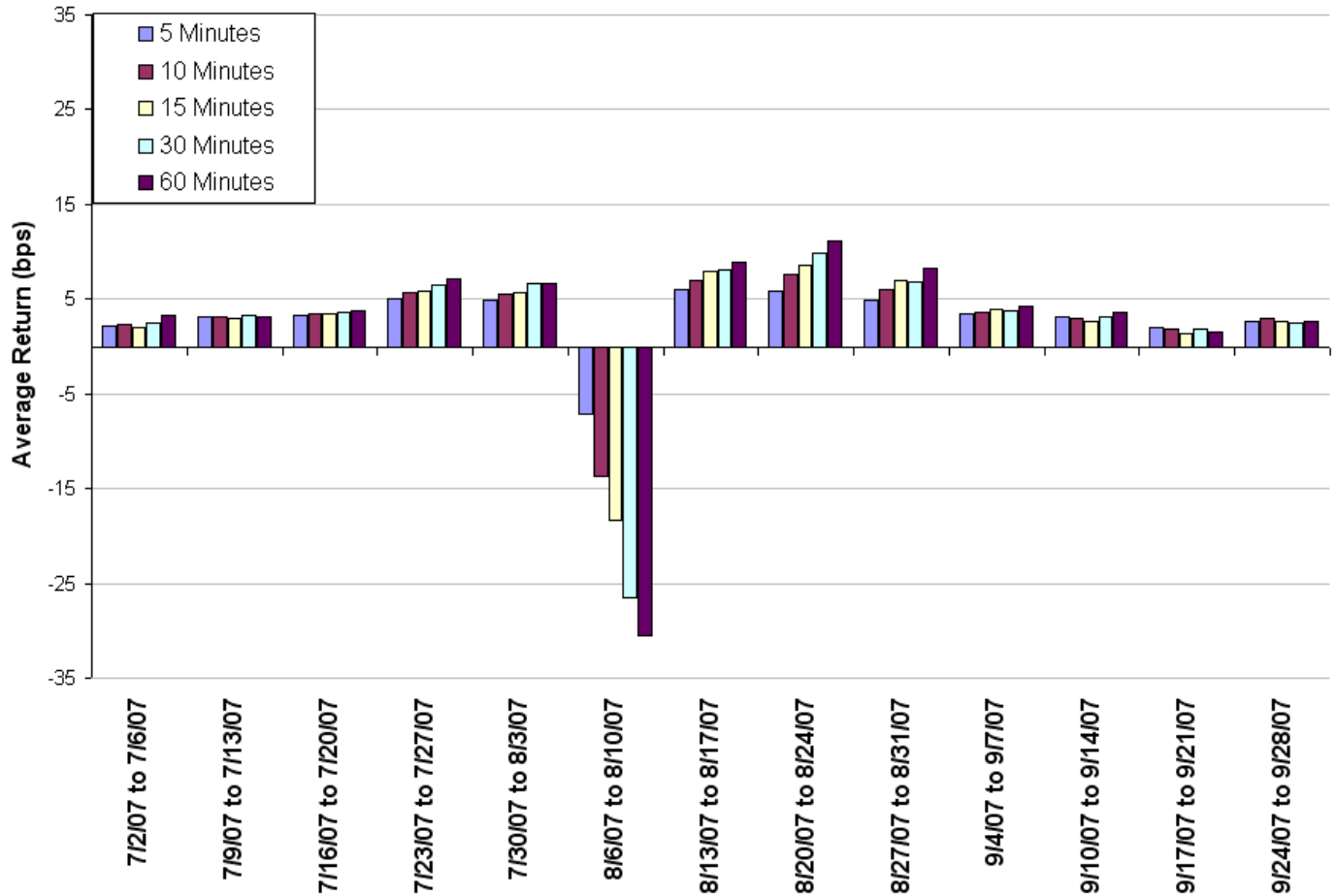
- Simulate simpler mean-reversion strategy using TAQ data
  - Sort stocks based on previous 5-minute returns
  - Put $1 long in decile 1 (losers) and $1 short in decile 10 (winners)
  - Rebalance every *m* minutes, *m* = 5, 10,…, 60
  - Cumulate profits
- Profitability of strategy should proxy for marketmaking P&L
- Let *m* vary to measure the value of liquidity provision vs. horizons
- Greater immediacy $\Rightarrow$ larger profits on average
- Positive profits suggest the presence of discretionary liquidity providers
- Negative profits suggest the absence of discretionary liquidity providers
- Given positive bid/offer spreads, on average, profits should be positive

Proxies for Marketmaking Profits

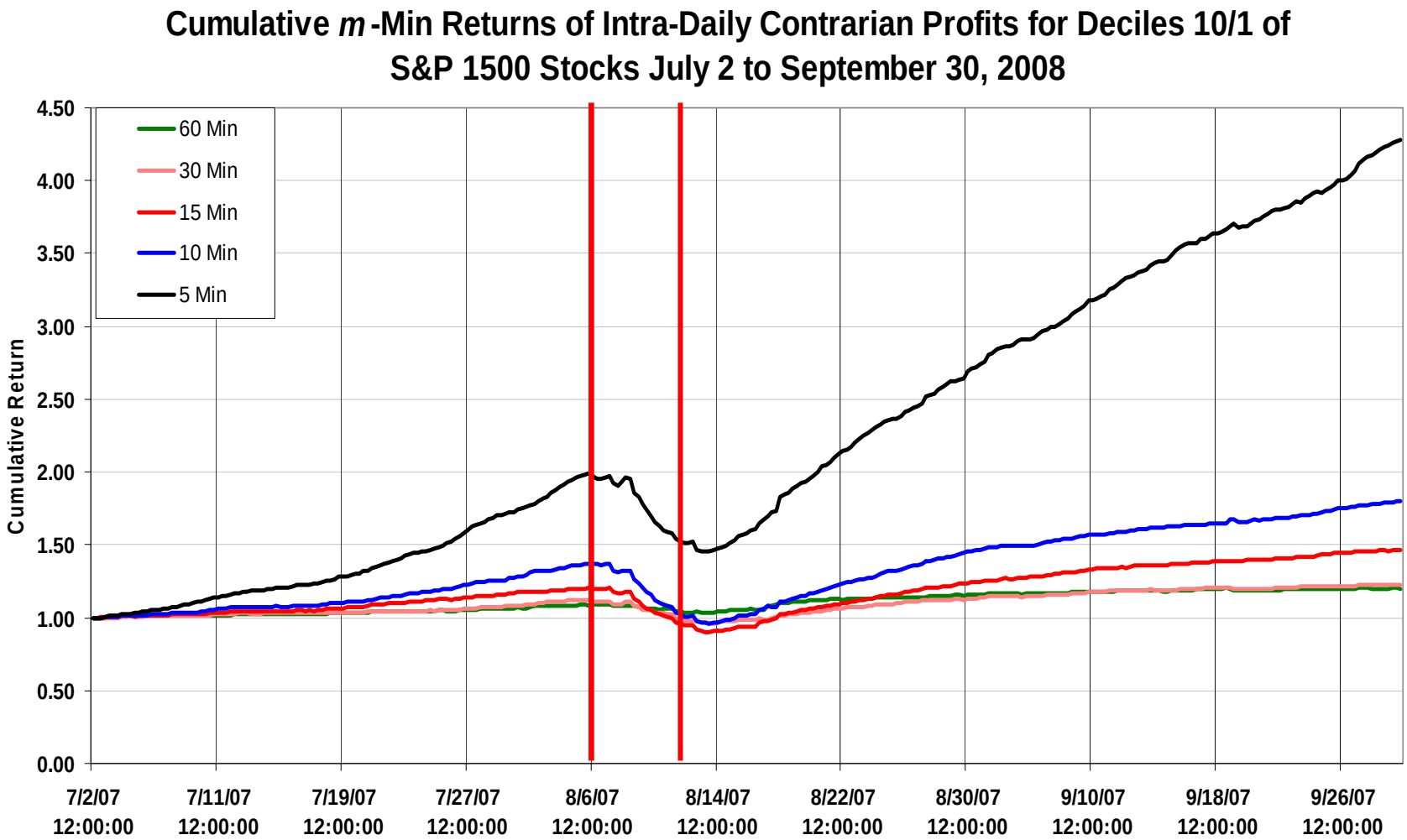


Proxies for Marketmaking Profits

Weekly Averages of Returns to Simple Marketmaking Strategy
Using Lagged 5-Minute Returns, July to September 2007



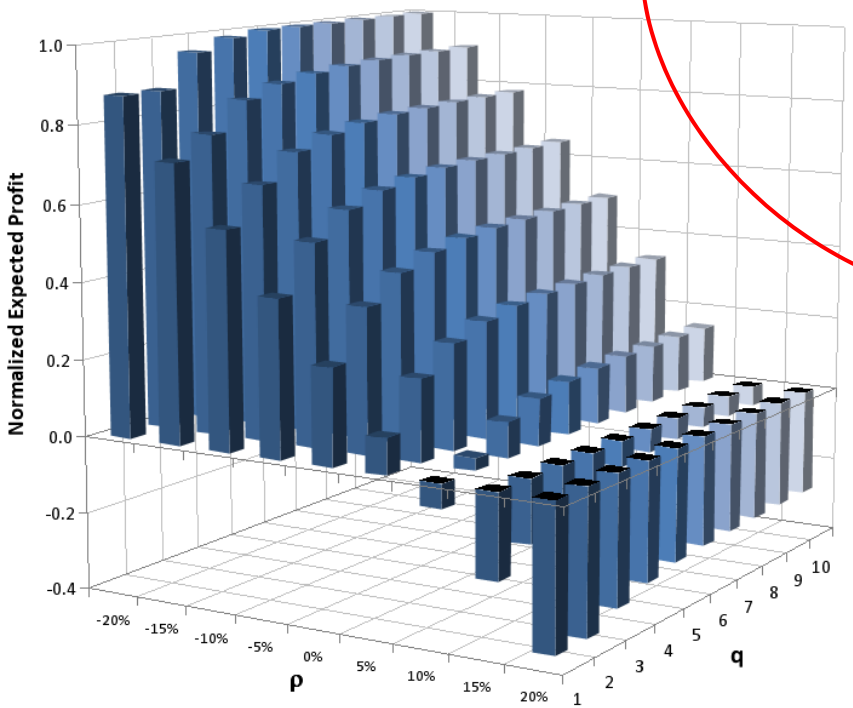
Proxies for Marketmaking Profits



Proxies for Marketmaking Profits

- Common factor plus idiosyncratic mean reversion

$$\mathrm{E}[\pi_t(q)] = \frac{N-1}{N^2}\sum_{i=1}^{N}\frac{1-\theta_i^q}{2}\sigma_{\lambda_i}^2 - \rho\frac{1-\rho^q}{1-\rho}\sigma_\nu^2\sigma^2(\beta) - q\sigma^2(\mu)$$



Common Factor

Idiosyncratic Mean Reversion

Proxies for Marketmaking Profits

Profitability of Intra-Daily and Daily Strategies Over Various Holding Period, August 1–15, 2007

Panel A: High-Frequency Contrarian Strategy

	Average Return (bps)				
Date	5 Minutes	10 Minutes	15 Minutes	30 Minutes	60 Minutes
8/1/2007	5.06	6.81	5.15	8.02	7.37
8/2/2007	6.74	6.97	8.47	9.48	9.02
8/3/2007	4.28	2.93	1.77	1.47	-0.62
8/6/2007	-1.30	-2.57	-3.57	-8.75	-5.30
8/7/2007	-1.12	-6.32	-10.14	-14.55	-15.43
8/8/2007	-18.69	-31.60	-40.99	-56.82	-62.49
8/9/2007	-9.82	-16.86	-20.87	-27.65	-26.06
8/10/2007	-4.38	-11.41	-16.25	-25.15	-42.97
8/13/2007	-4.90	-10.29	-15.17	-23.18	-28.69
8/14/2007	5.39	7.72	8.30	10.12	10.28
8/15/2007	6.79	8.96	9.63	8.46	8.35
July Sigma	1.58	1.96	2.15	2.58	3.53

Panel B: Daily Contrarian Strategy

	Return (%)				
Portfolio Construction Date	Held 1 Day	Held 2 Days	Held 3 Days	Held 4 Days	Held 5 Days
8/1/2007	0.14%	-1.03%	-2.69%	-2.57%	-0.34%
8/2/2007	-0.76%	-1.62%	-2.57%	-2.63%	-2.79%
8/3/2007	-0.30%	-0.57%	0.65%	0.29%	2.04%
8/6/2007	-1.47%	-1.79%	-1.75%	1.24%	3.44%
8/7/2007	-2.88%	-4.49%	1.38%	4.00%	4.52%
8/8/2007	-3.99%	3.79%	7.81%	8.31%	8.20%
8/9/2007	6.85%	10.12%	9.83%	9.47%	8.96%
8/10/2007	-1.46%	-1.71%	-1.48%	-1.84%	-1.49%
8/13/2007	0.19%	0.82%	3.79%	4.61%	3.77%
8/14/2007	-0.95%	-0.83%	0.22%	0.34%	0.56%
8/15/2007	-1.34%	-0.58%	0.31%	0.76%	1.69%
January to July 2007	0.36%	0.49%	0.59%	0.66%	0.69%
2007 Sigma	0.8%	1.1%	1.2%	1.5%	1.5%

Conclusions

New Lessons from August 2007

- "Quant" is not the issue; liquidity and credit are the issues
- Long/short equity space is more crowded now than in 1998
- All hedge-fund strategies are more crowded now (connectedness)
  - Similar factors (not surprisingly)
  - Centralized exchanges and mark-to-market accounting
- Hedge funds provide more significant amounts of liquidity today
- Hedge funds can withdraw liquidity suddenly, unlike banks
- Liquidity withdrawal can lead to market dislocation (August 2007)
- Financial markets are more highly connected $\Rightarrow$ **new betas**
- Simulating strategies can yield insights into market dynamics
- Systemic risk has increased

But All These Measures Are Indirect