Fundamentals

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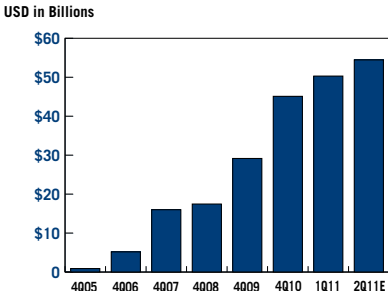
RAFI® Managed Assets*



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THE TROUBLE WITH QUANTS

Oliver Wendell Holmes' 1858 poem "The Deacon's Masterpiece"[1] describes a perfected one-horse "shay," a highly engineered carriage designed so that the failure of a single part could not cause an untimely breakdown. By eliminating the weakest links, the carriage performs flawlessly, at first. But the shay does not have a happy ending. It suddenly disintegrates with all the parts failing at once, leaving its rider dazed atop a pile of rubble. Holmes—the father of the eminent U.S. Supreme Court Justice—mocked the pseudo-scientific efforts of the overeducated Deacons of his day to engineer impractical structures.

In our domain, the Deacons are quants (financial engineers) and their Masterpiece is an overly complex quantitative investment strategy. The second week in August marks the four-year anniversary of the quant meltdown of 2007. While the events of 2008, including nationalization of Fannie Mae and Freddie Mac, the failure of Lehman, the bailout of AIG, creation of TARP, etc., have rightly

received more scrutiny, August 2007 foreshadowed the global financial crisis and deserves more attention by today's investors. Analyzing the underlying causes of the quant meltdown helps reveal the perils of complex quantitative strategies and highlights the difference between transparent and rules-based alternative beta strategies such as the Fundamental Index® methodology and newer optimized approaches.

The Quant Meltdown

During the week of August 6, 2007, many large and previously successful hedge funds were forced to de-lever their portfolios and

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liquidate commonly held securities, resulting in simultaneous drawdowns of 30%, 50%, or worse. To make matters worse, these investments had been sold as risk-controlled and uncorrelated to the market. Khandani and Lo concluded that a "… deadly feedback loop of coordinated forced liquidations leading to deterioration of collateral value took hold during the second week of August 2007, ultimately resulting in the collapse of a number of quantitative equity market-neutral managers, and double-digit losses for many others."[2] Quantitatively managed enhanced index funds experienced similar simultaneous traumas, though the magnitude of losses was lower due to the lack of leverage.

None could have forecast the precise timing of the sudden liquidation of a large trading desk that catalyzed the quant meltdown.[3] But should we have been surprised that those funds failed catastrophically? After all, the quant funds of 2007 shared the same structural flaws as the highly engineered financial trading strategies that caused the stock market crash in 1987 and the implosion of Long-Term Capital Management in 1998.[4]

Inside the Black Box

To help avoid future meltdowns in our portfolios, we need to look inside the black box of quant strategies. Simply put, quants use advanced statistical methods and high frequency data to create complex financial models. With experience, skill, and some luck, a few of these models successfully forecast future security price changes. In the short term, these strategies provide consistent trading profits and gather assets into associated funds.

Consistent profits can hide inherent risks, however. Most complex quant strategies have proven to be unstable. Markets evolve in response to the creation and adoption of these strategies. At first, the identified predictability in security price movements is reinforced as funds using the quant model, along with similar funds using similar models, begin buying and selling the same securities. Early success and clever marketing attracts large flows into the funds, which, in turn, drives the prices of securities held by these funds to unsustainable extremes. The result is a brittle price structure awaiting the inevitable crisis.

Leverage creates an even more toxic brew. In the years leading up to the quant meltdown in August 2007, the same models used to manage enhanced index funds (with relatively low tracking errors and high information ratios) were increasingly employed to create levered absolute return-oriented long/short funds. To facilitate the use of leverage, risk models were used to minimize country, sector, and other common factor risks. With all the risk seemingly wrung out of the strategy, ever more capital and leverage were applied.

Paradoxically, quantitative risk management was part of the problem. While risk models are useful tools for measuring risk, using models to tightly control risk is misguided and dangerous. Because no model is, or ever can be, a complete description of the complex dynamic system that is a market, all risk models fail to capture some risk. By eliminating all of the risks measured by their models, the quants transferred the risk in their funds into the areas their models could not measure and they did not understand.

Quant strategies produce remarkable profits in the early stages. But inevitably, the process becomes unstable and often ends with violent illiquidity events, such as the stock market crash of 1987, the Long-Term Capital Management-induced crisis in September 1998, and the quant meltdown in August 2007. The largest losses in those episodes were suffered by the most recent investors who were attracted by dazzling early performance records. Instead of consistent profits, the later investors were stuck with shocking losses realized during fund liquidation as investors fled from the imploding strategies.

As Harry Markowitz stated in the middle of the crisis, "…the layers of financially engineered products… combined with the high levels of leverage, proved to be too much of a good thing."[5]

Fundamental not Quant

Only four years after the last quant meltdown, over-engineered quantitative investment strategies are back. The latest incarnation is complexly optimized alternative betas. Such strategies attempt to engineer indices with the lowest possible volatility, the highest possible Sharpe ratio, or the maximum possible diversification. The more complex the engineering, the better the model performs in the backtest. As investors begin to adopt such narrow indices, early performance may be rewarding. Fund inflows will create buying and selling pressure on the same narrow set of securities. This pattern will create a brittle price structure resembling the Deacon's Masterpiece and will set the stage for the next wreck.

Recognizing the trouble with quants, should we eschew quantitative study of security price movements and abandon risk models? Of course not! Advanced statistical methods are invaluable tools to help us understand securities markets. Likewise, risk models help us measure, monitor, and decompose the risks in our portfolios. For example, with regard to the Fundamental Index methodology, we use quantitative methods to demonstrate how and why companies with low market prices relative to fundamental measures of company size provide higher returns than companies with high market prices relative to fundamentals. We use risk models to examine whether and how value priced companies have different risk characteristics than other companies.

The Fundamental Index methodology is far less complex and therefore less risky than a highly engineered quant model. Fundamental weights are simple, logical, and stable. Fundamental Index portfolios are transparently constructed and broadly diversified. The Fundamental Index strategy uses the time-tested technique of systematic rebalancing to capture the long-term return premium offered by the market's excess volatility.

The following passage from Holmes' poem descries the end of the one-horse shay. But it could easily be a fitting narrative to the quant strategies during that fateful week in August 2007.

> *"…it went to pieces all at once, —*
> *All at once, and nothing first, —*
> *Just as bubbles do when they burst.*
> *End of the wonderful one-hoss shay.*
> *Logic is logic. That's all I say."*

The performance of Fundamental Index strategies may break down occasionally over the long winding road to investment success, just as traditional index funds can create some nasty surprises. However, these setbacks are just that and eventually the Fundamental Index strategy's simple and stable rebalancing process puts the portfolio back on track. That's our logic. What do you say?

Endnotes

1. Oliver Wendell Holmes, 1890, *The Deacon's Masterpiece or The Wonderful "One-Hoss Shay": A Logical Story*, New York: Houghton, Mifflin and Company. Illustrations by Howard Pyle.
2. Amir E. Khandani and Andrew W. Lo, 2007, "What Happened to the Quants in August 2007?" *Journal of Investment Management*, vol. 5, Fourth Quarter
3. Khandani and Lo, 2007.
4. Richard Bookstaber, 2007, *A Demon of Our Own Design: Markets, Hedge Funds, and the Perils of Financial Innovation*, New York: Wiley.
5. Harry Markowitz, 2008 "The Father of Portfolio Theory on the Crisis," *Wall Street Journal*, November 3. http://online.wsj.com/article/SB122567428153591981.html?mod=djemEditorialPage

Performance Update

FTSE RAFI® Equity Index Series*

TOTAL RETURN AS OF 7/31/11	BLOOMBERG TICKER	YTD	12 MONTH	ANNUALIZED 3 YEAR	ANNUALIZED 5 YEAR	ANNUALIZED 10 YEAR	ANNUALIZED 10 YEAR VOLATILITY
FTSE RAFI® All World 3000[1]	TFRAW3	2.38%	17.13%	4.75%	5.36%	9.48%	18.76%
MSCI All Country World[2]	GDUEACWF	3.32%	18.97%	1.81%	3.22%	5.29%	17.11%
FTSE RAFI® Developed ex US 1000[3]	FRX1XTR	2.98%	16.10%	1.61%	3.24%	8.32%	19.99%
MSCI World ex US Large Cap[4]	MLCUWXUG	3.38%	17.18%	-1.01%	1.76%	5.97%	18.16%
FTSE RAFI® Developed ex US Mid Small[5]	TFRDXUSU	5.19%	24.65%	10.41%	7.24%	14.68%	18.58%
MSCI World ex US Small Cap[6]	GCUDWXUS	2.82%	25.96%	5.71%	3.84%	11.34%	20.22%
FTSE RAFI® Emerging Markets[7]	TFREMU	0.02%	15.68%	7.50%	14.54%	24.05%	24.40%
MSCI Emerging Markets[8]	GDUEEGF	0.65%	17.79%	5.72%	11.34%	17.26%	23.99%
FTSE RAFI® 1000[9]	FR10XTR	2.30%	18.43%	7.30%	3.91%	5.27%	18.12%
Russell 1000[10]	RU10INTR	4.06%	20.68%	3.33%	2.80%	3.13%	16.02%
S&P 500[11]	SPTR	3.87%	19.65%	2.92%	2.39%	2.61%	15.83%
FTSE RAFI® US 1500[12]	FR15USTR	2.13%	23.80%	11.86%	7.47%	10.72%	22.50%
Russell 2000[13]	RU20INTR	2.37%	23.92%	5.18%	4.00%	6.47%	20.80%
FTSE RAFI® Europe[14]	TFREUE	-3.14%	3.62%	2.14%	-0.25%	2.97%	19.17%
MSCI Europe[15]	GDDLE15	-1.72%	6.39%	0.67%	-0.07%	1.95%	16.95%
FTSE RAFI® Australia[16]	FRAUSTR	-5.58%	0.32%	2.31%	2.54%	8.01%	13.07%
S&P/ASX 200[17]	ASA51	-4.86%	2.70%	0.52%	1.91%	7.30%	13.31%
FTSE RAFI® Canada[18]	FRCANTR	-2.45%	8.27%	5.63%	6.44%	9.07%	14.28%
S&P/TSX 60[19]	TX60AR	-3.26%	9.77%	-0.58%	4.52%	7.50%	14.67%
FTSE RAFI® Japan[20]	FRJPNTR	-6.83%	0.36%	-10.84%	-8.49%	0.17%	18.55%
MSCI Japan[21]	GDDLJN	-6.06%	0.79%	-12.37%	-10.21%	-2.16%	18.24%
FTSE RAFI® UK[22]	FRGBRTR	-0.18%	13.24%	7.06%	2.57%	4.48%	17.14%
MSCI UK[23]	GDDLUK	0.78%	14.20%	6.48%	3.37%	4.03%	15.02%

*To see the complete series, please go to: http://www.ftse.com/Indices/FTSE_RAFI_Index_Series/index.jsp.

Russell Fundamental Index® Series*

TOTAL RETURN AS OF 7/31/11	BLOOMBERG TICKER	YTD	12 MONTH	ANNUALIZED 3 YEAR	ANNUALIZED 5 YEAR	ANNUALIZED 10 YEAR	ANNUALIZED 10 YEAR VOLATILITY
Russell Fundamental Global Index Large Company[24]	RUFGLTU	3.52%	19.34%	4.87%	5.56%	9.52%	17.47%
MSCI All Country World Large Cap[25]	MLCUAWOG	3.27%	18.24%	1.23%	2.95%	4.65%	16.80%
Russell Fundamental Developed ex US Index Large Company[26]	RUFDXLTU	3.34%	16.94%	5.36%	3.18%	9.97%	18.39%
MSCI World ex US Large Cap[27]	MLCUWXUG	3.38%	17.18%	-1.01%	1.76%	5.97%	18.16%
Russell Fundamental Developed ex US Index Small Company[28]	RUFDXSTU	3.67%	22.06%	8.06%	5.86%	13.17%	18.44%
MSCI World ex US Small Cap[6]	GCUDWXUS	2.82%	25.96%	5.71%	3.84%	11.34%	20.22%
Russell Fundamental Emerging Markets[29]	RUFGETRU	2.66%	23.26%	10.20%	16.16%	24.05%	24.26%
MSCI Emerging Markets[8]	GDUEEGF	0.65%	17.79%	5.72%	11.34%	17.26%	23.99%
Russell Fundamental US Index Large Company[30]	RUFUSLTU	3.85%	20.18%	6.58%	4.36%	6.14%	16.55%
Russell 1000[10]	RU10INTR	4.06%	20.68%	3.33%	2.80%	3.13%	16.02%
S&P 500[11]	SPTR	3.87%	19.65%	2.92%	2.39%	2.61%	15.83%
Russell Fundamental US Index Small Company[31]	RUFUSSTU	4.29%	25.91%	12.73%	8.87%	11.87%	20.94%
Russell 2000[13]	RU20INTR	2.37%	23.92%	5.18%	4.00%	6.47%	20.80%
Russell Fundamental Europe[32]	RUFEUTE	-1.75%	7.38%	4.13%	1.94%	5.88%	18.10%
MSCI Europe[15]	GDDLE15	-1.72%	6.39%	0.67%	-0.07%	1.95%	16.95%

*To see the complete series, please go to: http://www.russell.com/indexes/data/Fundamental/About_Russell_Fundamental_indexes.asp.

Fixed Income/Alternatives

TOTAL RETURN AS OF 7/31/11	BLOOMBERG TICKER	YTD	12 MONTH	ANNUALIZED 3 YEAR	ANNUALIZED 5 YEAR	ANNUALIZED 10 YEAR	ANNUALIZED 10 YEAR VOLATILITY
RAFI® Bonds Investment Grade Master[33]		5.63%	6.54%	10.30%	7.91%	6.58%	6.04%
ML Corporate Master[34]	C0A0	5.65%	6.87%	9.51%	7.12%	6.33%	6.21%
RAFI® Bonds High Yield Master[35]		7.50%	12.91%	15.40%	11.21%	9.61%	11.03%
ML Corporate Master II High Yield BB-B[36]	H0A4	6.22%	12.44%	11.51%	8.30%	7.85%	9.87%
RAFI US Equity Long/Short[37]		-4.05%	-2.78%	12.58%	2.90%	5.49%	11.77%
1-Month T-Bill[38]	GB1M	0.04%	0.10%	0.20%	1.64%	1.87%	0.48%
FTSE RAFI® Global ex US Real Estate[39]	FRXR	0.26%	16.82%	0.30%	-0.71%	9.78%	22.39%
FTSE EPRA/NAREIT Global ex US[40]	EGXU	1.11%	16.77%	-3.29%	-3.24%	7.54%	20.30%
FTSE RAFI® US 100 Real Estate[41]	FRUR	7.31%	20.15%	5.20%	-3.46%	5.47%	27.12%
FTSE EPRA/NAREIT United States[42]	UNUS	9.60%	19.91%	-0.49%	-2.83%	5.15%	25.51%

Definition of Indices:

(1) The FTSE RAFI® All World 3000 Index is a measure of the largest 3,000 companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value), across both developed and emerging markets.
(2) The MSCI All Country World Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed and emerging markets.
(3) The FTSE RAFI® Developed ex US 1000 Index is a measure of the largest 1000 non U.S. listed, developed market companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(4) The MSCI World ex US Large Cap Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets, excluding the United States.
(5) The FTSE RAFI® Developed ex US Mid Small Index tracks the performance of small and mid-cap companies domiciled in developed international markets (excluding the United States), selected and weighted based on the following four fundamental measures of firm size: sales, cash flow, dividends and book value.
(6) The MSCI World ex US Small Cap Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of small cap developed markets, excluding the United States.
(7) The FTSE RAFI® Emerging Markets Index comprises the largest 350 Emerging Market companies selected and weighted using fundamental factors (sales, cash flow, dividends, book value).
(8) The MSCI Emerging Markets Index is an unmanaged, free-float-adjusted cap-weighted index designed to measure equity market performance of emerging markets.
(9) The FTSE RAFI® 1000 Index is a measure of the largest 1,000 U.S. listed companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(10) The Russell 1000 Index is a market-capitalization-weighted benchmark index made up of the 1,000 highest-ranking U.S. stocks in the Russell 3000.
(11) The S&P 500 Index is an unmanaged market index that focuses on the large-cap segment of the U.S. equities market.
(12) The FTSE RAFI® US 1500 Index is a measure of the 1,001st to 2,500th largest U.S. listed companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(13) The Russell 2000 is a market-capitalization weighted benchmark index made up of the 2,000 smallest U.S. companies in the Russell 3000.
(14) The FTSE RAFI® Europe Index is comprised of all European companies listed in the FTSE RAFI® Developed ex U.S. 1000 Index, which in turn is comprised of the largest 1,000 non U.S. listed developed market companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(15) The MSCI Europe Index is a free-float adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in Europe.
(16) The FTSE RAFI® Australia Index is comprised of all Australian companies listed in the FTSE RAFI® Developed ex U.S. 1000 Index, which in turn is comprised of the largest 1,000 non U.S. listed developed market companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(17) The S&P/ASX 200 Index, representing approximately 78% of the Australian equity market, is a free-float-adjusted, cap-weighted index.
(18) The FTSE RAFI® Canada Index is comprised of all Canadian companies listed in the FTSE RAFI® Developed ex U.S. 1000 Index, which in turn is comprised of the largest 1,000 non U.S. listed developed market companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(19) The S&P/Toronto Stock Exchange (TSX) 60 is a cap-weighted index consisting of 60 of the largest and most liquid (heavily traded) stocks listed on the TSX, usually domestic or multinational industry leaders.
(20) The FTSE RAFI® Japan Index is comprised of all Japanese companies listed in the FTSE RAFI® Developed ex U.S. 1000 Index, which in turn is comprised of the largest 1,000 non U.S. listed developed market companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(21) The MSCI Japan Index is an unmanaged, free-float-adjusted cap-weighted index that aims to capture 85% of the publicly available total market capitalization of the Japanese equity market.
(22) The FTSE RAFI® UK Index is comprised of all UK companies listed in the FTSE RAFI® Developed ex U.S. 1000 Index, which in turn is comprised of the largest 1,000 non U.S. listed developed market companies, selected and weighted using fundamental factors; (sales, cash flow, dividends, book value).
(23) The MSCI UK Index is an unmanaged, free-float-adjusted cap-weighted index that aims to capture 85% of the publicly available total market capitalization of the British equity market.
(24) The Russell Fundamental Global Index Large Company is a measure of the largest companies, selected and weighted using fundamental factors; (adjusted sales, retained cash flow, dividends + buybacks), across both developed and emerging markets.
(25) The MSCI All Country World Large Cap Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed and emerging markets.
(26) The Russell Fundamental Developed ex US Large Company is a subset of the Russell Fundamental Developed ex US Index, and is a measure of the largest non-U.S. listed developed country companies, selected and weighted using fundamental factors; (adjusted sales, retained cash flow, dividends + buybacks).
(27) The MSCI World ex US Large Cap Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of large cap-developed markets, excluding the United States.
(28) The Russell Fundamental Developed ex US Index Small Company is a subset of the Russell Fundamental Developed ex US Index, and is a measure of small non-U.S. listed developed country companies, selected and weighted using fundamental factors; (adjusted sales, retained cash flow, dividends + buybacks).
(29) The Russell Fundamental Emerging Markets Index is a measure of Emerging Market companies, selected and weighted using fundamental factors; (adjusted sales, retained cash flow, dividends + buybacks).
(30) The Russell Fundamental U.S. Index Large Company is a subset of the Russell Fundamental US Index, and is a measure of the largest U.S. listed companies, selected and weighted using fundamental measures; (adjusted sales, retained cash flow, dividends + buybacks).
(31) The Russell Fundamental US Index Small Company is a subset of the Russell Fundamental US Index, and is a measure of U.S. listed small companies, selected and weighted using fundamental measures; (adjusted sales, retained cash flow, dividends + buybacks).
(32) The Russell Fundamental Europe Index is a measure of European companies, selected and weighted using fundamental factors; (adjusted sales, retained cash flow, dividends + buybacks).
(33) The RAFI® Bonds Investment Grade Master Index is a U.S. investment-grade corporate bond index comprised of non-zero fixed coupon debt with maturities ranging from 1 to 30 years issued by publicly traded companies. The issuers held in the index are weighted by a combination of four measures of their fundamental size—sales, cash flow, dividends, and book value of assets.
(34) The Merrill Lynch U.S. Corporate Master Index is representative of the entire U.S. corporate bond market. The index includes dollar-denominated investment-grade corporate public debt issued in the U.S. bond market.
(35) The RAFI® Bonds High Yield Master is a U.S. high-yield corporate bond index comprised of non-zero fixed coupon debt with maturities ranging from 1 to 30 years issued by publicly traded companies. The issuers held in the index are weighted by a combination of four measures of their fundamental size—sales, cash flow, dividends, and book value of assets.
(36) The Merrill Lynch Corporate Master II High Yield BB-B Index is representative of the U.S. high yield bond market. The index includes domestic high-yield bonds, including deferred interest bonds and payment-in-kind securities. Issues included in the index have maturities of one year or more and have a credit rating lower than BBB-/Baa3, but are not in default.
(37) The RAFI® US Equity Long/Short Index utilizes the Research Affiliates Fundamental Index® (RAFI®) methodology to identify opportunities that are implemented through long and short securities positions for a selection of U.S. domiciled publicly traded companies listed on major exchanges. Returns for the index are collateralized and represent the return of the strategy plus the return of a cash collateral yield.
(38) The 1-Month T-bill return is calculated using the Bloomberg Generic 1-month T-bill. The index is interpolated based off of the currently active U.S. 1 Month T-bill and the cash management bill closest to maturing 30 days from today.
(39) The FTSE RAFI® Global ex US Real Estate Index comprises 150 companies with the largest RAFI fundamental values selected from the constituents of the FTSE Global All Cap ex U.S. Index that are classified by the Industry Classification Benchmark (ICB) as Real Estate.
(40) The FTSE EPRA/NAREIT Global ex US Index is a free float-adjusted index, and is designed to represent general trends in eligible listed real estate stocks worldwide, excluding the United State. Relevant real estate activities are defined as the ownership, trading and development of income-producing real estate.
(41) The FTSE RAFI® US 100 Real Estate Index comprises of the 100 U.S. companies with the largest RAFI fundamental values selected from the constituents of the FTSE USA All Cap Index that are classified by the Industry Classification Benchmark (ICB) as Real Estate.
(42) The FTSE EPRA/NAREIT United States Index is a free float-adjusted index, is a subset of the EPRA/NARIET Global Index and the EPRA/NAREIT North America Index and contains publicly quoted real estate companies that meet the EPRA Ground Rules. EPRA/NARIET Index series is seen as the representative benchmark for the real estate sector.

Source: All index returns are calculated using total return data from Bloomberg, except for the real estate indices and benchmarks, which use price return data. Returns for all single country strategies and Europe regional strategies are in local currency. All other returns are in USD.