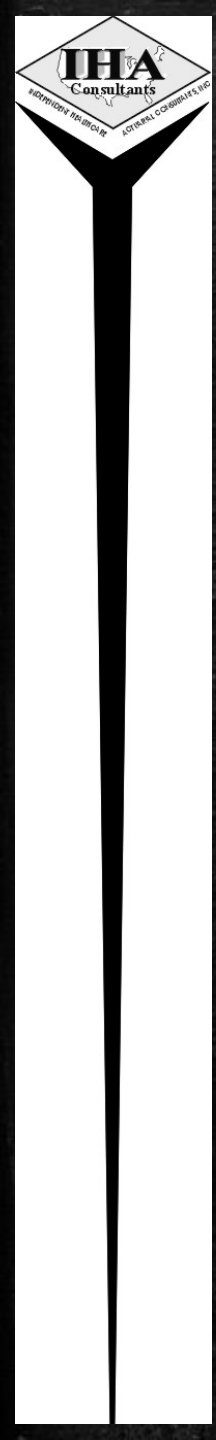




TRI-SIGNAL Investment Analytics: Theory and Background (See Series {1,2,3} Deep Dive Video)

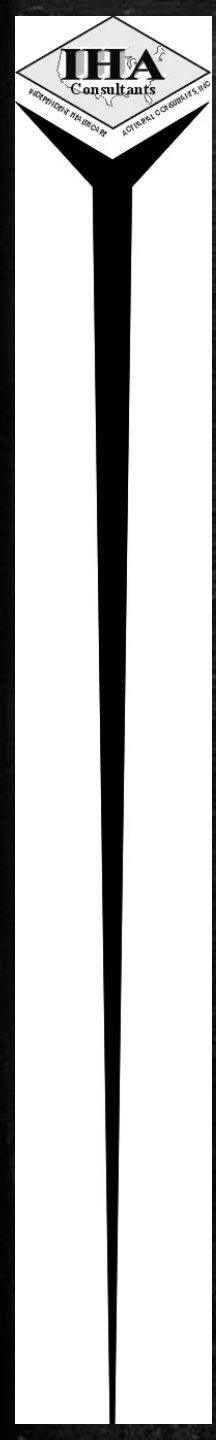
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TRI-SIGNAL Investment Analytic Tool: Theory and Background

TRI-SIGNAL Analytic Tool integrates the well documented stock price “time series momentum effect,” factor models and value investing concepts with “robust machine learning” to produce value-added predictive fields which can be easily interpreted in graphical form (human) in Microsoft Excel / Tableau or as input into neural net based prediction.

- For each data series, for each trade-day nine (9) value added fields are reported:
 - Series 1 Signal
 - Series 2 Signal
 - Series 3 Signal
 - Short-run expected return %
 - Long-run expected return %
 - Next trade-day upper bound return %
 - Next trade-day lower bound return %
 - Long-run forecast / comment
 - Volatility status



TRI-SIGNAL Investment Analytic Tool: Theory and Background (continued)

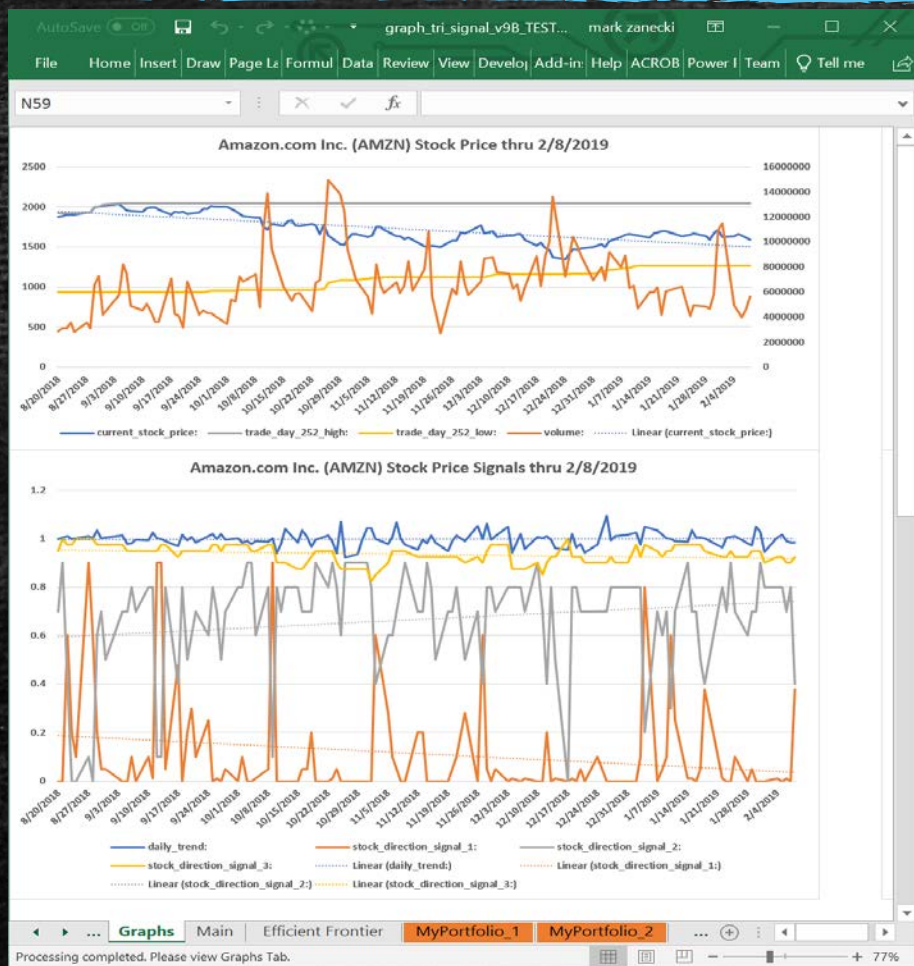
On any trade-day, approximately **10% or less** of U.S. equities exhibit a signal pattern of sufficient strength to be included in analysis. (See Heat Map.)

User analysis correlating U.S. equity price movement with Series {1,2,3} is key insight that enables identification of short-run excess return opportunities as well as detection of downturn in any US equity.

- The goal of TRI-SIGNAL is to identify signal patterns of sufficient strength that exhibit historic reliable predictive power against a background of “noise.”
- Description of Series {1,2,3} Signals:
 - Series 1 Signal – (**true signal**) – indicates (price, date) for a specific U.S. equity that merits attention. Can be used standalone or in combination with Series {3}.
 - Series 2 Signal – (**noise signal**) – ubiquitous signal that varies in strength by (price, date) for each U.S. equity. Can be informative at times and not so much at other times.
 - Series 3 Signal – (**true signal**) - indicates (price, date) that is responsive to Series 3 signal level or CHANGE in Series 3 signal level for a specific U.S. equity that merits attention. Can be used standalone or in combination with Series {1}.



TRI-SIGNAL Investment Analytic Tool: Graph of Stock Metrics and Associated Series {1,2,3} Signals.



120 Trade-day history of U.S. equity price series with 252 trade-day High/Low and Volume

Do you see a pattern as price series increases / decreases and Series {1,2,3}?

Did the pattern appear prior to market response in Volume?

120 Trade-day history of U.S. equity daily trend with Series {1,2,3} Signals



TRI-SIGNAL Investment Analytic Tool: Value-Added Fields

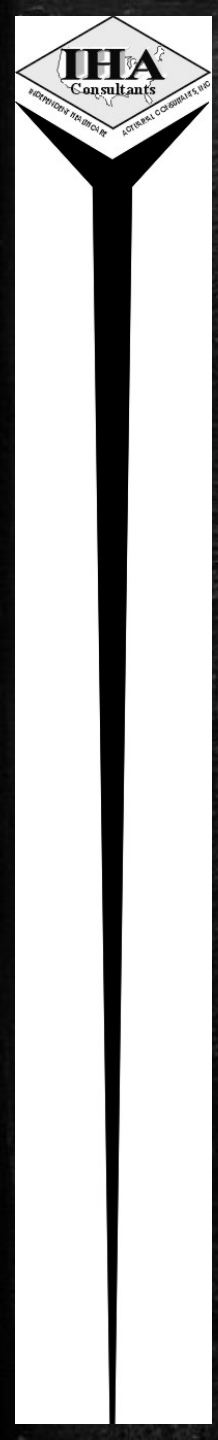
For current trade-day, the value-added fields are searchable. Rolling 120 trade-day history is reported.

AutoSave (ON) graph_tri_signal_v6.xlsm - Excel

File Home Insert Draw Page Layout Formulas Data Review View Developer Add-ins Help ACROBAT PowerPivot Team Tell me what you want to do

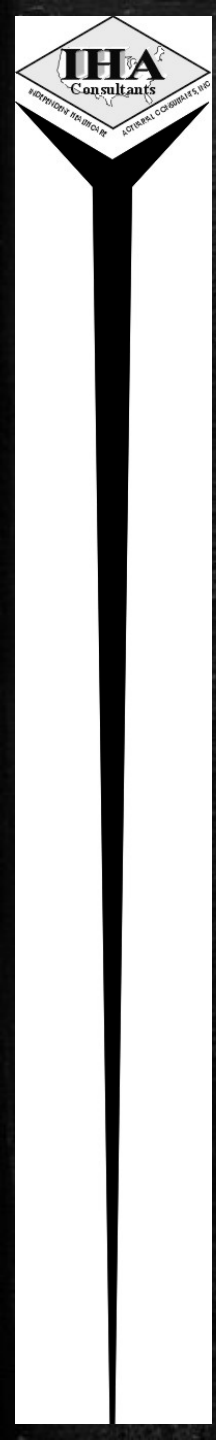
A1 Stock_symbol:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Stock_syn	Company_Sector:	Exchange:	Prior_Clos	Volume:	Market_C	PE_Ratio:	Recent_Tr	Est. Lower	Short_run	Est. Upper	Short_run	Short_run	Stock_dir	Stock_dir	Stock_dir	Long_run	Long_run	Column_S	Trade_date:		8/20/2018
2	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	current_stock_price:		64.470001
3	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	next_trade_day_est_high_price:		64.470001
4	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	next_trade_day_est_low_price:		64.470001
5	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	trade_day_est_high_percent_price:		
6	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	trade_day_est_low_percent_price:		
7	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	long_run_comment:		Long_run_fa
8	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	pe_ratio:		25.09
9	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	volume:		1619930
10	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	market_capitalization:		2.0566E+10
11	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	volatility:		non-stable
12	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	daily_trend:		1.00162735
13	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	exceed_upper_bound:		
14	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	exceed_lower_bound:		
15	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	stock_direction_signal_1:		0
16	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	stock_direction_signal_2:		0.7
17	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	stock_direction_signal_3:		0.95
18	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	long_run_optimal_buy_ind:		0
19	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	trade_day_252_high:		75
20	A	Agilent Te	Healthcar	New York	76.31	1593537	2.43E+10	27.35	1.003683	76.69351	1.005026	77.47109	1.015215	0	0	0.6	0.975	1.010588	0	trade_day_252_low:		60.42



TRI-SIGNAL Investment Analytic Tool: Visualization of Signal Effects





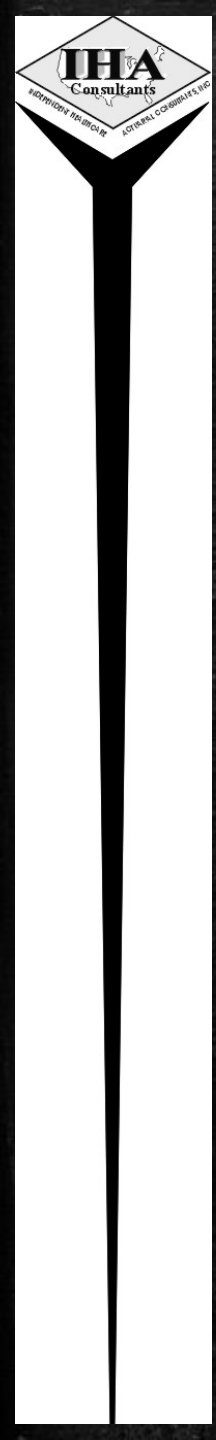
TRI-SIGNAL Investment Analytic Tool: Theory and Background (Drill Down)

- The goal of TRI-SIGNAL is to identify signal patterns of sufficient strength that exhibit historic reliable predictive power against a background of “noise.”
 - **Filtering for Series {1,3} is provided in stock search mode and in portfolio modes.**
- Description of Series {1,2,3} Signals:
 - Series 1 Signal – (**true signal**) – Has two roles: 1) indicates (price, date) that merits attention and 2) plays role of degree of risk aversion.
 - Value ranges from zero (0) to one (1). The average value varies per U.S. equity / stock over time and is generally < 0.1 .
 - Series 1 Signal ≥ 0.2 is significant but “risky.”
 - Signal strength of 0.6 or better is considered strong and “moderately risky.”
 - Signal strength of 0.9 or better is very strong and “lowest risk.”
 - Can be used standalone or in combination with Series {3}.
 - Series 2 Signal – (**noise signal**) – ubiquitous signal that varies in strength by (price, date) for each U.S. equity. Can be informative at times and not so much at other times.
 - Series 3 Signal – (**true signal**) – The recent Series 3 signal level and local trend of Series 3 signal are very significant and are primary predictive indicators.
 - Value for Series 3 range from 0.7 to 1.0.
 - When Series 3 is used in combination with Series 1, Series 3 is first consideration and then Series 1.
 - Stocks with a “buy signal” will generally have Series 3 signal at 0.97 to 1.0+.



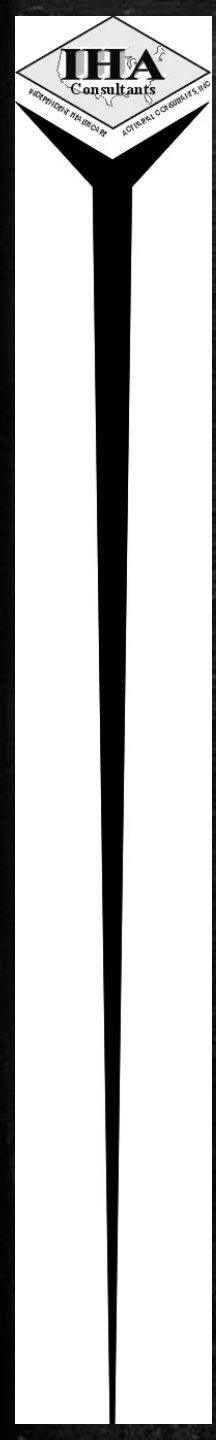
TRI-SIGNAL Investment Analytic Tool: Theory and Background (Want frequent smaller gains over 1-2-3 trade-days rather than “swinging for the fence – large gain in 1-2- 3 trade-days) – COMPOUNDING EFFECT

- Frequent smaller gains over 1-2-3 trade-days rather than “swinging for the fence – large gain in 1-2-3 trade-days) is **optimal strategy**.
 - Smaller gains around 1.001 to 1.005 to 1.01 are much more common and attainable in 1-2-3 trade-days.
 - Rule of thumb: “the market has rewarded you if you gained \$ 1 per share or 1%.”
 - **GOAL: If earned 1.005 for 50 trades with reinvestment of profits would have return of $1.005^{50} = 28.3\%$ (before tax and transaction costs).**
 - Large gains in 1-2 trade-days will be “surprise good news events” and will be speculative in nature without “inside information.”
 - Earnings announcements (week before and up to and including day of announcement) can be volatile.
 - Want to buy U.S. equities at low and sell at high.
 - Always measure the maximal historic gain (52 High / 52 Low) vs remaining potential gain (52 High / current price) to gauge if sufficient gain potential remains versus universe of stocks available for short-run gain opportunities. Compare p/e ratios.
 - You will observe US equities / stocks that move “very little” and those that move “quite a bit.” Money invested in stocks that move very little require much more time to attain a gain and are not suitable for short-run strategies.



TRI-SIGNAL Investment Analytic Tool: Theory and Background (How to Identify Next Best Investment that involves Smallest Risk vs. Certain Return of Savings Account using Series {1,2,3} Signals.)

- Series {1,2,3} Signals allow any investor to identify the Next Best Investment that involves smallest risk vs. certain return of a savings account.
- For no risk scenario, under arbitrage arguments, the maximal return will be the current daily equivalent to annual savings account rate.
- For smallest risk scenario, under arbitrage arguments, the maximal return will be "incrementally more" than the savings account rate.
- **The Next Best Investment with smallest risk is identified as follows:**
 - **Series 3 Signal level at 0.97 or better and Trend of Series 3 Signal over last 3-5-10 trade days increasing COMBINED with Series 1 signal of 0.9 or better and local trend in Series 1 increasing over last 20 trade-days or last 10 trade-days. Assumes no news events or macro-economic new events.**
- As reduce Series 3 Signal threshold (with Series 1 Signals as above) have high potential gains with higher level of risk – Can target any risk preference level – after calibration steps.
- **Speculators** would use Series 2 and Series 3 signals as well as Series 1 and Series 3 Signal patterns.



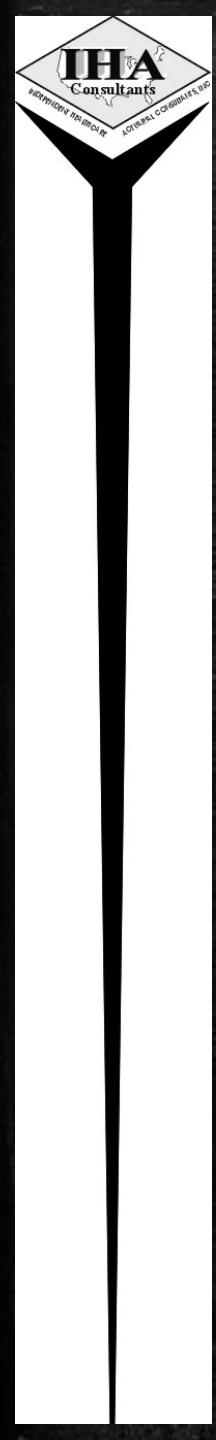
TRI-SIGNAL Investment Analytic Tool: Theory and Background (Drill Down Diversification)

- The goal of TRI-SIGNAL is to identify signal patterns of sufficient strength that exhibit historic reliable predictive power against a background of “noise.”
- Diversification:
 - Traditional equity/ stock diversification has two goals: spread risk over many equities to reduce individual effect (volatility reduction) as well as to capture as many “opportunities” for equity appreciation.
 - Costs are up-front
 - Too much diversification reduces yield appreciation. (logic if you knew which equities or stocks were likely to increase, you would put your money in that set of stocks rather than diversify over say 30 to 100+ equities / stocks with little potential for return appreciation.)
 - **By scanning 8,300 U.S. equity / stocks each trade-day you avoid up-front costs of traditional diversification (to some degree), attain more yield by weighting to short-run opportunities and accomplish the goal of reduced volatility which higher expected return. This is called mean-variance dominating strategy and is superior to traditional equity / stock diversification.**



TRI-SIGNAL Investment Analytic Tool: Partial Listing of Relevant Academic Papers

- Asness, Clifford; Frazzini, Abdrea; Israel, Rowen; Moskowitz, Tobias J., "Fact, Fiction and Value Investing ", The Journal of Portfolio Management, (Fall 2015), Vol. 42, No. 1. (<https://faculty.chicagobooth.edu/tobias.moskowitz/research/Fact%20Fiction%20and%20Value%20Investing%20-%20June%202015.pdf>)
- Black F. and Litterman R.: Global Portfolio Optimization, Financial Analysts Journal, September 1992, pp. 28–43 JSTOR 4479577 (https://faculty.fuqua.duke.edu/~charvey/Teaching/BA453_2006/Black_Litterman_Global_Portfolio_Optimization_1992.pdf)
- Chen, Hsiu-Lang, Narasimhan Jegadeesh, and Russ Wermers, "The Value of Active Mutual Fund Management: An examination of the Stockholdings and Trades of Fund Managers," Journal of Financial and Quantitative Analysis, Vol. 35, (2000), 343-368. (https://faculty.chicagobooth.edu/john.cochrane/teaching/35150_advanced_investments/chan_jegadeesh_wermers_funds_jfqa.pdf)
- Danial, Kent; Grinblatt, Mark; Titman, Sheridan; Wermers, Russ, "Measuring Mutual Fund Performance with Characteristic-Based Benchmarks", Journal of Finance, 52, (2012),1035-1058.
- Fama, Eugene F. and French, Kenneth R., "Permanent and Temporary Components of Stock Prices", Journal of Political Economy, Vol. 96, No. 2 (Apr., 1988), pp. 246-273. (<https://teach.business.uq.edu.au/courses/FINM6905/files/module-2/readings/Fama%20French.pdf>)
- Fama, Eugene F. and French, Kenneth R., "Profitability, investment and average returns", Journal of Financial Economics 82 (2006) 491–51. (http://finpko.faculty.ku.edu/myssi/FIN938/Fama%20French_Profitability%20Investment%20%26%20Avg%20Returns_JFE_2006.pdf)
- Fama, Eugene F. and French, Kenneth R., "Dissecting Anomalies", (June 2007). CRSP Working Paper No. 610. (http://schwert.ssb.rochester.edu/f532/ff_JFo8.pdf)



TRI-SIGNAL Investment Analytic Tool: Partial Listing of Relevant Academic Papers (Cont.)

- Thomas M. Idzorek: A Step-By-Step Guide to the Black-Litterman Model - Incorporating user-specified confidence levels. (<http://corporate.morningstar.com/ib/documents/MethodologyDocuments/IBBAssociates/BlackLitterman.pdf>)
- Merton, Robert C., "An Analytic Derivation of the Efficient Portfolio Frontier", The Journal of Financial and Quantitative Analysis, Vol. 7, No. 4 (Sep., 1972), pp.1851-1872. (http://www.stat.ucla.edu/~nchristo/statistics_c183_c283/analytic_derivation_frontier.pdf)
- Moskowitz, Tobias J. ; Grinblatt, Mark, "Do Industries Explain Momentum?", The Journal of Finance, Vol. 54, No. 4, Papers and Proceedings, Fifty-Ninth Annual Meeting, American Finance Association, New York, New York, January 4-6, 1999. (Aug., 1999), pp.1249-1290. (<http://www-stat.wharton.upenn.edu/~stele/Courses/956/Resource/Momentum/MoskowitzGrinblatt99.pdf>)
- Moskowitz, Tobias J. ; Grinblatt, Mark, "Predicting stock price movements from past returns: The role of consistency and tax-loss selling", Journal of Financial Economics 00 (2003) 000-000. (https://faculty.chicagobooth.edu/tobias.moskowitz/research/Grinblatt_Moskowitz_JFE.pdf)
- Moskowitz, Tobias J. ; Ooi, Yao Hua; Pedersen, Lasse Heje, "Time series momentum", Journal of Financial Economics, Volume 104, Issue 2, (May 2012), Pages 228-250. (<https://www.sciencedirect.com/science/article/pii/S0304405X11002613>)
- Narasimhan Jegadeesh; Sheridan Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency", The Journal of Finance, Vol. 48, No. 1. (Mar., 1993), pp. 65-91. (http://www.business.unr.edu/faculty/liuc/files/BADM742/Jegadeesh_Titman_1993.pdf)