Portfolio Visualizer

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Agenda

- Background and Motivation
- Portfolio Visualizer Tools for Investors
  - Overview of tools and related theoretical background
  - Investment process alignment
  - Live examples
- Limitations of Financial Modeling
- Q & A

Background and Motivation

- Empower investors and advisors with better tools
- Easy-to-use web based platform
- Focus on quantitative, factor based investing
- No product promotions or bias
- Self-guided education

Portfolio Visualizer Tools

- Portfolio and asset allocation backtesting
  - Explore portfolio construction and diversification benefits
  - Explore risk metrics and risk tolerance
- Monte Carlo simulation
  - Explore long term expected portfolio growth and portfolio survival during retirement withdrawals
- Modern portfolio theory (MPT)
  - Efficient frontier and mean variance optimization
  - Black-Litterman model
- Factor model regression analysis (CAPM, FF3, CH4, FF5)
  - Understanding risk factors and fund performance attribution
- Tactical asset allocation models
  - Managing portfolio risk

Portfolio Backtesting

- Explore return and risk characteristics of different asset allocations
  - Asset allocation is the primary driver of portfolio returns
  - Identify diversification benefits
- Easy comparisons
  - Portfolios and asset allocations
  - Rebalancing strategies
  - Common lazy portfolios
  - Nominal vs. real returns
  - Portfolio asset correlations
  - Portfolio yield and income

Risk Measures and Risk Tolerance

- Risk related measures
  - Standard deviation
  - Beta
  - Sharpe Ratio
  - Sortino Ratio
  - Treynor Ratio
  - Skewness and kurtosis of return distribution
  - Value-at-Risk (VaR)
- Personal comfort level
  - Volatility (standard deviation)
  - Worst year
  - Maximum drawdown and recovery time
  - Rolling returns
  - Positive vs. negative periods & gain/loss ratio

Portfolio Backtesting Example

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Portfolio Analysis Results (Jan 1997 - Aug 2016) Link Print Download

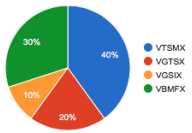
Summary | Metrics | Annual Returns | Monthly Returns | Drawdowns | Assets | Rolling Returns

Portfolio Allocations

Portfolio 1

Ticker	Name	Allocation
VTSMX	Vanguard Total Stock Market Index Fund	40.00%
VGTSX	Vanguard Total International Stock Index Fund	20.00%
VGSIX	Vanguard REIT Index Fund	10.00%
VBMFX	Vanguard Total Bond Market Index Fd	30.00%

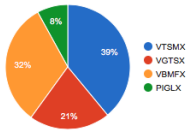
Portfolio saved as 'Example 1'. Manage saved models »



Portfolio 2

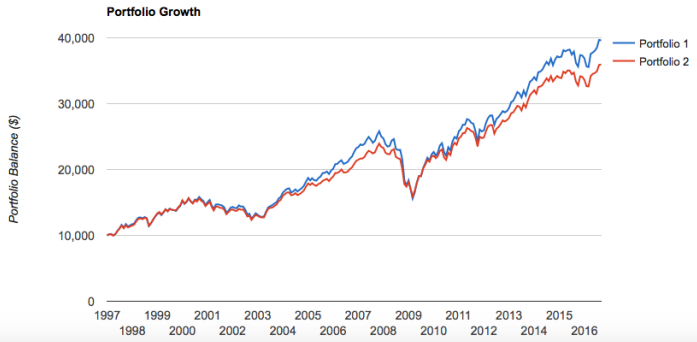
Ticker	Name	Allocation
VTSMX	Vanguard Total Stock Market Index Fund	39.00%
VGTSX	Vanguard Total International Stock Index Fund	21.00%
VBMFX	Vanguard Total Bond Market Index Fd	32.00%
PIGLX	PIMCO Funds Global Bond Fund Institutional Shares	8.00%

Save portfolio »



Portfolio Returns

#	Initial Balance	Final Balance	CAGR	Std.Dev.	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
1	$10,000	$39,599	7.25%	10.84%	25.67%	-25.82%	-39.58%	0.51	0.72	0.95
2	$10,000	$35,940	6.72%	9.63%	23.62%	-22.30%	-33.55%	0.50	0.73	0.96



Monte Carlo Simulation

- Explore expected future portfolio growth
- Explore sustainable withdrawals
  - Sequence risk of returns
  - Variability of outcomes
- Withdrawal models
  - Fixed withdrawals (inflation adjusted)
  - Percentage based withdrawals
  - Life expectancy based withdrawals (RMD)
- Multiple simulation models
  - Historical returns
  - Statistical distributions
  - Forecasted returns
- What-if scenario analysis
  - Forecasted inflation and asset returns

Monte Carlo Simulation Example

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Monte Carlo Simulation Results

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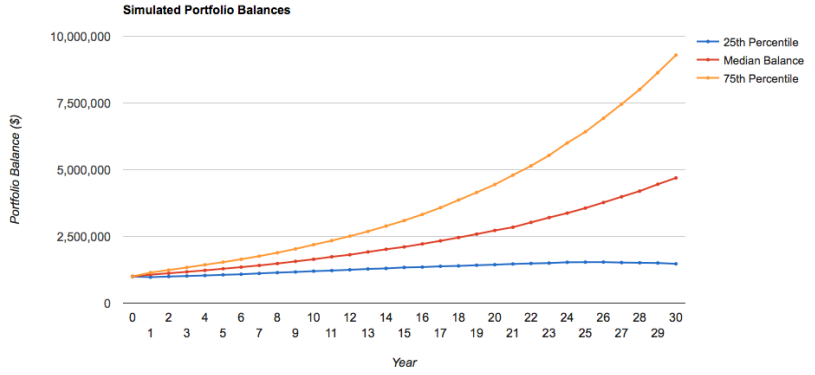
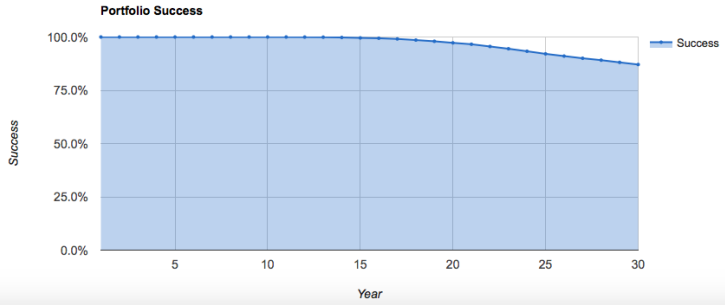
Monte Carlo simulation results for 10000 portfolios with $1,000,000 initial portfolio balance using available asset class data from 1972 to 2015. The historical return for the selected allocation from 1972 to 2015 was 10.06% mean return with 11.62% standard deviation. The results are based on simulated nominal returns and specified inflation adjusted withdrawals ($45,000/year). The simulated inflation model used historical inflation with 4.10% mean and 3.14% standard deviation based on the Consumer Price Index (CPI-U) data from 1972 to 2015.

Simulation Summary | Histograms

Allocation	Withdrawal	Years	Median End Balance	25th Percentile End Balance	75th Percentile End Balance	Max. Drawdown	Probability of Success
60.00% US Stock Market 40.00% Total Bond	$45,000	30	$4,691,416	$1,472,629	$9,294,113	Mean: -37.23% Median: -25.52% StdDev: 28.87%	87%

Portfolio saved as 'MC Sample'. Manage saved models »

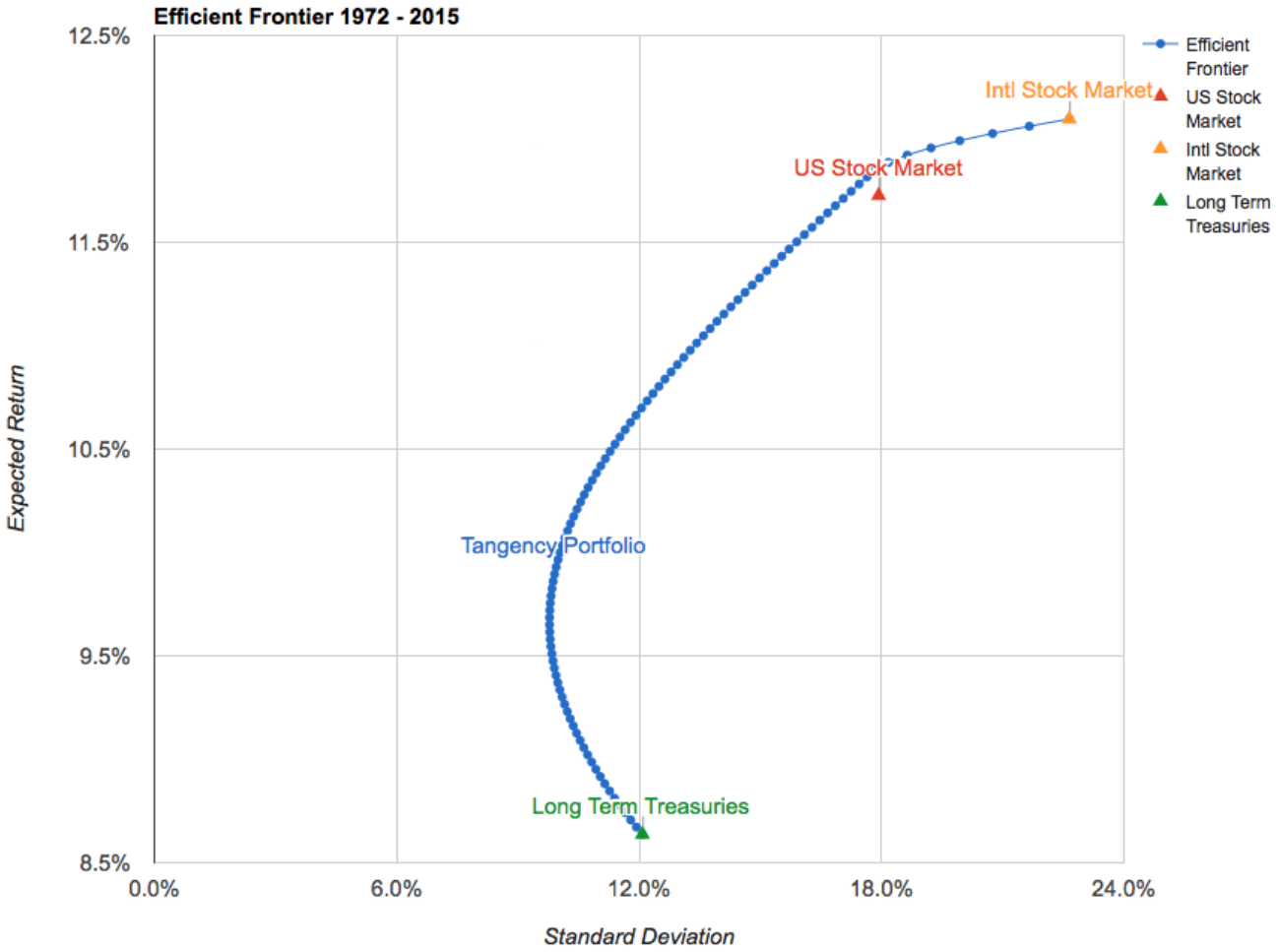




Modern Portfolio Theory

- Theory pioneered by Harry Markowitz on how risk-averse investors construct portfolios
  - Maximize expected return based on a given level of market risk
  - Minimize risk based on a given level of expected return
- Efficient frontier shows the portfolios that offer the maximum return for a given level of risk
  - Highlights the return and risk relationship
  - Evaluating assets in the context of overall portfolio
    - Portfolio risk level optimization

Efficient Frontier Example



Black-Litterman Model

- Main weaknesses of mean variance optimization
  - Concentrates the portfolio assets based on past performance and thus loses future diversification benefits
  - Results are typically unstable and vary significantly based on inputs (asset returns and correlations are dynamic)
- Black-Litterman model
  - No need to estimate expected asset returns
  - Derive equilibrium returns for benchmark portfolio
  - Update benchmark portfolio weights based on investor's views
  - Supports both relative and absolute views on asset returns
  - Supports confidence levels for views

Black-Litterman Model Example

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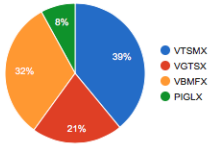
Black-Litterman Asset Allocation Model

This online portfolio optimizer tool implements the Black-Litterman asset allocation model. The Black-Litterman asset allocation model combines ideas from the Capital Asset Pricing Model (CAPM) and the Markowitz's mean-variance optimization model to provide a a method to calculate the optimal portfolio weights based on the given inputs. The model first calculates the implied market equilibrium returns based on the given benchmark asset allocation weights, and then allows the investor to adjust these expected returns based on the investor's views. The opinion adjusted returns are then passed to the mean variance optimizer to derive the optimal asset allocation weights.

Step 3/3: Optimization Results

Benchmark Portfolio with Equilibrium Excess Returns

Ticker	Name	Equilibrium Return	Allocation
VTSMX	Vanguard Total Stock Market Index Fund (VTSMX)	10.86%	39.00%
VGTSX	Vanguard Total International Stock Index Fund (VGTSX)	11.94%	21.00%
VBMFX	Vanguard Total Bond Market Index Fd (VBMFX)	0.32%	32.00%
PIGLX	PIMCO Funds Global Bond Fund Institutional Shares (PIGLX)	1.90%	8.00%



Equilibrium returns are based on the expected annual return of 7.00%. Covariance matrix is based on monthly asset returns from Jun 1996 to Aug 2016.

Investor Views and Opinion Based Adjustments

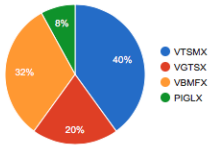
Asset 1	View		Value		Confidence
Vanguard Total International Stock I...	will outperform (->) ...	Vanguard Total Stock Market Index ...	1.00	%	75%
Select asset...	will return		0.00	%	75%
Select asset...	will return		0.00	%	75%

+ Add View

Optimized Portfolio

Optimization Type: Constrained

Ticker	Name	Adjusted Return	Allocation
VTSMX	Vanguard Total Stock Market Index Fund (VTSMX)	10.87%	40.01%
VGTSX	Vanguard Total International Stock Index Fund (VGTSX)	11.89%	19.99%
VBMFX	Vanguard Total Bond Market Index Fd (VBMFX)	0.32%	32.00%
PIGLX	PIMCO Funds Global Bond Fund Institutional Shares (PIGLX)	1.88%	8.00%



Adjusted returns are equilibrium returns adjusted for the given views. The optimized portfolio has expected return of 6.98% with annualized standard deviation of 9.86% and total allocation of 100.00%.

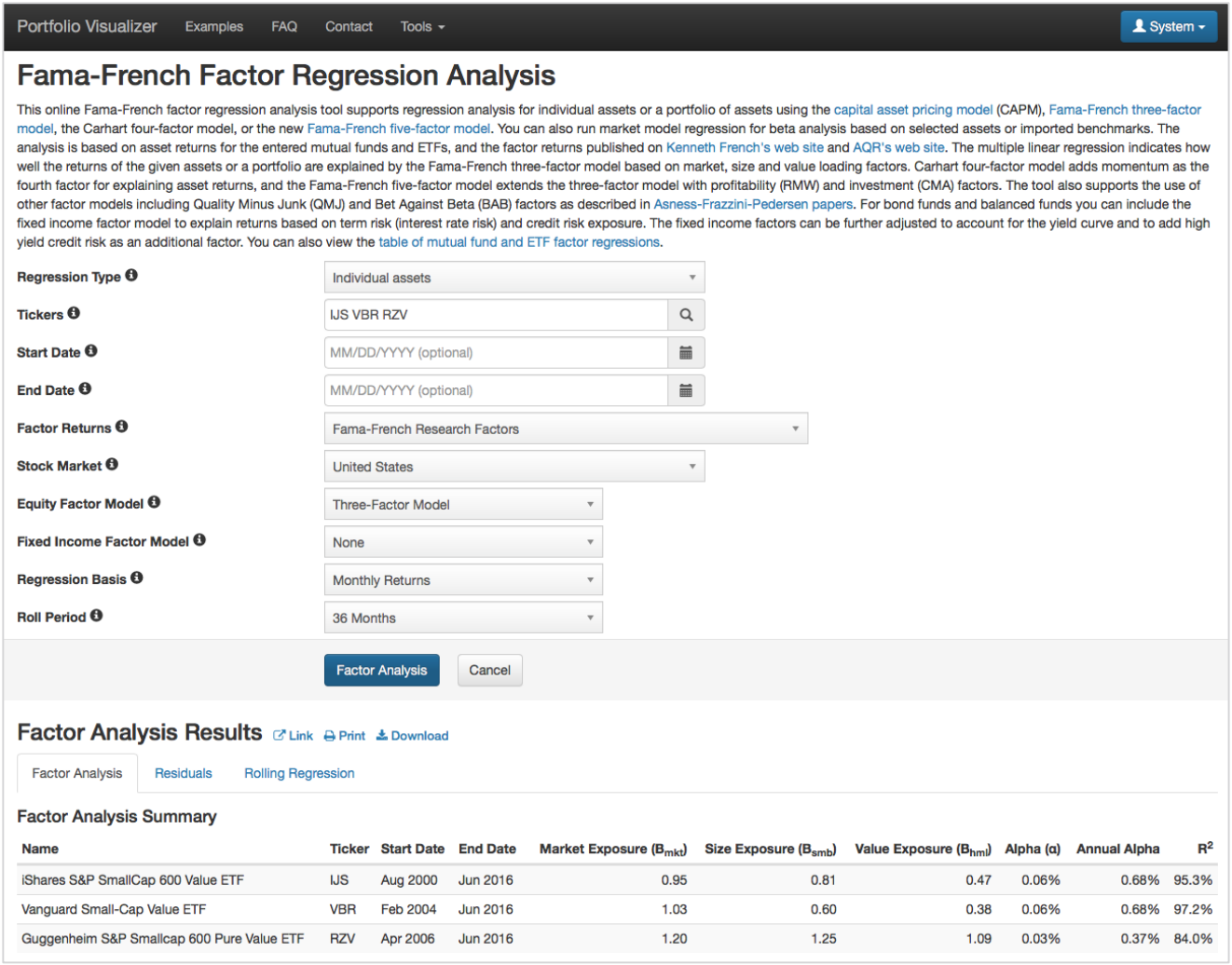
Save portfolio »

Update Views « Previous Restart Cancel

Factor Models

- Explaining returns by risk factor exposures
- Supports factor regression across multiple factor models
  - Capital Asset Pricing Model (beta)
  - Fama-French 3-factor model (MKT, SMB, HML)
  - Carhart 4-factor model (MKT, SMB, HML, MOM)
  - Fama-French 5-factor model (MKT, SMB, HML, RMW, CMA)
  - Fixed income factor models (TRM, CDT)
  - Other equity factors: LT/ST Rev, QMJ, BAB, …
  - Any combination of above factors
- Applications
  - Identifying what factors drove fund returns
  - Active fund analysis (alpha, closet index, …)
  - Portfolio tilts to size/value

Factor Regression Example



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Fama-French Factor Regression Analysis

This online Fama-French factor regression analysis tool supports regression analysis for individual assets or a portfolio of assets using the capital asset pricing model (CAPM), Fama-French three-factor model, the Carhart four-factor model, or the new Fama-French five-factor model. You can also run market model regression for beta analysis based on selected assets or imported benchmarks. The analysis is based on asset returns for the entered mutual funds and ETFs, and the factor returns published on Kenneth French's web site and AQR's web site. The multiple linear regression indicates how well the returns of the given assets or a portfolio are explained by the Fama-French three-factor model based on market, size and value loading factors. Carhart four-factor model adds momentum as the fourth factor for explaining asset returns, and the Fama-French five-factor model extends the three-factor model with profitability (RMW) and investment (CMA) factors. The tool also supports the use of other factor models including Quality Minus Junk (QMJ) and Bet Against Beta (BAB) factors as described in Asness-Frazzini-Pedersen papers. For bond funds and balanced funds you can include the fixed income factor model to explain returns based on term risk (interest rate risk) and credit risk exposure. The fixed income factors can be further adjusted to account for the yield curve and to add high yield credit risk as an additional factor. You can also view the table of mutual fund and ETF factor regressions.

Regression Type	Individual assets
Tickers	IJS VBR RZV
Start Date	MM/DD/YYYY (optional)
End Date	MM/DD/YYYY (optional)
Factor Returns	Fama-French Research Factors
Stock Market	United States
Equity Factor Model	Three-Factor Model
Fixed Income Factor Model	None
Regression Basis	Monthly Returns
Roll Period	36 Months

Factor Analysis Cancel

Factor Analysis Results

Link Print Download

Factor Analysis | Residuals | Rolling Regression

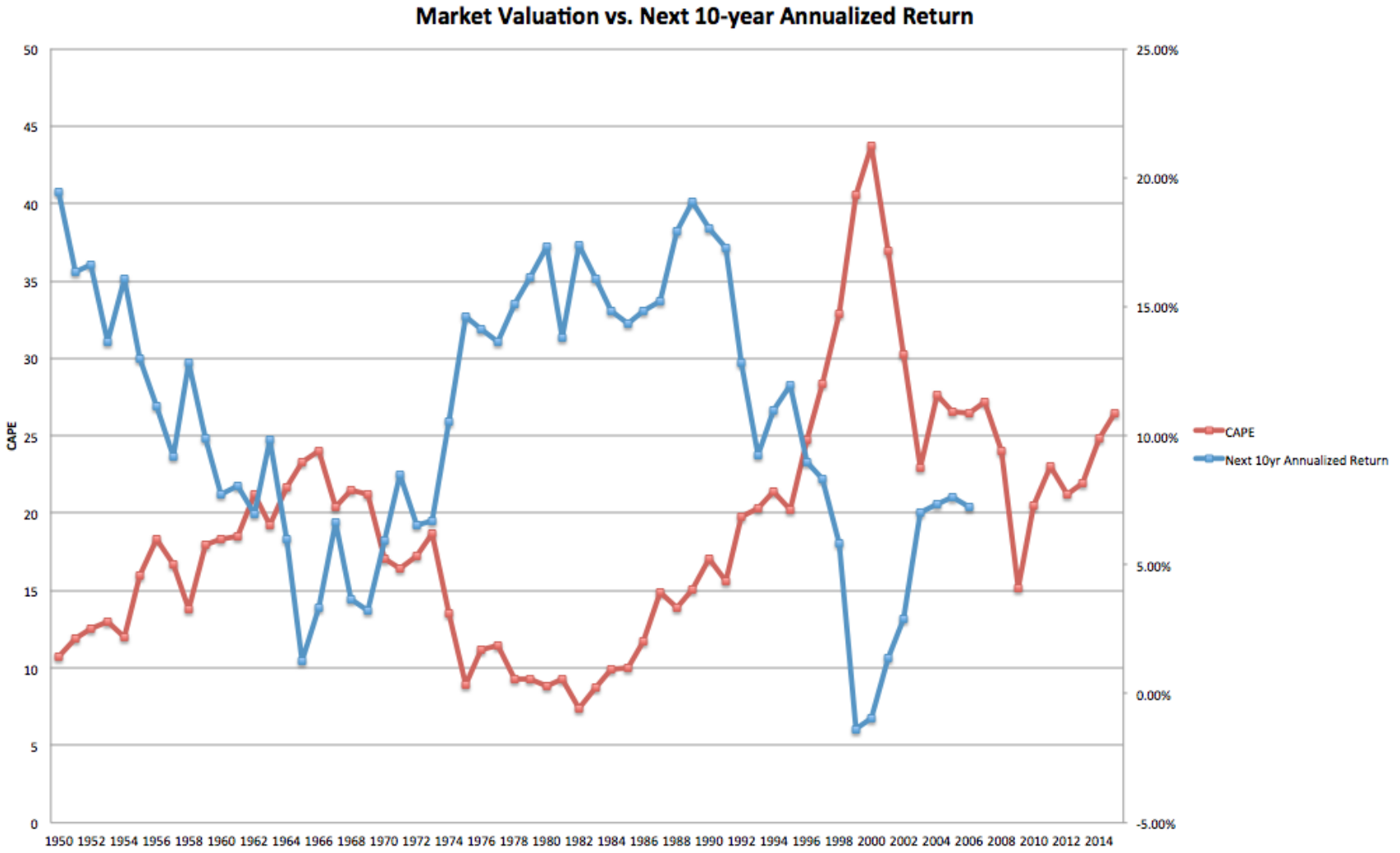
Factor Analysis Summary

Name	Ticker	Start Date	End Date	Market Exposure (B_{mkt})	Size Exposure (B_{smb})	Value Exposure (B_{hml})	Alpha (α)	Annual Alpha	R^2
iShares S&P SmallCap 600 Value ETF	IJS	Aug 2000	Jun 2016	0.95	0.81	0.47	0.06%	0.68%	95.3%
Vanguard Small-Cap Value ETF	VBR	Feb 2004	Jun 2016	1.03	0.60	0.38	0.06%	0.68%	97.2%
Guggenheim S&P Smallcap 600 Pure Value ETF	RZV	Apr 2006	Jun 2016	1.20	1.25	1.09	0.03%	0.37%	84.0%

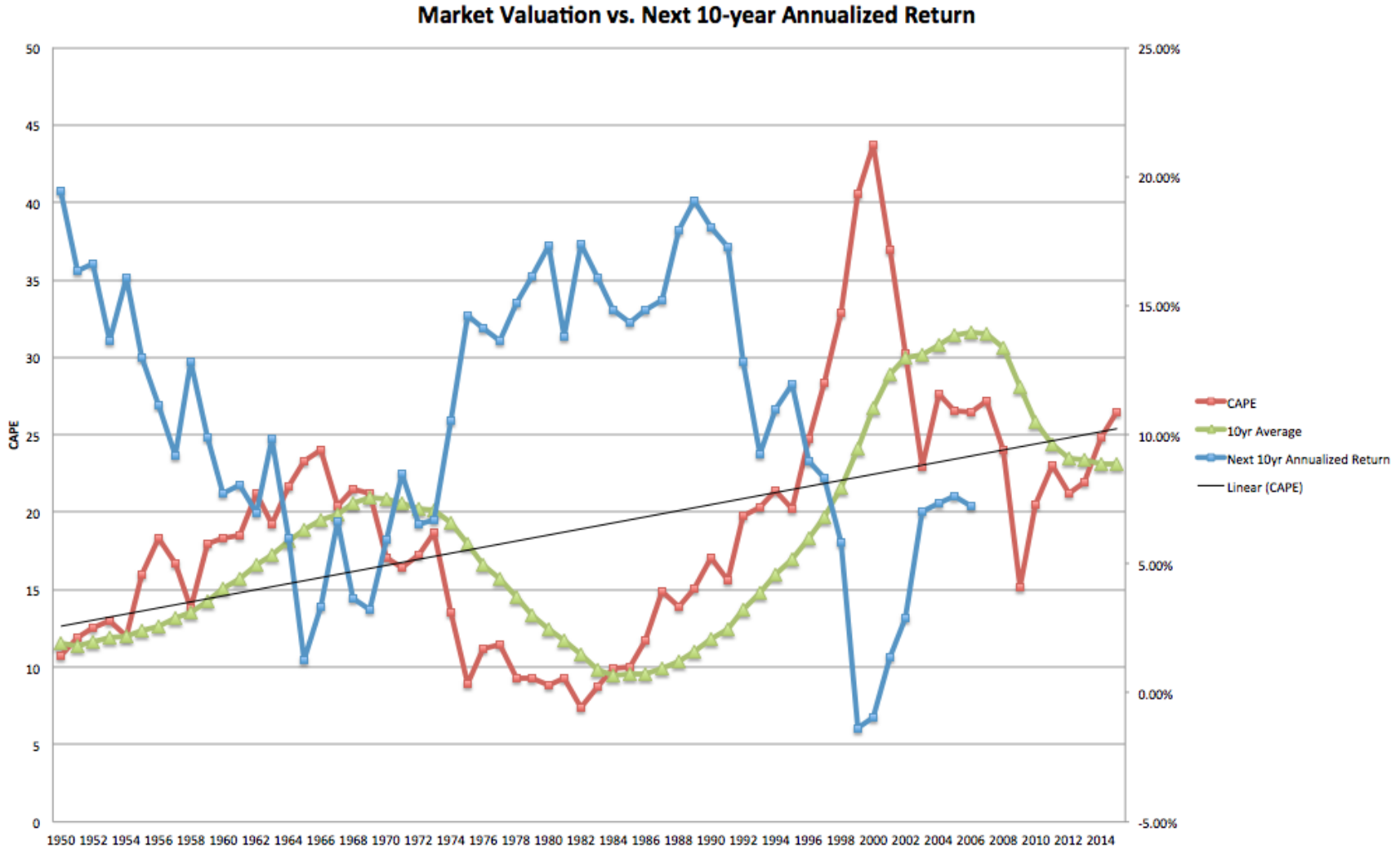
Tactical Asset Allocation

- Explore tactical asset allocation models that aim to provide better risk adjusted returns
  - Protecting capital during major drawdown events
- Models can be based on multiple techniques such as
  - Economic and fundamental indicators
  - Technical indicators
  - Sentiment indicators
  - Volatility indicators
  - Combinations of above
- Many popular technical indicators are based on momentum
  - Premier market anomaly observed across multiple asset classes and market regions
- Tactical asset allocation can be controversial
  - Market timing is seldom easy and reliable
  - Many published models are subject to data mining and over optimization
  - Many models use binary on/off risk model that assumes 100% confidence in signals
  - Tactical asset allocation models can have long periods of underperformance
  - Tax implications can have big impact on tactical asset allocation model returns
  - Multiple research papers both in favor and against market timing

Valuation Model Example



Valuation Model Example

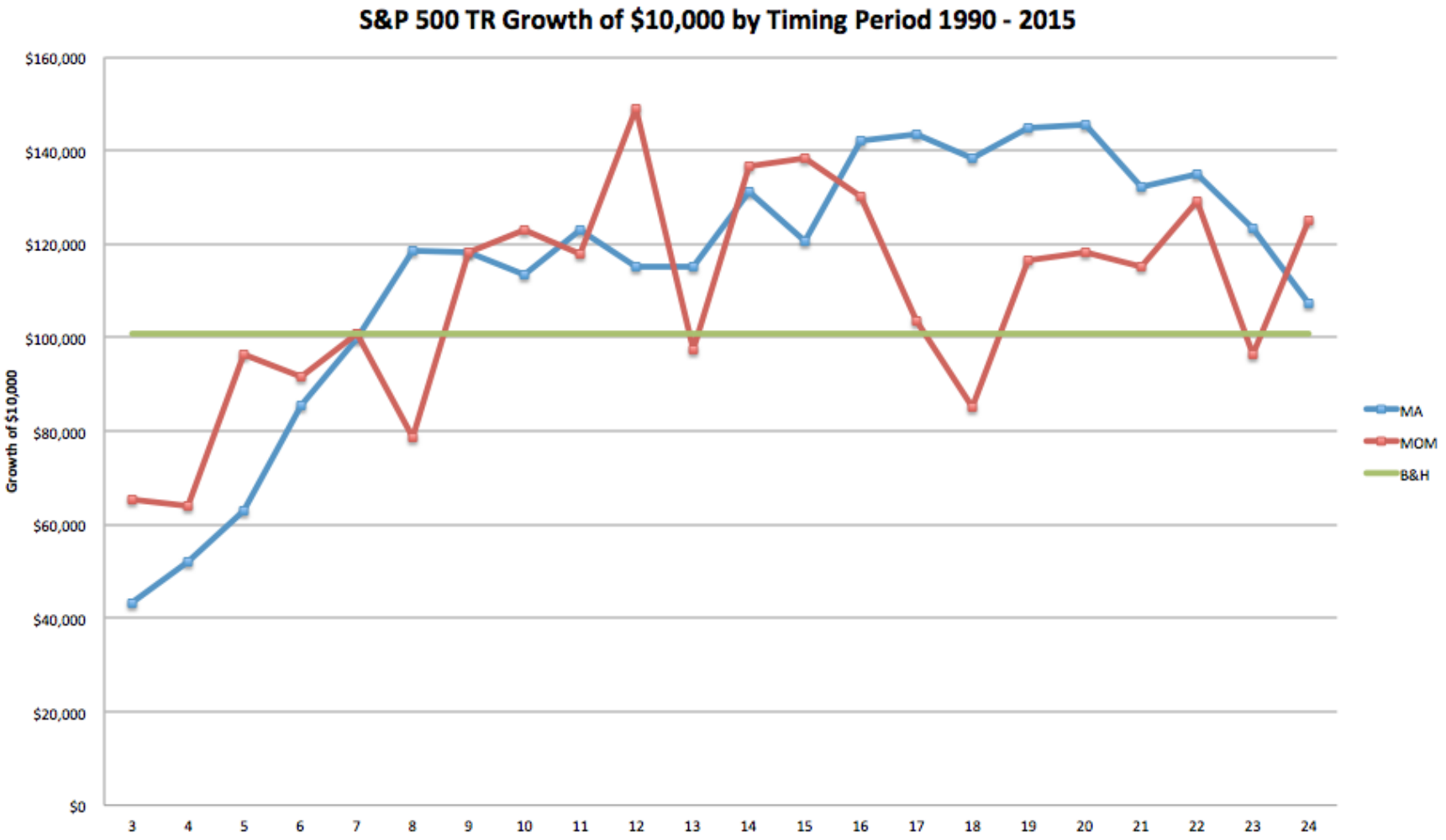


Momentum Examples

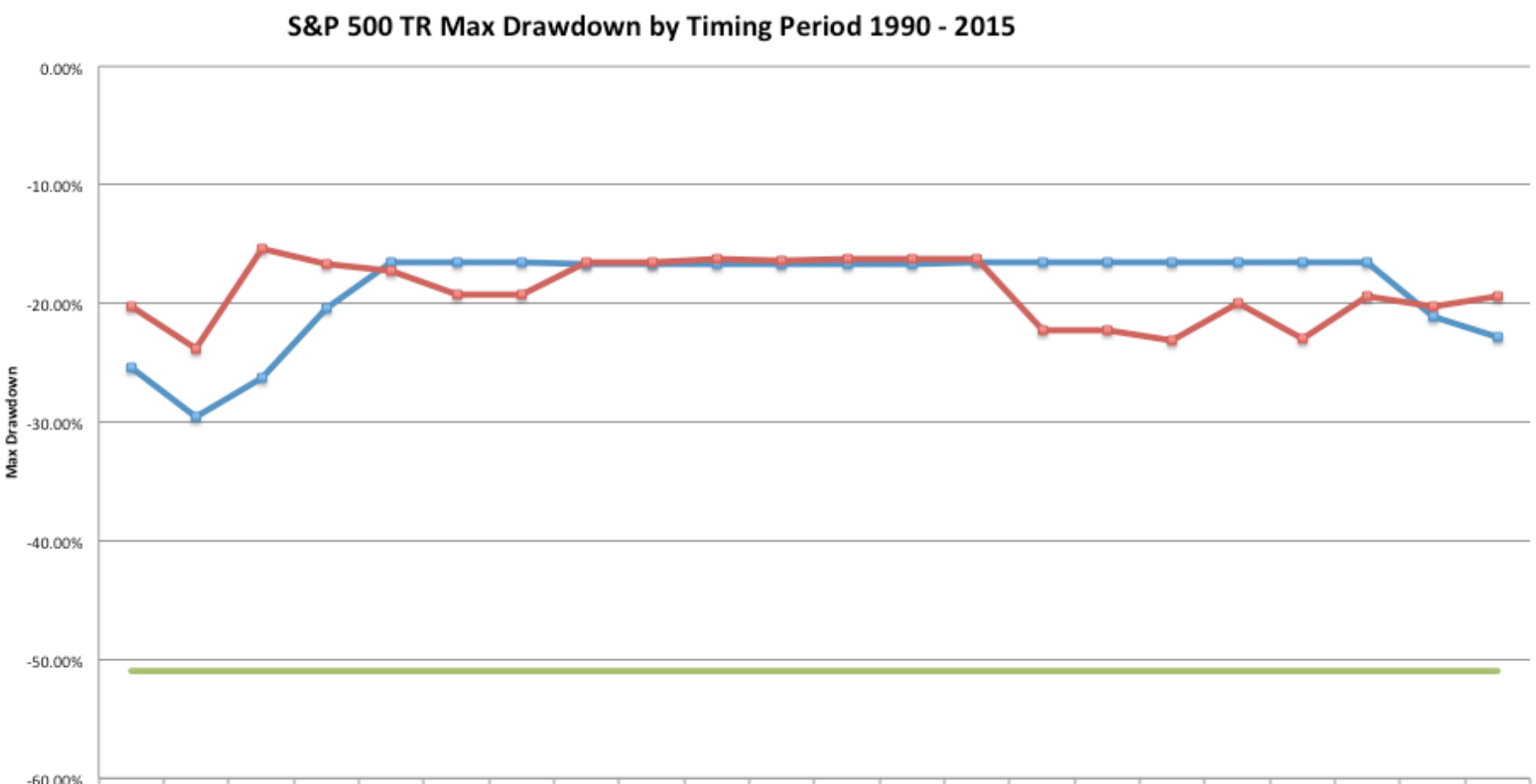
	Domestic Stocks			International Stocks			Real Estate			Commodities			Bonds		
	B&H	MA	MOM	B&H	MA	MOM	B&H	MA	MOM	B&H	MA	MOM	B&H	MA	MOM
CAGR	11.74%	11.56%	11.78%	9.44%	10.62%	9.69%	13.67%	13.85%	14.43%	5.64%	7.88%	8.63%	8.55%	8.43%	9.17%
StDev	15.01%	12.00%	11.90%	17.04%	12.45%	11.86%	16.92%	12.17%	12.19%	19.15%	15.19%	15.23%	8.37%	7.11%	5.94%
Sharpe	0.50	0.57	0.59	0.33	0.49	0.44	0.56	0.74	0.78	0.13	0.26	0.31	0.45	0.50	0.70
Max DD	-50.21%	-23.58%	-29.58%	-56.68%	-21.07%	-25.72%	-68.30%	-20.78%	-19.98%	-69.38%	-52.38%	-55.02%	-20.97%	-11.26%	-6.41%

- 12 month moving average and time series momentum comparison across asset classes from January 1976 to December 2014
  - Used with permission from DIY Financial Advisor by David Foulke, Jack Vogel, and Wesley Gray (Wiley, 2015)

Momentum Examples

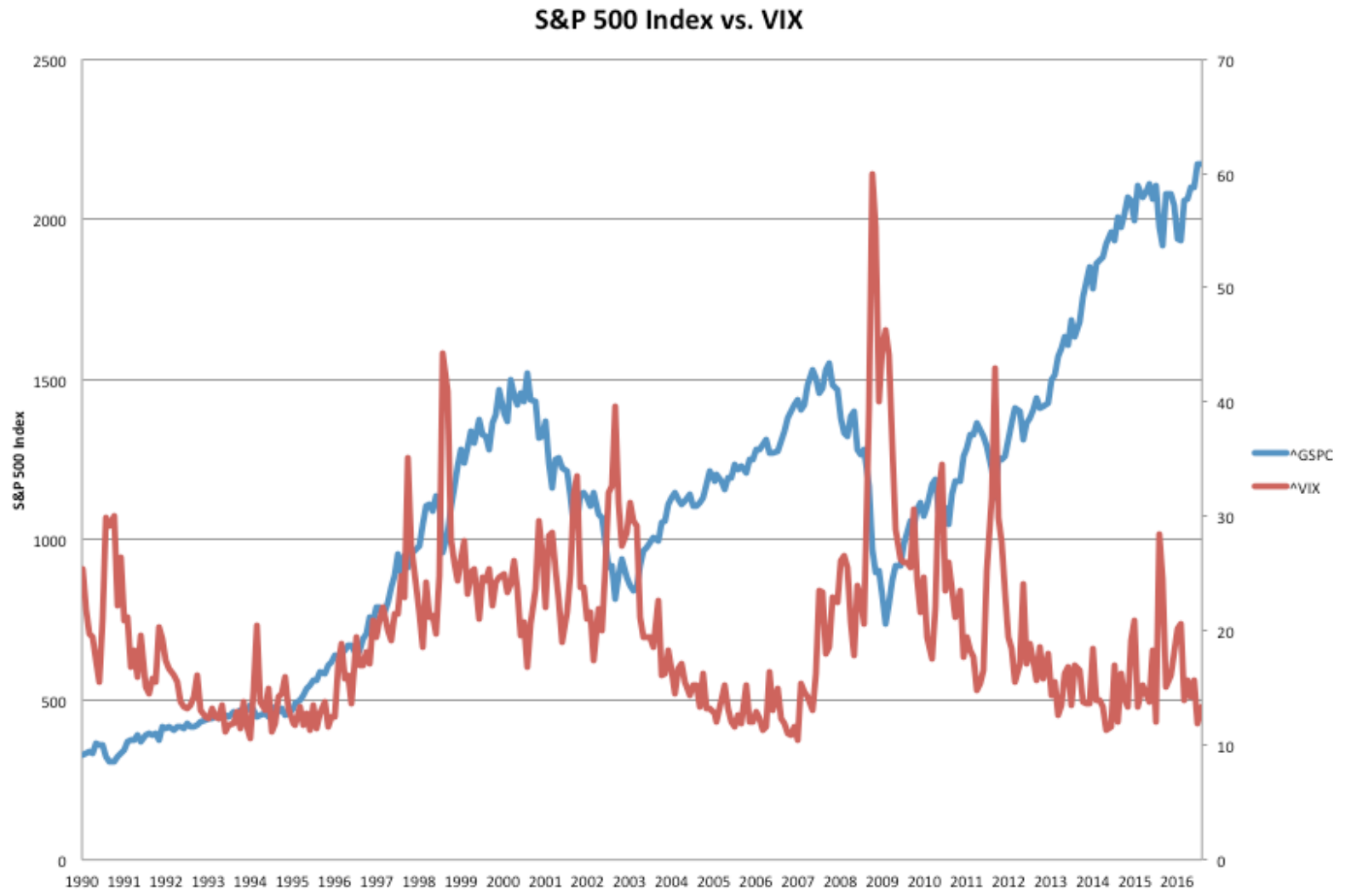


Momentum Examples

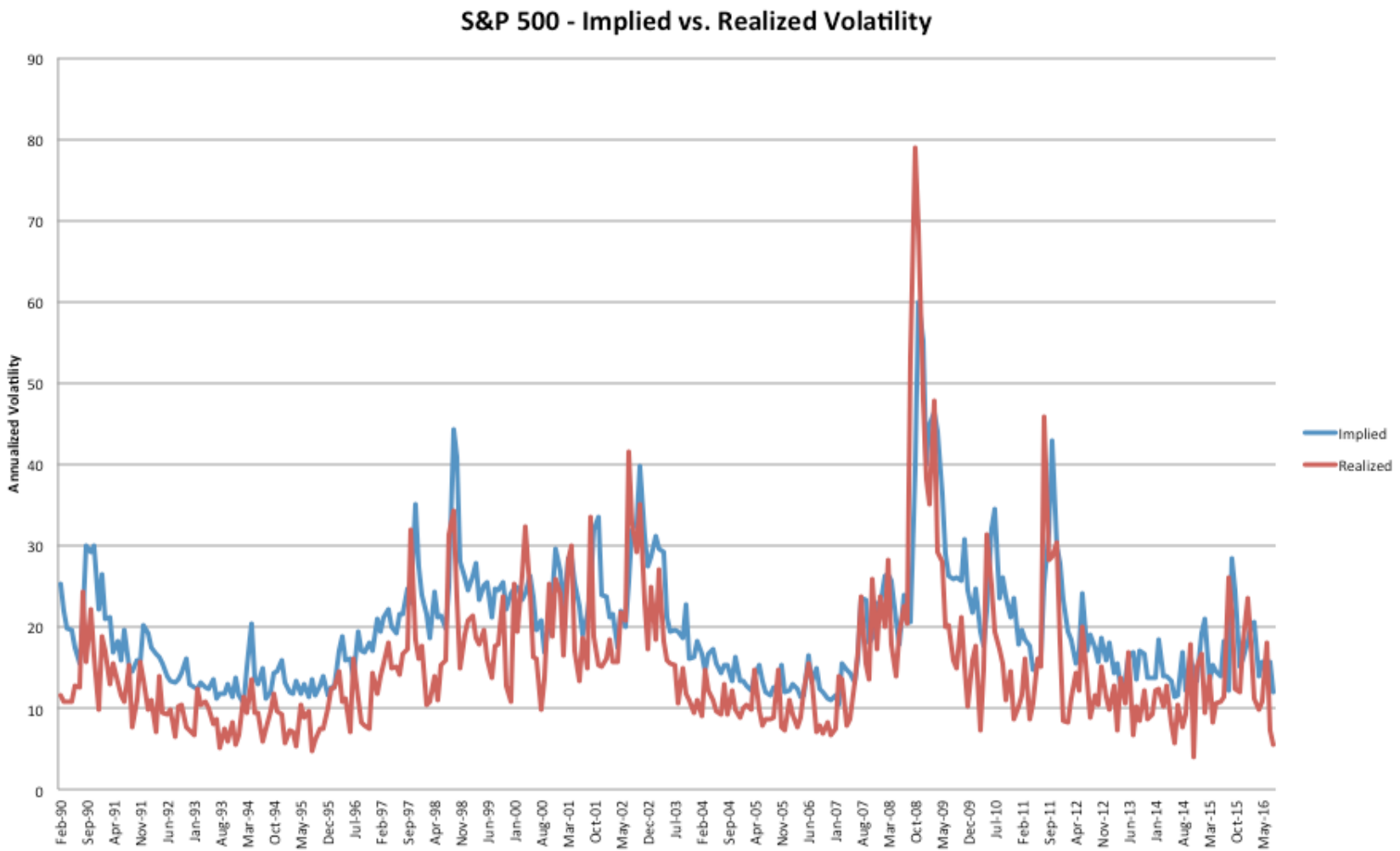


	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
MA	-25.36%	-29.61%	-26.25%	-20.44%	-16.53%	-16.53%	-16.53%	-16.73%	-16.73%	-16.73%	-16.73%	-16.73%	-16.73%	-16.45%	-16.45%	-16.45%	-16.45%	-16.45%	-16.45%	-16.45%	-21.06%	-22.88%
MOM	-20.24%	-23.78%	-15.37%	-16.73%	-17.17%	-19.22%	-19.22%	-16.45%	-16.45%	-16.26%	-16.33%	-16.26%	-16.26%	-16.26%	-22.31%	-22.31%	-23.13%	-19.93%	-23.02%	-19.45%	-20.21%	-19.45%
B&H	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%	-50.95%

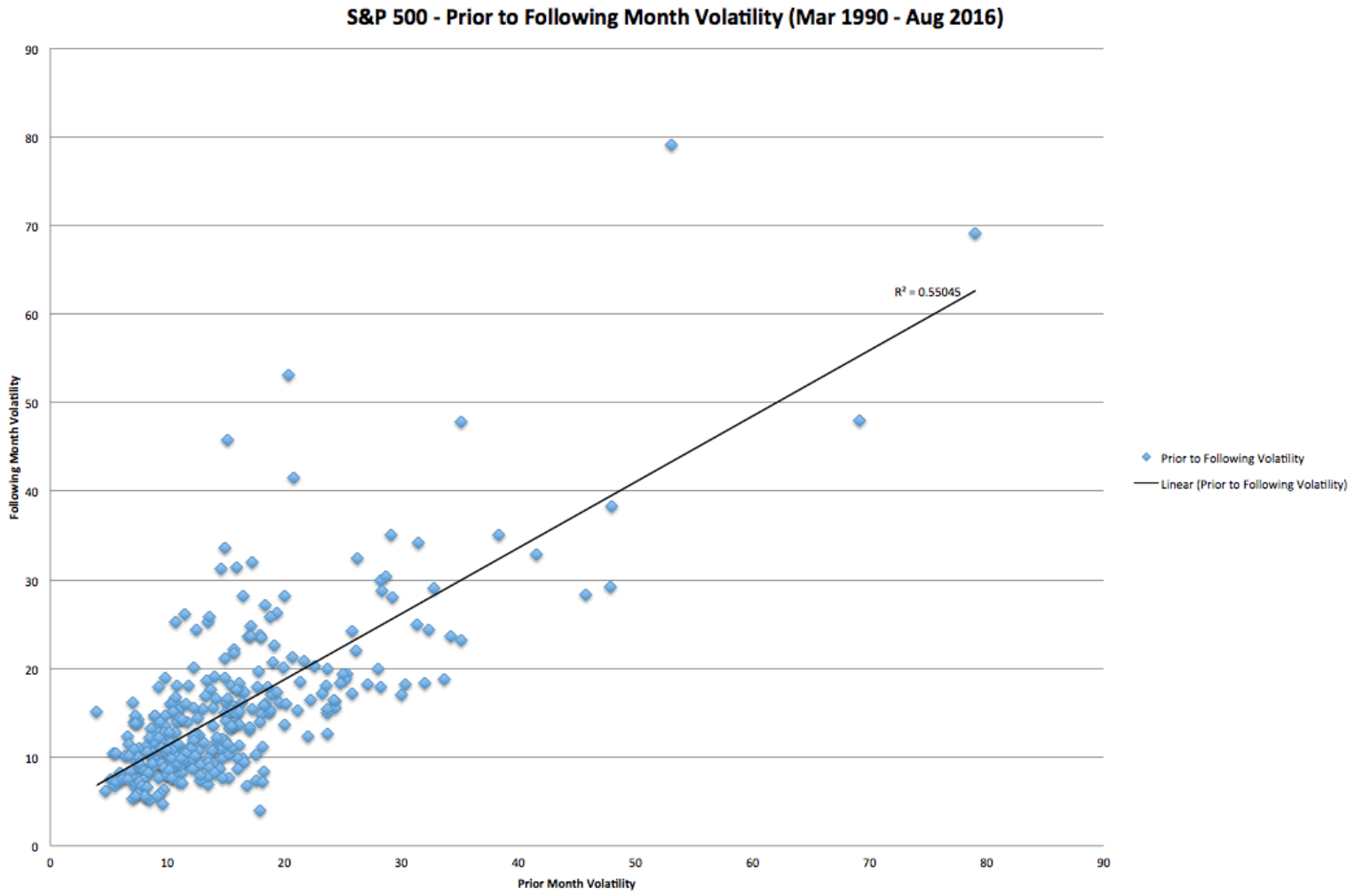
Volatility Example



Volatility Example



Volatility Example



Tactical Asset Allocation Examples

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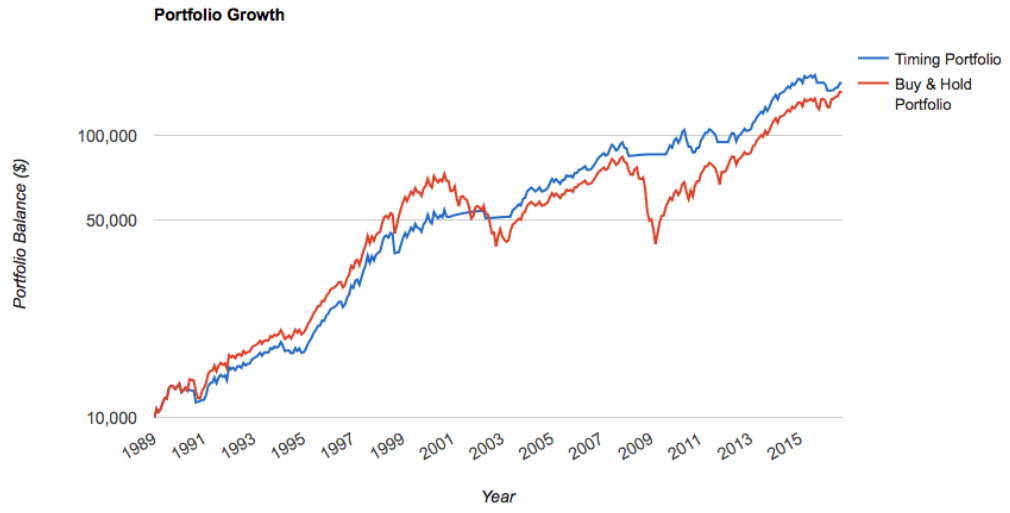
Market Timing Results (Jan 1989 - Aug 2016) Link Print Download

Portfolio Statistics | Metrics | Annual Returns | Monthly Returns | Drawdowns | Timing Periods

Market timing results from 1989 to 2016 for S&P 500 Total Return (^SPXTR) based on 12-month simple moving average. The timing portfolio is invested in the asset when the price is greater than or equal to the 12-month moving average, otherwise the portfolio is invested in cash. Note that the selected year range for the timing test was automatically adjusted based on the available data for S&P 500 Total Return (^SPXTR) (1988-2016).

Portfolio	Initial Balance	Final Balance	CAGR	Std.Dev.	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
Timing Portfolio	$10,000	$153,620	10.38%	10.71%	37.58%	-12.13%	-16.73%	0.70	1.10	0.73
Buy & Hold Portfolio	$10,000	$143,006	10.09%	14.54%	37.58%	-37.00%	-50.95%	0.53	0.78	0.99

Save timing model »



Financial Modeling Limitations

- Models and related tools can be helpful in understanding concepts and market dynamics
- Understanding limitations and assumptions behind models is important
- Common limitations and issues
  - Assumptions on return distribution (skewness, kurtosis)
  - Limited amount of historical data for statistical analysis
  - Asset returns and correlations are dynamic and change over time
  - Fundamental changes in the macro environment
    - Interest rates
  - Future returns may be different than past returns
    - Unexpected events
  - Taxes and trading costs are typically not reflected in the results
  - Model may suffer from biases
    - Data mining and data fitting bias
    - Sample selection bias
    - Survivorship bias
    - Look ahead bias

Questions and Answers