

Will My Risk Parity Strategy Outperform?



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Can We Beat the Market?

CAPM Investors Hold the Market Portfolio



- CAPM

$$E[r_i] = r_f + \beta_i(E[r_m] - r_f)$$

- To adjust risk CAPM investors borrow or lend at the risk-free rate.

- Black, Jensen, and Scholes (1972)

$$\alpha_i \equiv E[r_i] - r_f - \beta_i(E[r_m] - r_f)$$

- If the CAPM holds, then all assets should have an alpha of zero.
- Tests indicate that alpha depends in a systematic way on their beta: high-beta assets tend to have negative alphas and low-beta assets tend to have positive alphas.

Leverage Aversion May Explain the Dependence of Alpha on Beta



- Leverage Aversion: Frazzini and Pedersen (2011), Asness, Frazzini, and Pedersen (2012)
 - Investors who are leverage averse or leverage constrained hold higher-beta assets to achieve higher expected returns even if those assets have lower Sharpe ratios
 - This drives up the price (and lowers expected returns) of higher-beta assets
 - As a result, demand is shifted away from lower-beta assets, resulting in lower prices and higher expected returns for these assets
 - Another consequence is that higher-beta assets have lower Sharpe ratios than do lower-beta assets
 - This is an opportunity for investors who are neither leverage averse nor leverage constrained to harvest a premium by leveraging lower-beta portfolios
- Can these insights be exploited to achieve a *realized* Sharpe ratio that is higher than that of the market (value-weighted) portfolio at the same volatility as the market portfolio?

Investors Try a Variety of Strategies to Beat the Market...



- Levered Risk Parity
 - Equal risk contributions from stocks and bonds
 - Levered to match the market volatility
- Unlevered Risk Parity
 - Equal risk contributions from stocks and bonds
 - Fully invested
- Fixed Mix
 - 60% Stocks
 - 40% Bonds

...and Empiricists Backtest These Strategies

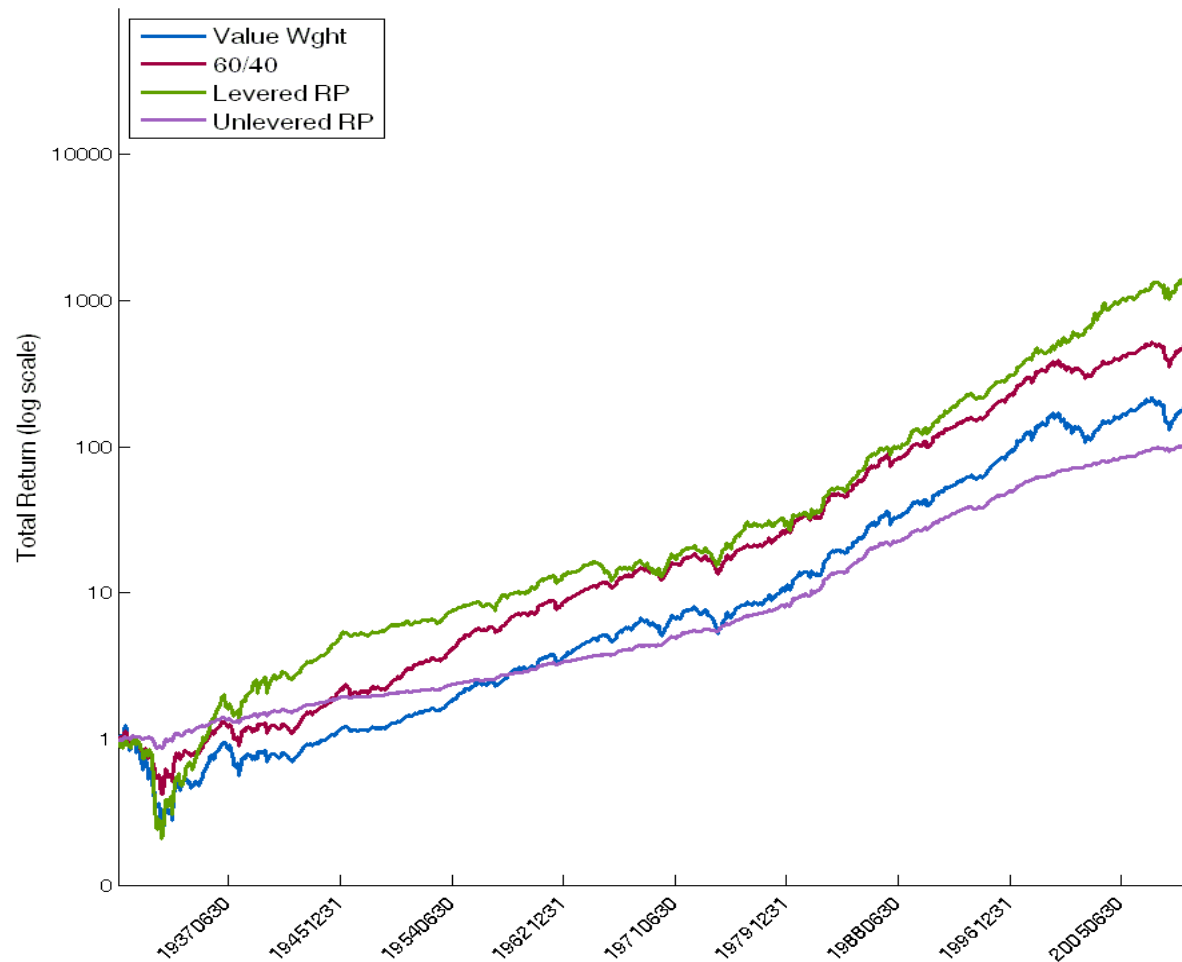


- Full Sample: Stocks and Bonds from 1926-2010
- Sub-samples:
 - Pre-1946 (1926-1945)
 - Post-War (1946-1982)
 - Bull Market (1983-2000)
 - Dot-Com & Beyond (2001-2010)
- Base Case (borrow at the risk-free rate, no trading costs)
 - Except for the Post-War sub-sample, the *unlevered* risk parity portfolio achieves the highest realized Sharpe ratio, but with low volatility and low return
 - Except for the Post-War sub-sample, the *levered* risk parity portfolio achieves the second highest realized Sharpe ratio
- Accounting for more realistic borrowing and trading costs
 - Except for the Post-War sub-sample, the *unlevered* risk parity portfolio achieves the highest realized Sharpe ratio, but with low volatility and low return
 - The results for the *levered* risk parity portfolio are dependent on the time period considered

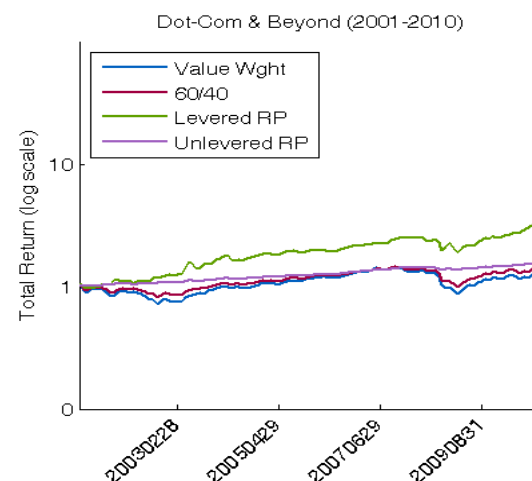
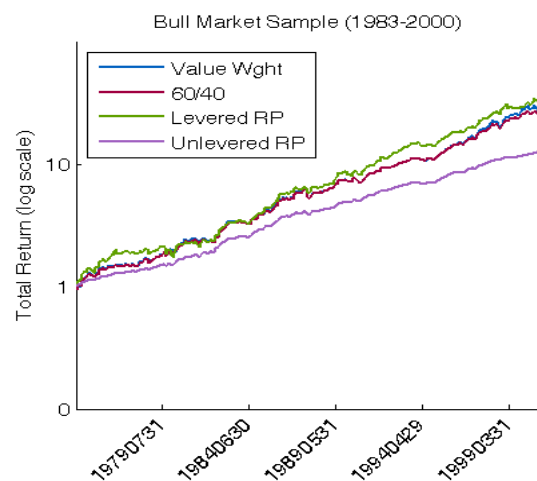
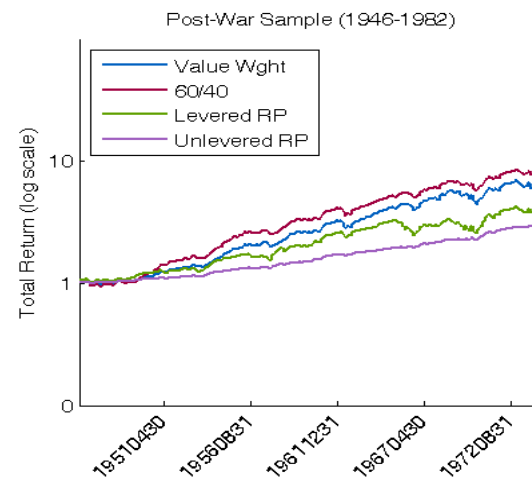
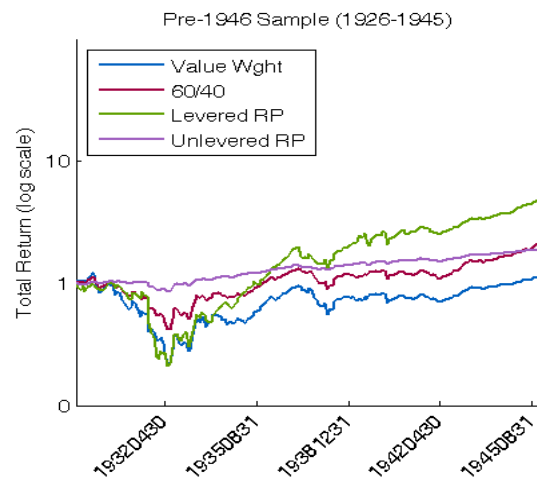


A Close Look at What Might Have Happened

Levered Risk Parity Outperformed 1926-2010 (Base Case)...



...But Not Uniformly

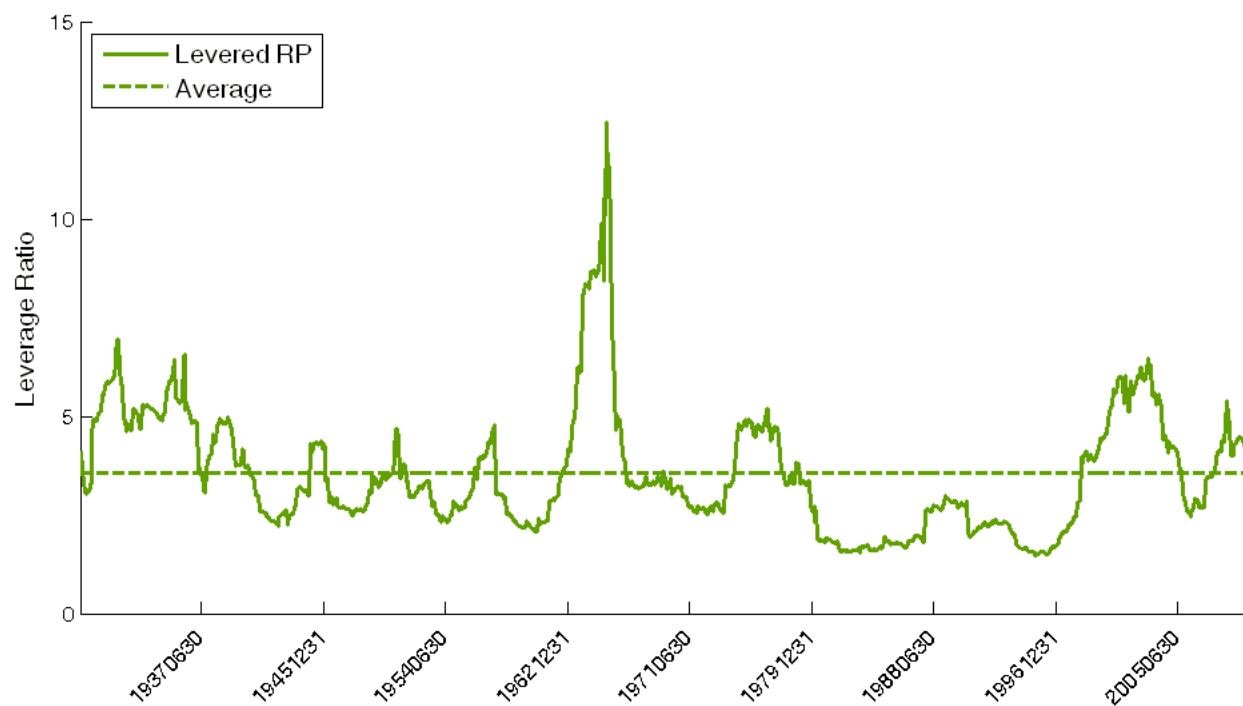


We May Not Have Accounted Properly for the Cost of Borrowing in the Previous Slides

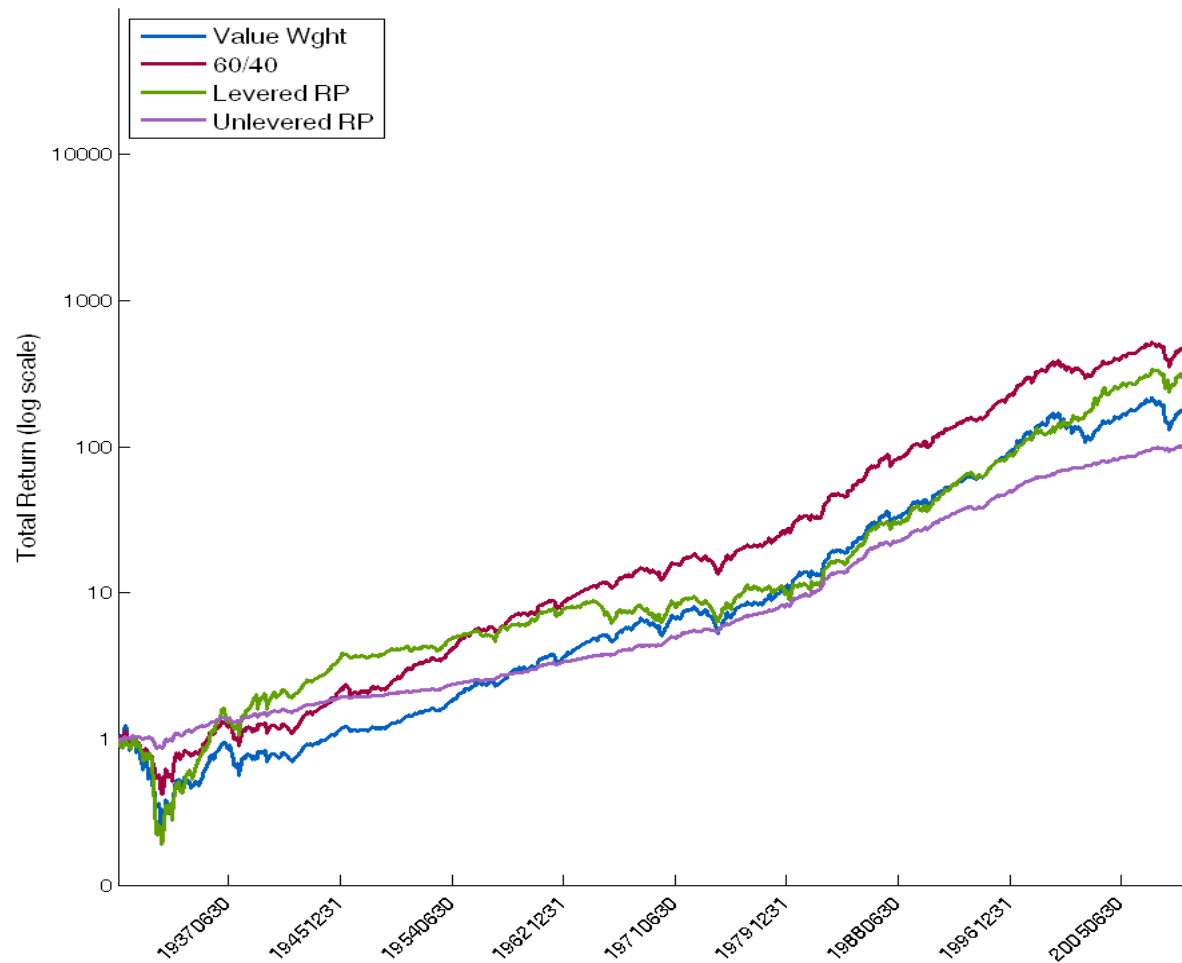


- The levered risk parity strategy requires financing
- Leverage financed through futures contracts costs about LIBOR or Eurodollar deposit rates - roughly 60-100 basis points higher than the risk-free rate
- With higher leverage, 60 basis points can make a qualitative difference

The Leverage Implicit in the Levered Risk Parity Strategy is 3.75 on Average, and it Varies Over Time



After Accounting for Eurodollar Borrowing Costs, 60/40 Outperformed 1926-2010



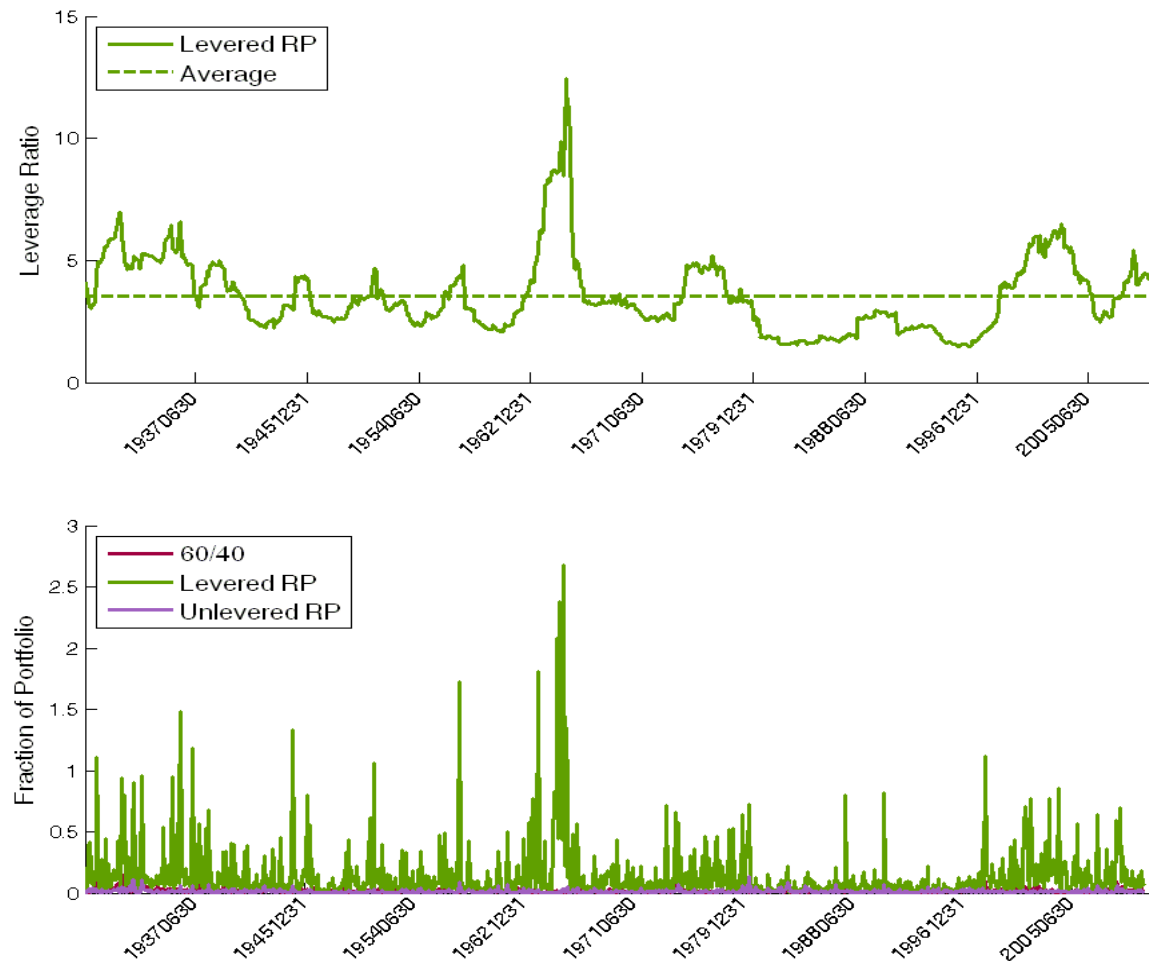
We May Not Have Accounted Properly for the Cost of Trading in the Previous Slide



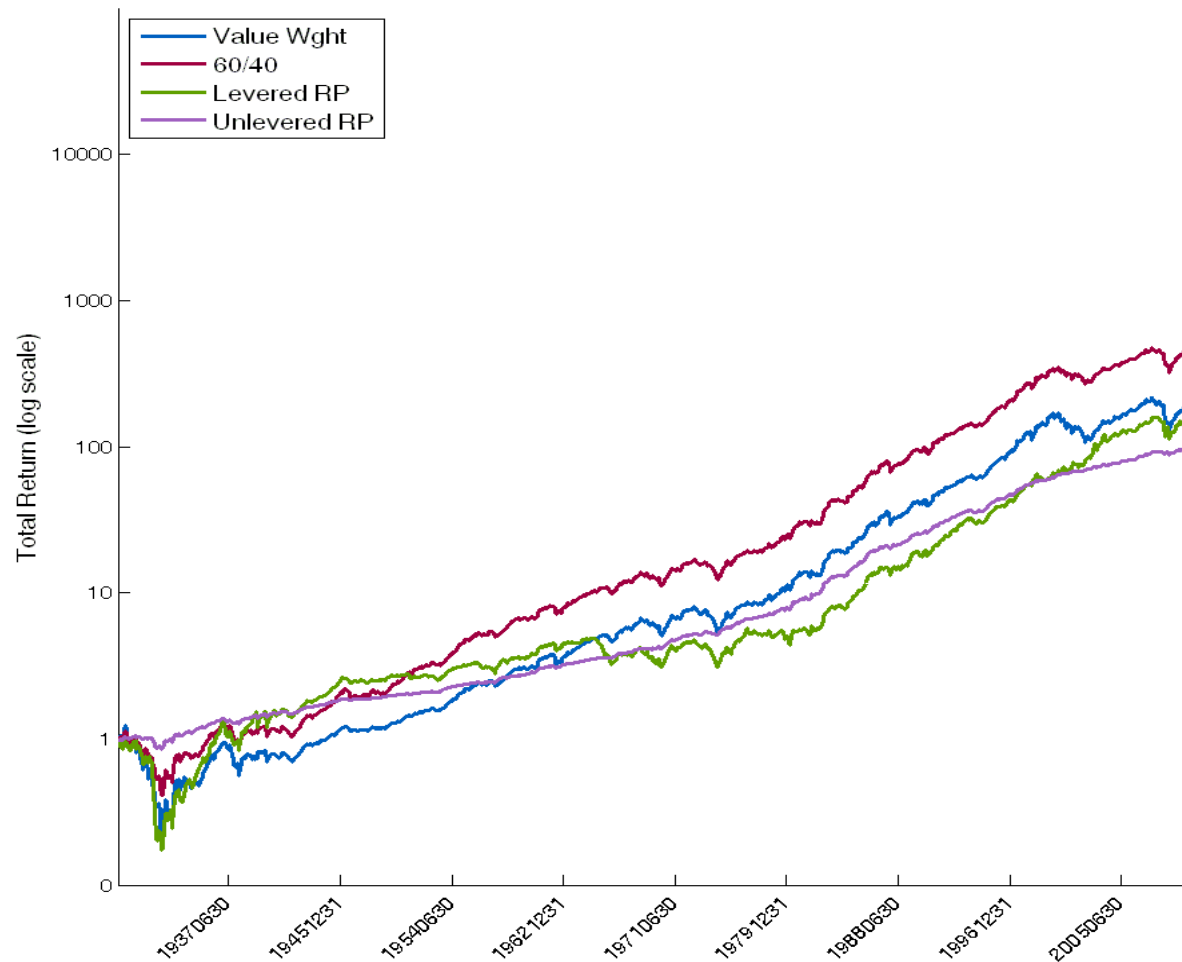
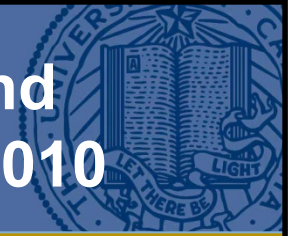
- The value weighted (market) portfolio requires rebalancing only in response to a limited set of events, e.g., new issues and redemptions
- Other strategies require rebalancing in response to price change
- We measure turnover due to price change, and adjust the strategy returns for trading costs

Period	Adjustment (basis points)
1926-1955	100
1956-1970	50
1971-2010	10

Levered Risk Parity Has Relatively High Turnover



After Accounting for Eurodollar Borrowing Costs and Trading Costs, 60/40 Outperformed Between 1926-2010





Are the Results Statistically Significant?

Assessing the Premium of Levered Risk Parity Over 60/40



- Two Metrics
 - Excess Return

$$E[r_{LRP}] - E[r_{60/40}]$$

- Regression Alpha

$$r_{LRP} = \alpha + \beta r_{60/40} + \varepsilon$$

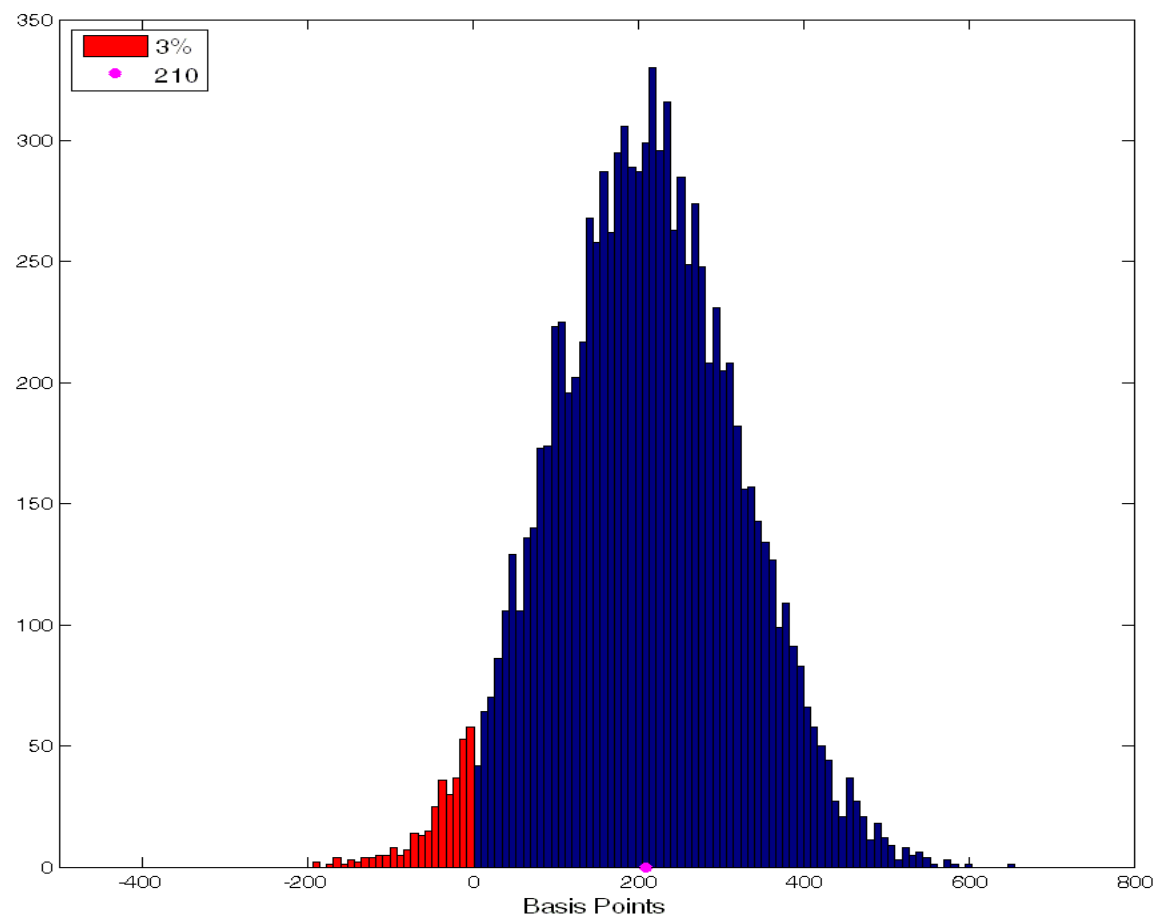
- Two assessments of significance
 - T-statistic: Gaussian
 - Bootstrap P-value: Empirical

The Premium is Significant Only if Levered Risk Parity is Financed at the Risk-free Rate and Trading Costs are Neglected



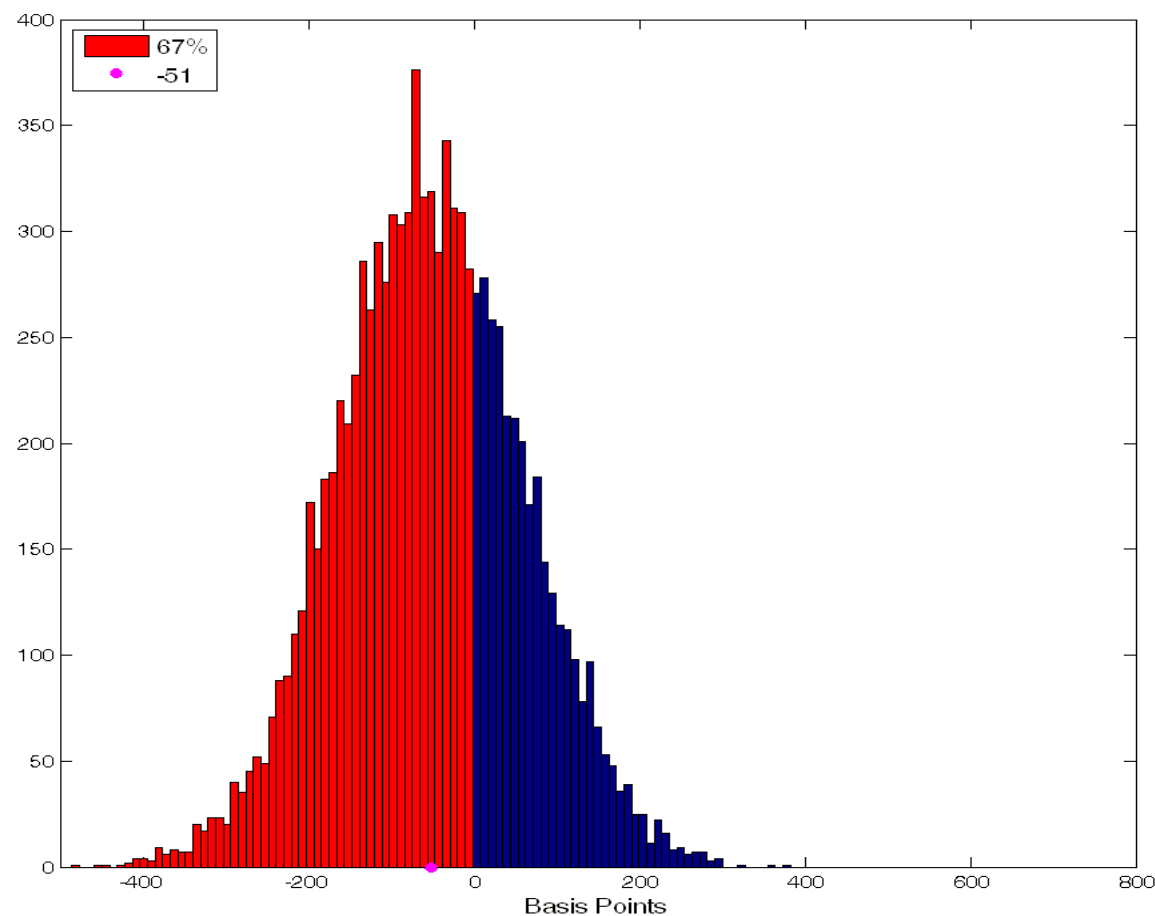
	Excess Return (basis points)	P-Value (T-Stat)	Alpha (basis points)	P-Value (T- Stat)
Financed at Risk-free rate	210	.03 (1.88)	181	.06 (1.62)
Financed at Eurodollar deposit rate	29	.40 (.26)	-2	.50 (-.02)
Financed at Eurodollar deposit rate and adjusted for trading costs	-51	.67 (-.46)	-81	.76 (-.73)

Bootstrap Assessment of the Premium of Levered Risk Parity Over 60/40: Excess Return



- Financed at the risk-free rate, not adjusted for trading costs

Bootstrap Assessment of the Premium of Levered Risk Parity Over 60/40: Excess Return



- Financed at the Eurodollar rate and adjusted for trading costs

Bootstrapping Also Provides an Assessment of Cumulative Return



- Create 10,000 scenarios for the levered risk parity and 60/40 strategies
 - Bootstrap returns from the empirical observations
- Twenty year horizon
- Compute scenario cumulative returns and plot histograms of the differences

High Volatility can Reverse the Performance of Strategies over Decades

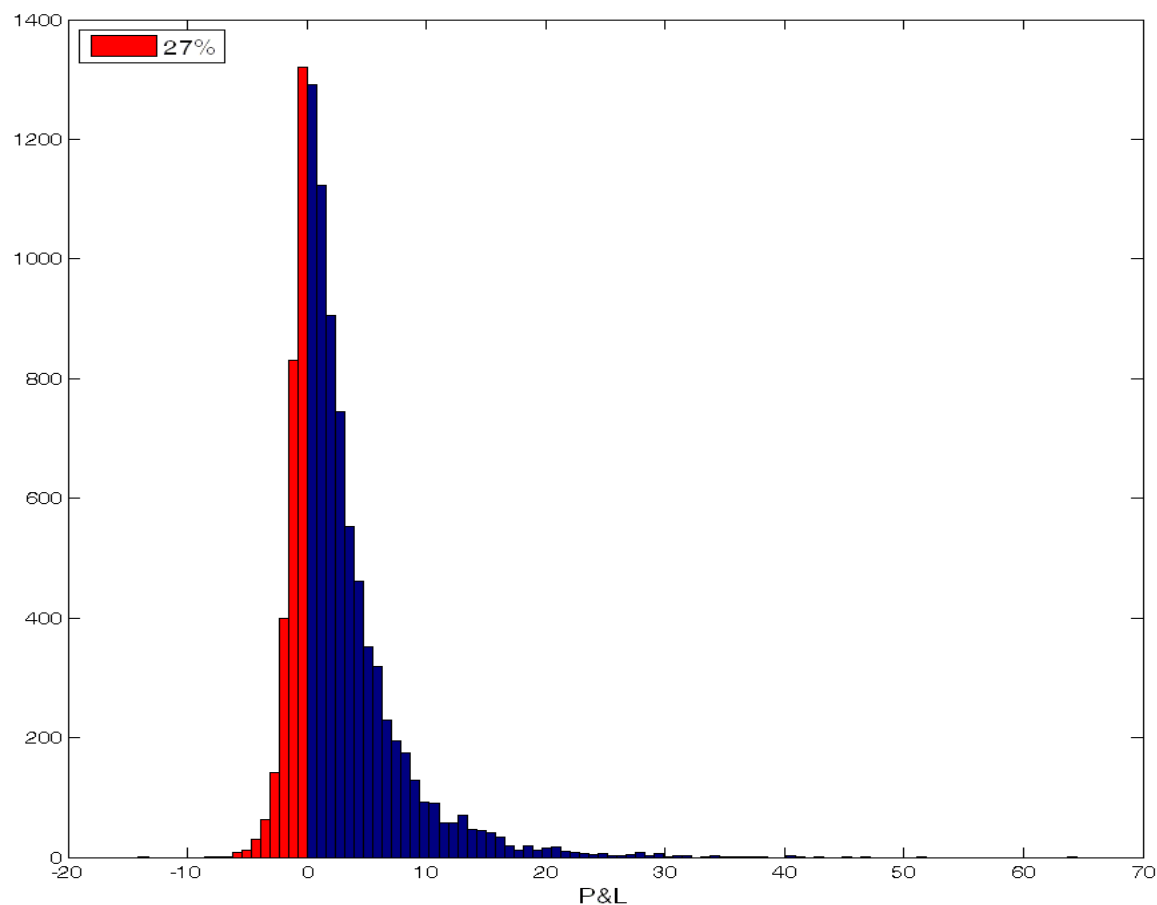


- Even if we were reasonably confident that one strategy achieved higher expected returns than another without incurring extra risk, it would be entirely possible for the weaker strategy to outperform over periods of several decades, certainly beyond the investment horizon of most individuals and even perhaps of institutions like pension funds or endowments.

Probability that 60/40 Outperforms Levered Risk Parity

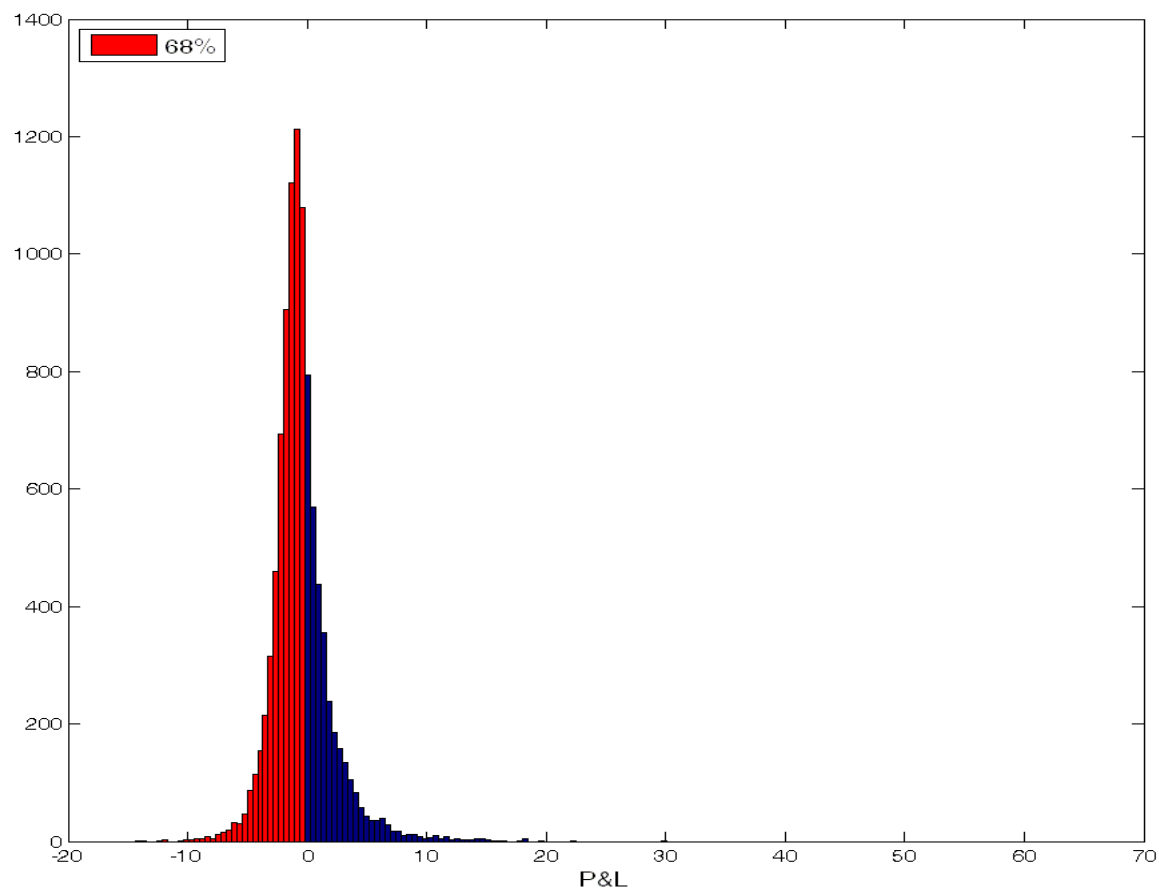
	Over the next 20 years	Over the next 50 years
Financed at the risk-free rate, not adjusted for trading costs	27%	17%
Financed at the Eurodollar rate and adjusted for trading costs	68%	79%

Bootstrap Difference Between Cumulative Returns to Levered Risk Parity and 60/40: Twenty Year Horizon



- Financed at the risk-free rate, not adjusted for trading costs

Bootstrap Difference Between Cumulative Returns to Levered Risk Parity and 60/40: Twenty Year Horizon



- Financed at the Eurodollar rate and adjusted for trading costs



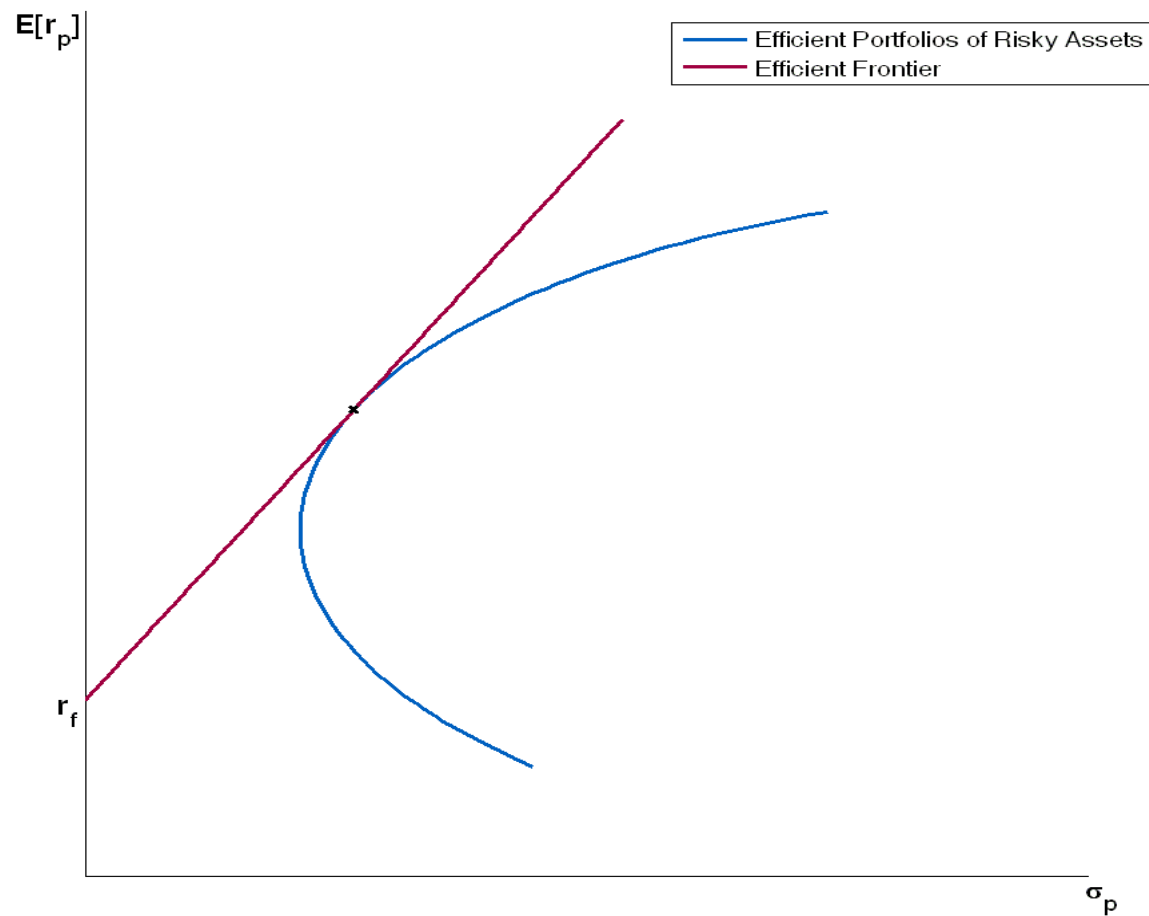
What do the CAPM and Sharpe Ratio Teach Us?

Some Investors are Interested in Risk-Adjusted Return

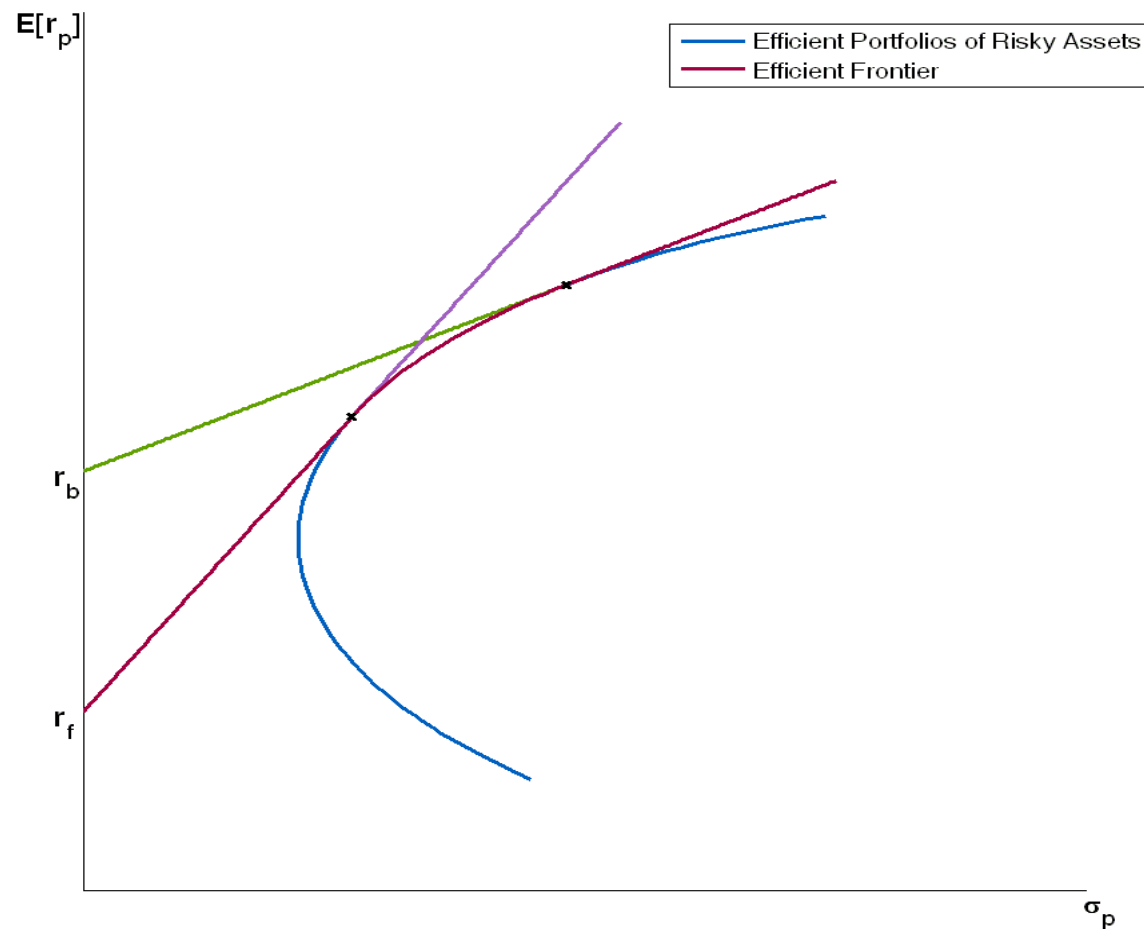
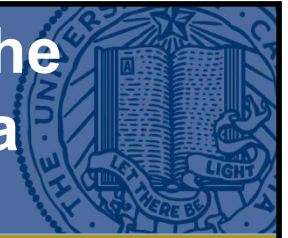


- The industry-standard measure for risk-adjusted return is the Sharpe ratio, which is the ratio of excess return to risk
- An investor must also consider the levels of risk and return of a portfolio separately
- Under the assumptions of CAPM, the value weighted (market) portfolio has the highest Sharpe ratio among all portfolios

With Borrowing at the Risk-free Rate, the Efficient Frontier is a Straight Line



When the Riskless Borrowing Rate is Higher Than the Riskless Lending Rate, the Efficient Frontier is Not a Straight Line



When the Borrowing Rate is Higher than the Risk-free Rate, Leverage Affects the Sharpe Ratio

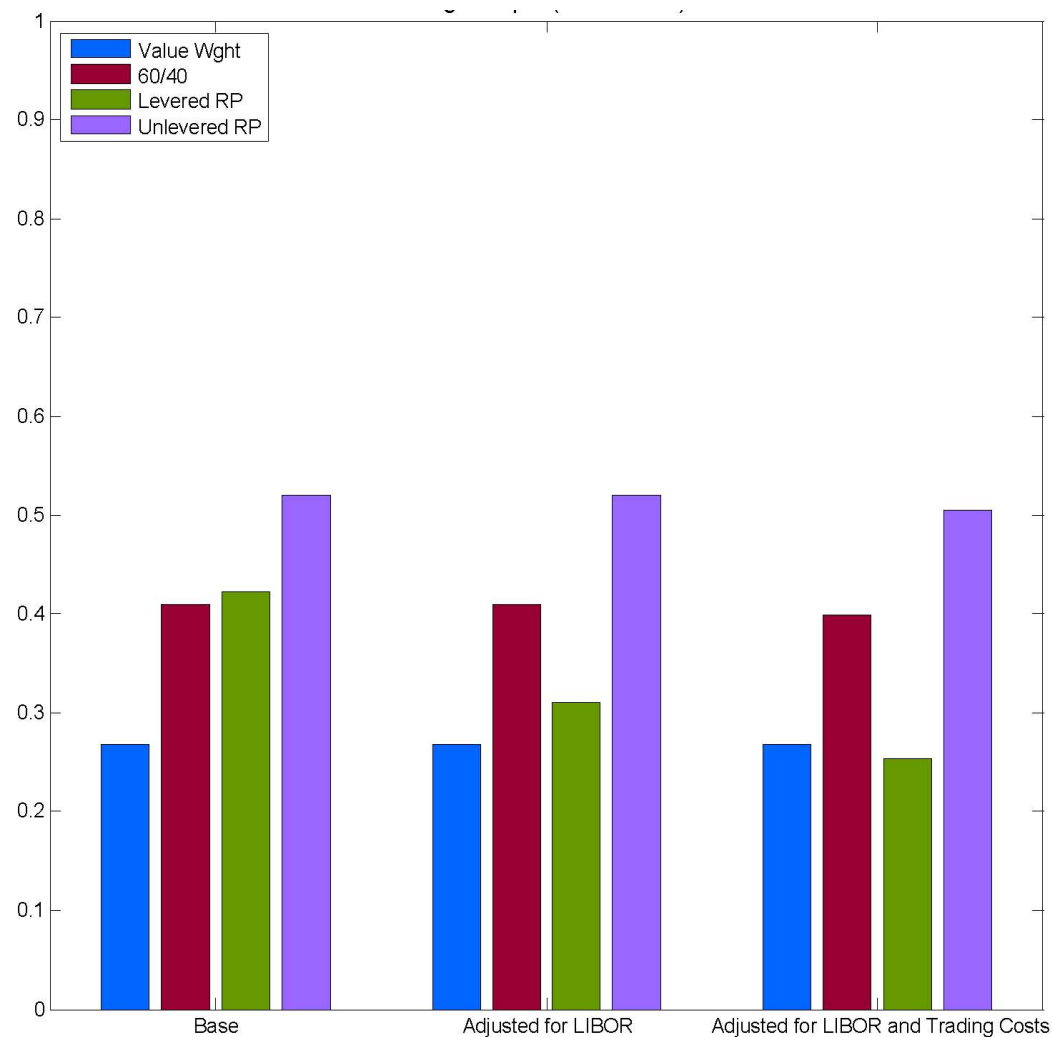


$$S_L = S_U - \frac{(\lambda - 1)(r_b - r_f)}{\lambda \sigma}$$

- For large leverage,

$$S_L \approx S_U - \frac{r_b - r_f}{\sigma}$$

Unlevered Risk Parity had the Best Sharpe Ratios 1926-2010



However...

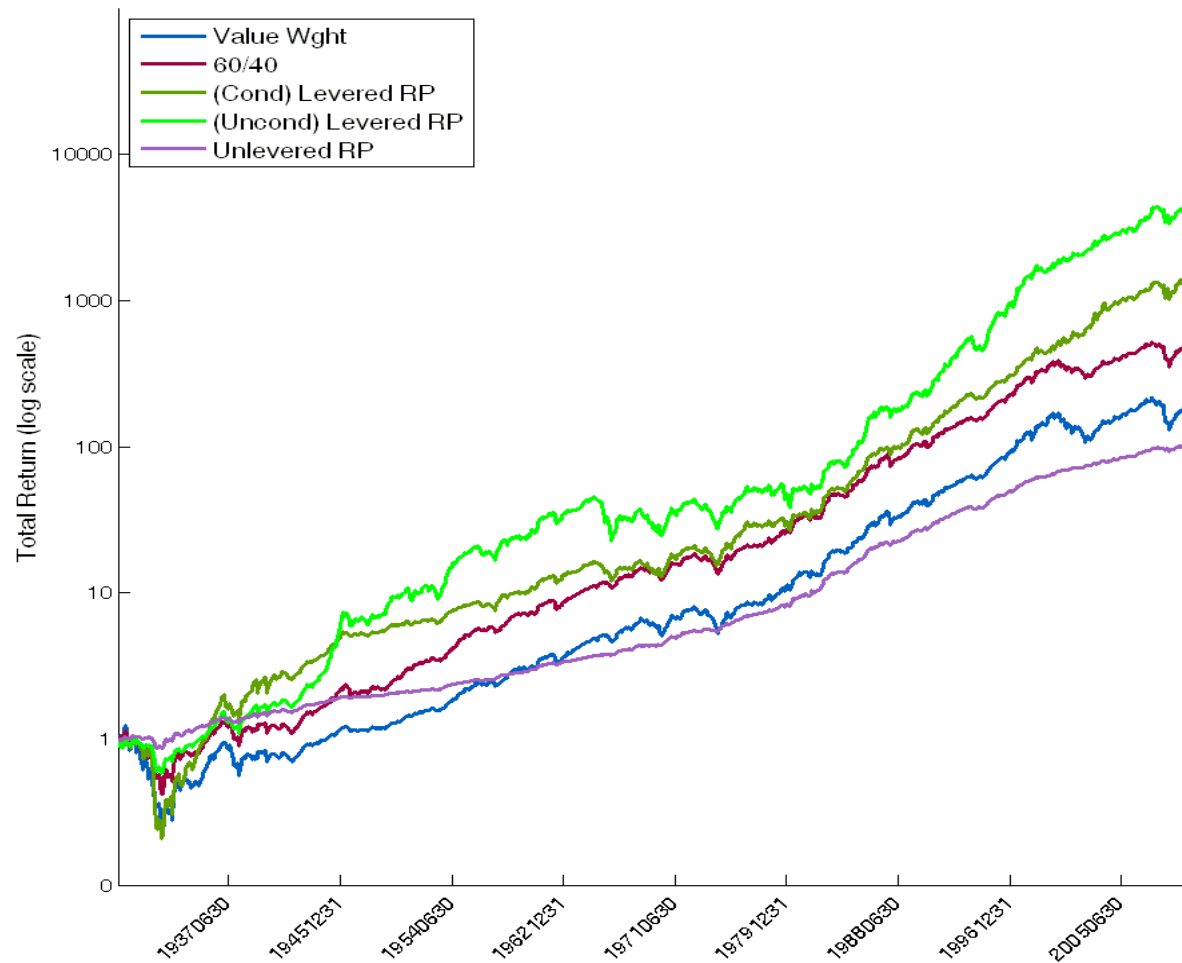


- ...Unlevered Risk Parity had relatively low risk, so it returned less than the other strategies in the long run.



Closing Comments

There is More Than One Way to Lever Risk Parity



Summary



- CAPM investors hold the market portfolio and lever or delever to adjust risk...
- ...but practical considerations imply that leveraging a portfolio diminishes Sharpe ratio
- A weaker strategy may outperform a stronger one over periods of several decades, certainly beyond the investment horizon of most individuals and even perhaps of institutions like pension funds or endowments
- Results of backtests depend on:
 - The test period
 - Assumptions about transaction costs
- “When the experiments are done, we still have to decide what to believe”
 - Jonah Lehrer, “The Truth Wears Off”

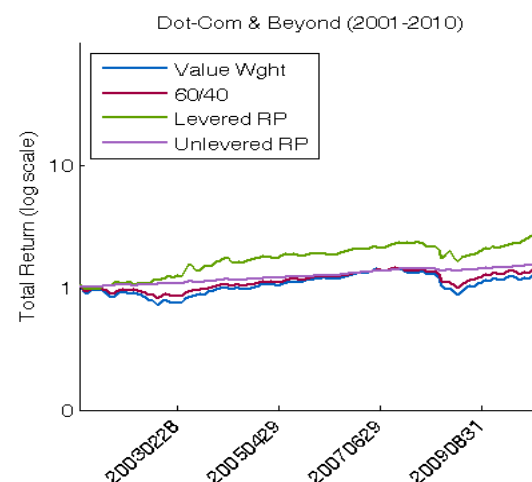
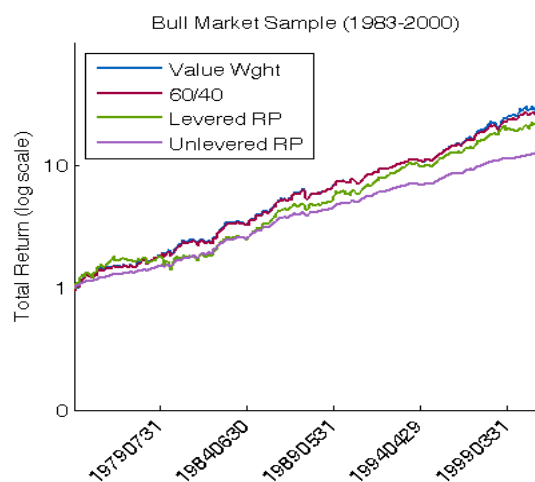
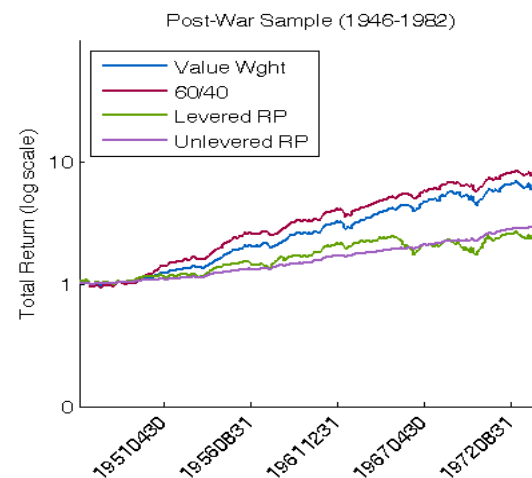
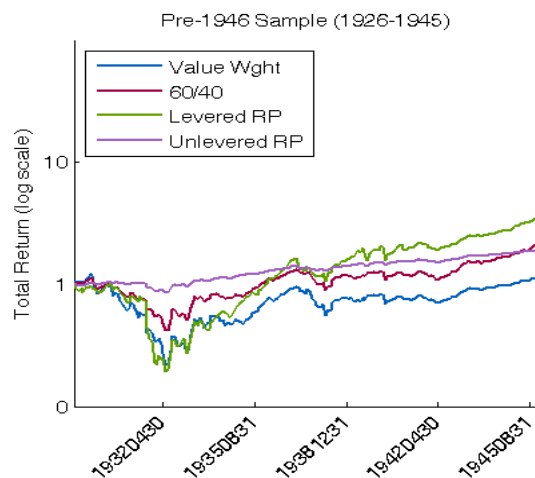


Appendices

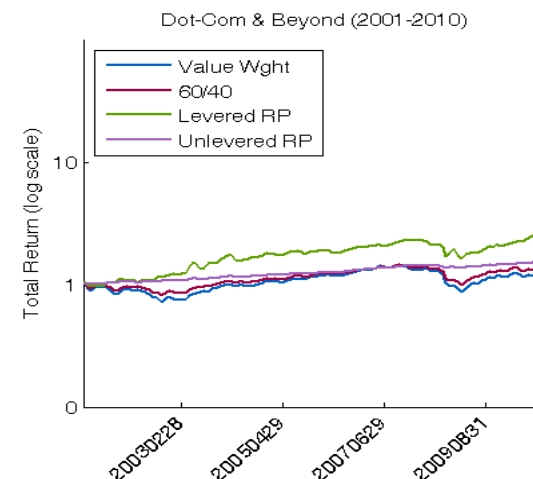
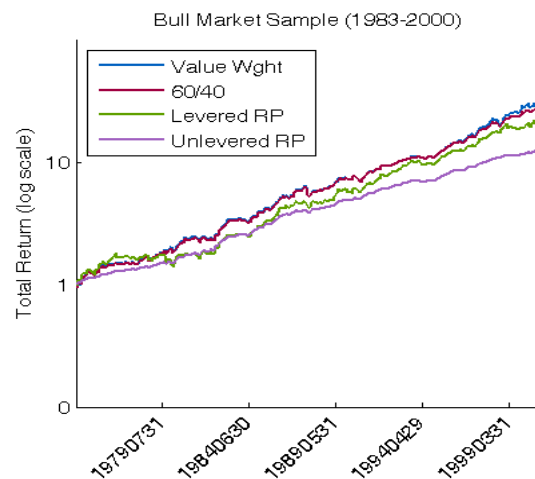
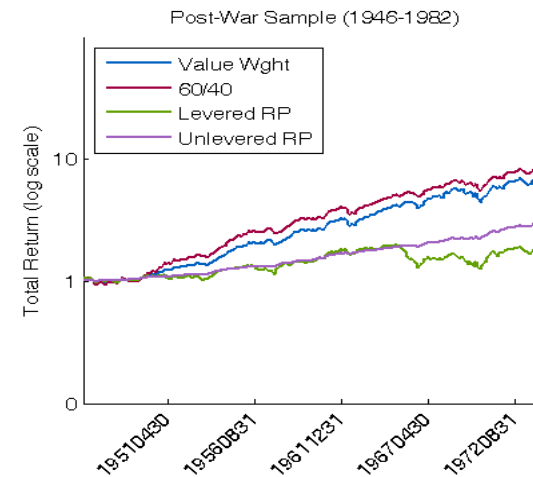
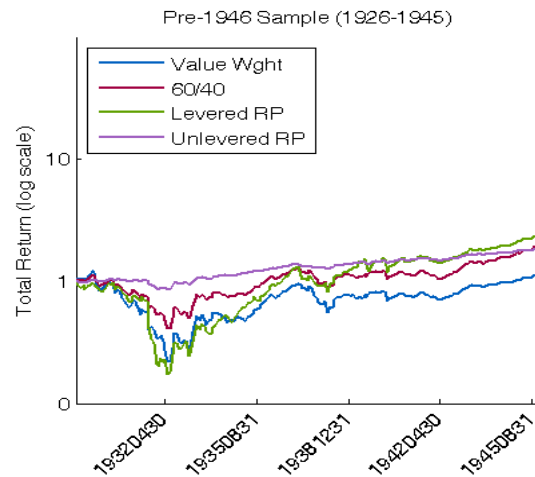


Appendix I: Performance Over Sub-Periods

Cumulative Returns to the Strategies Financed at the Eurodollar Rate: Four Sub-periods of 1926-2010



Cumulative Returns to the Strategies Financed at the Eurodollar Rate and Adjusted for Trading Costs: Four Sub-periods of 1926-2010





Appendix II: More on Levered Risk Parity Versus 60/40

Bootstrapping Alpha



$$r_{LRP} = \alpha + \beta r_{60/40} + \varepsilon$$

Base regression equation

$$\hat{\varepsilon} = r_{LRP} - \hat{\alpha} - \hat{\beta} r_{60/40}$$

Solve for residuals

$$r_{LRP}^* = \hat{\alpha} + \hat{\beta} r_{60/40} + \varepsilon^*$$

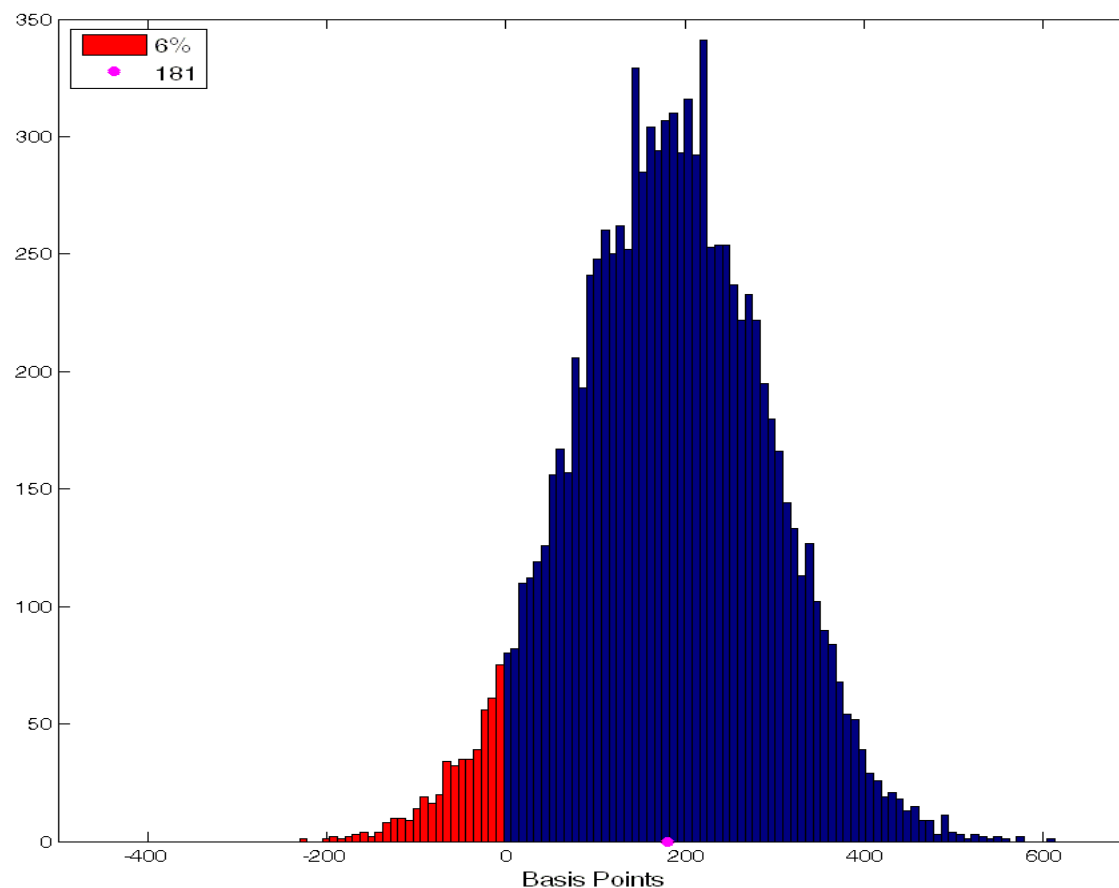
Scramble residuals
and solve for bootstrap
levered risk parity returns

$$r_{LRP}^* = \hat{\alpha}^* + \hat{\beta}^* r_{60/40} + \hat{\varepsilon}^*$$

Bootstrap regression
equation

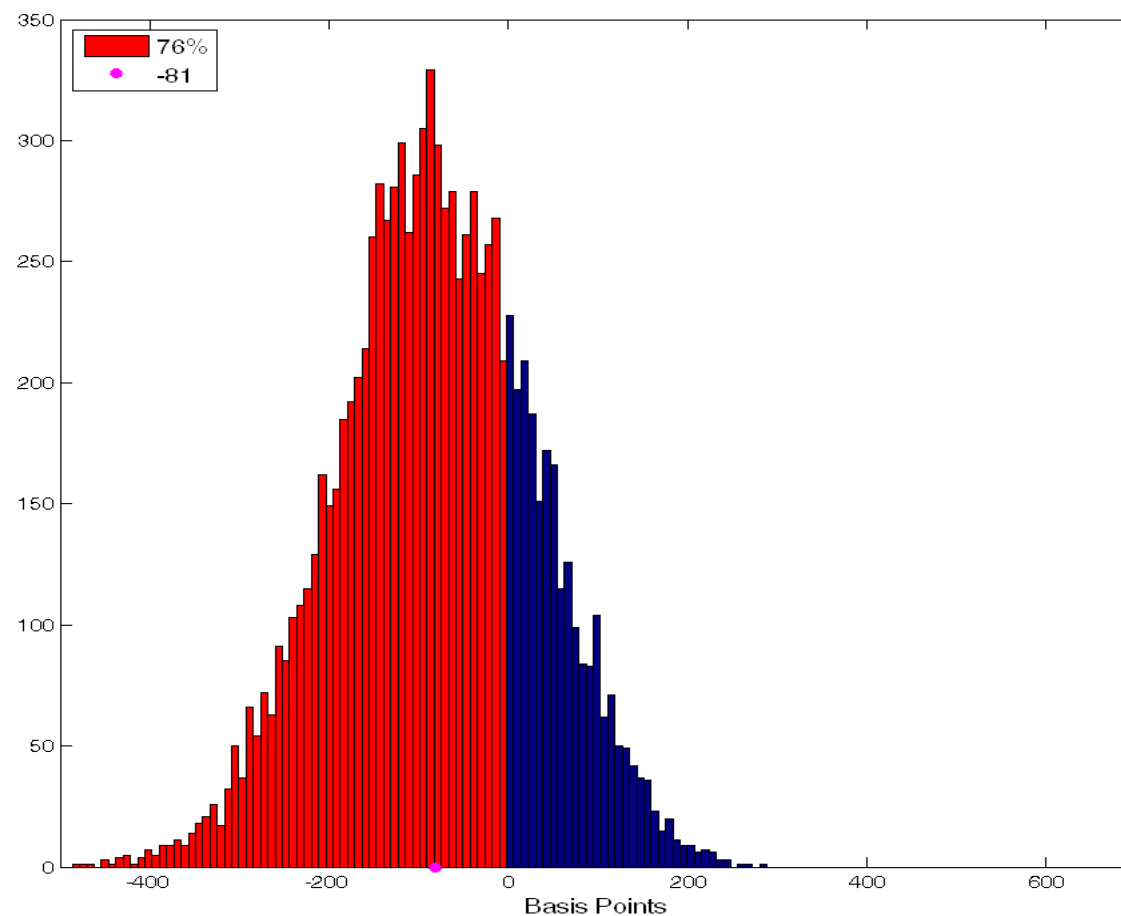
Estimate $\hat{\alpha}^*$ and solve bootstrap regression equation 10,000 times.

Bootstrap Assessment of the Premium of Levered Risk Parity Over 60/40: Alpha



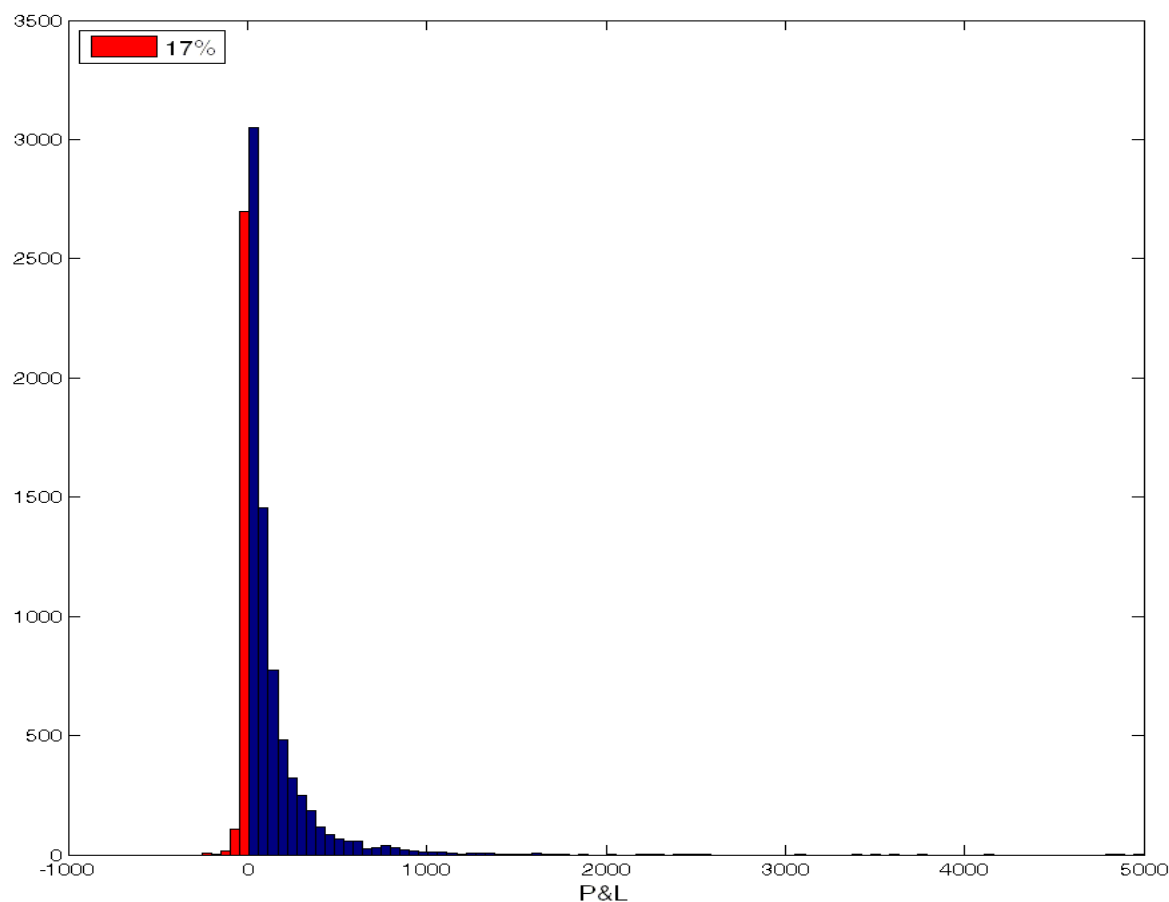
- Financed at the risk-free rate, not adjusted for trading costs

Bootstrap Assessment of the Premium of Levered Risk Parity Over 60/40: Alpha



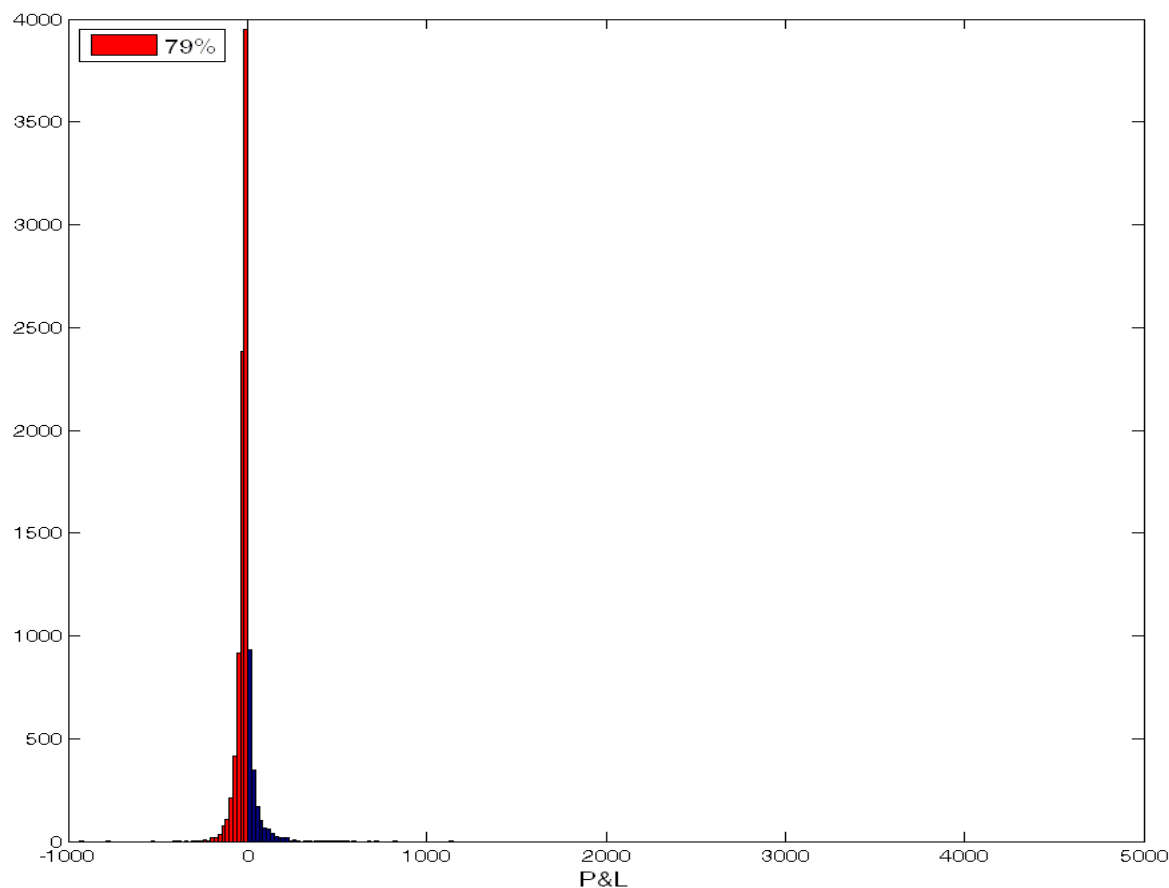
- Financed at the Eurodollar rate and adjusted for trading costs

Bootstrap Difference Between Cumulative Returns to Levered Risk Parity and 60/40: Fifty Year Horizon



- Financed at the risk-free rate, not adjusted for trading costs

Bootstrap Difference Between Cumulative Returns to Levered Risk Parity and 60/40: Fifty Year Horizon

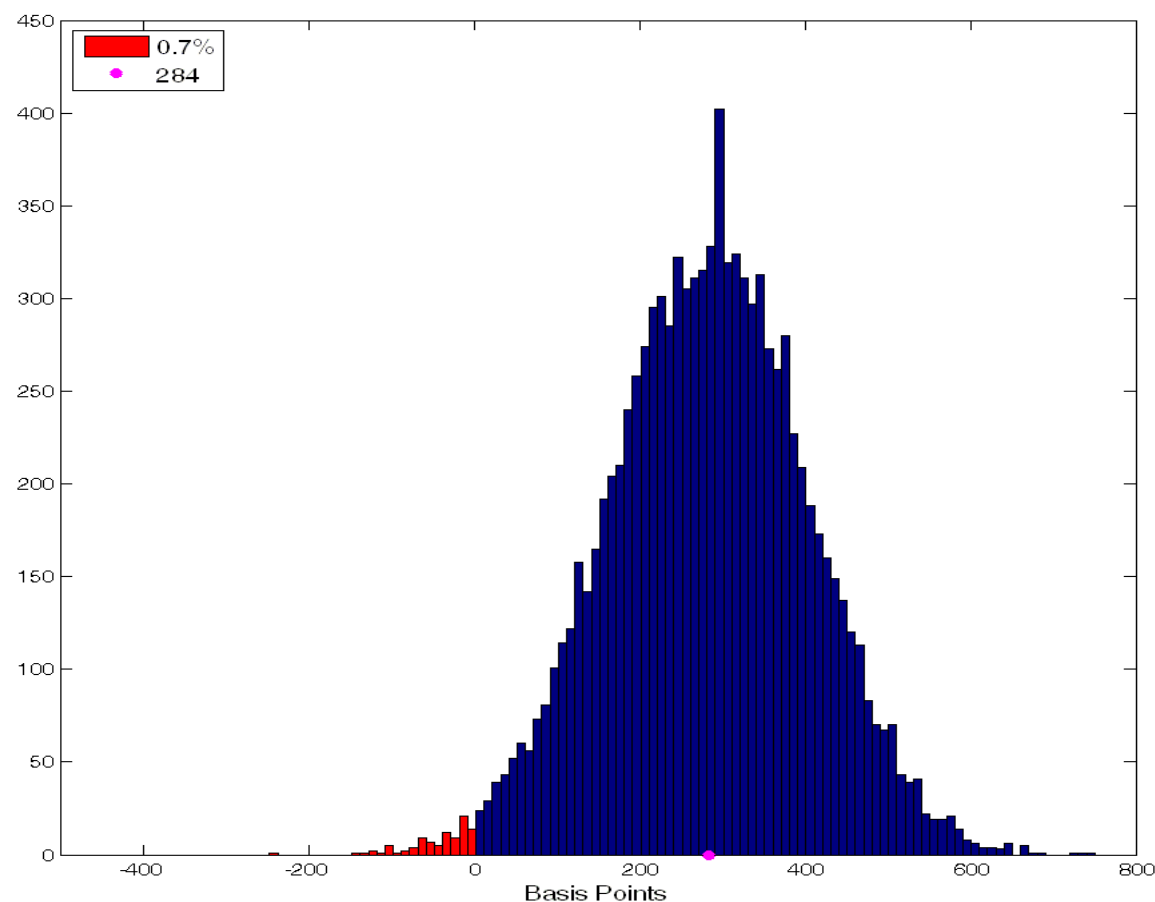


- Financed at the Eurodollar rate and adjusted for trading costs



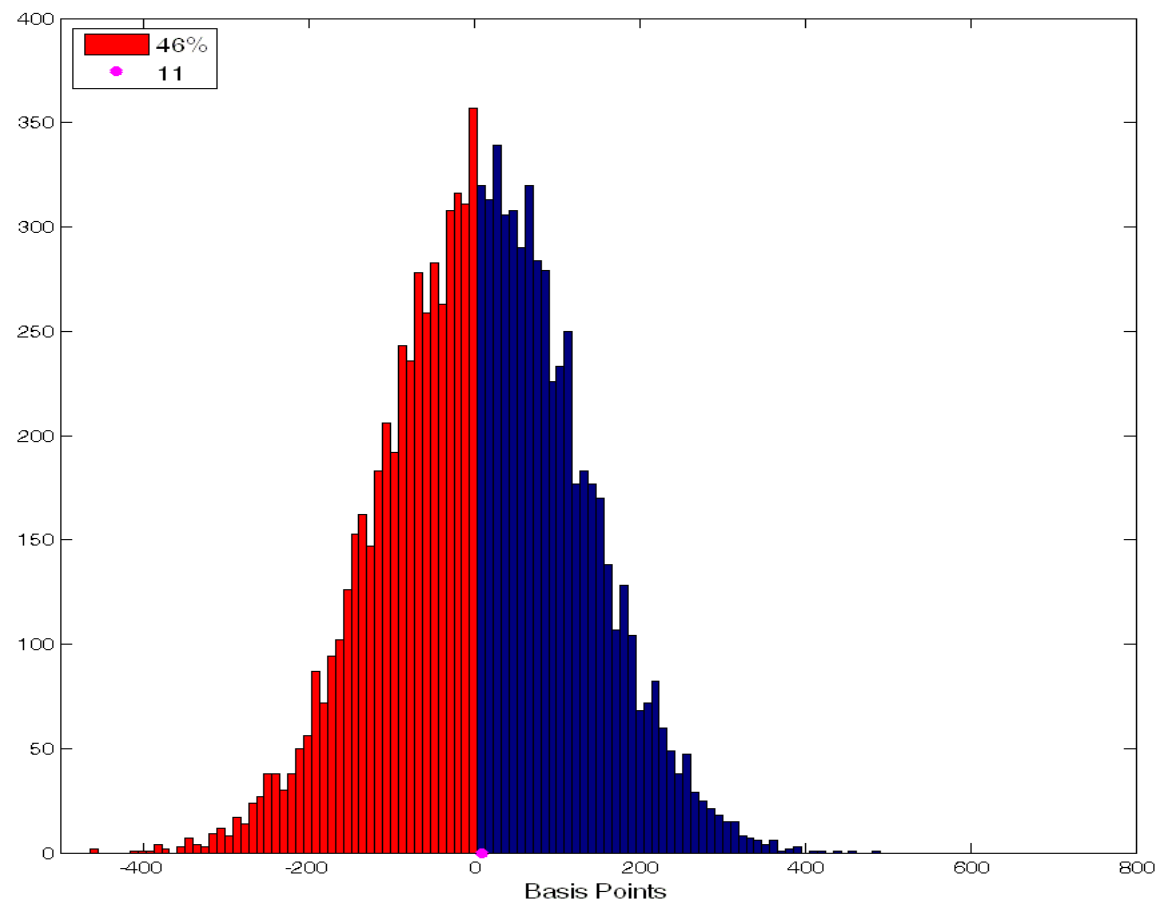
Appendix II: Levered Risk Parity Versus the Market

Bootstrap Assessment of the Premium of Levered Risk Parity Over the Market: Excess Return



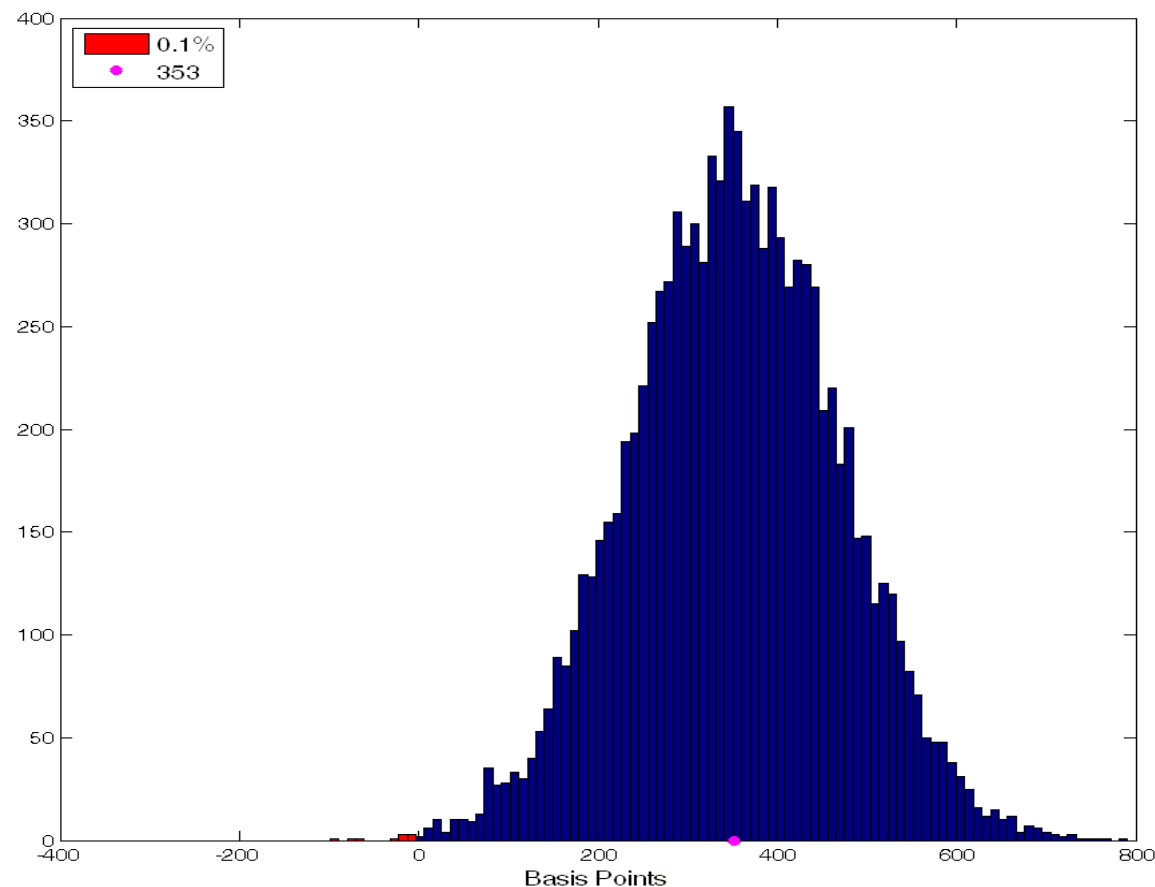
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Bootstrap Assessment of the Premium of Levered Risk Parity Over the Market: Excess Return



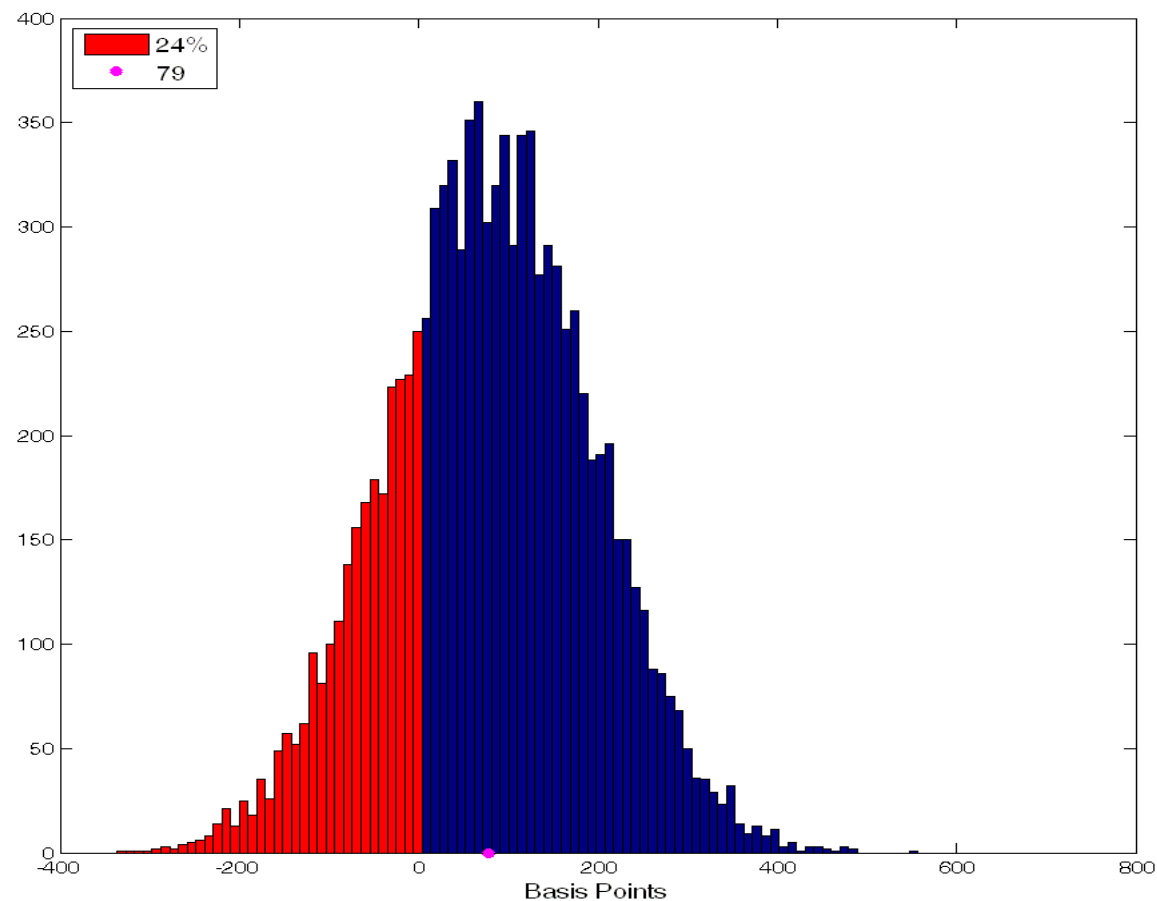
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Bootstrap Assessment of the Premium of Levered Risk Parity Over the Market: Alpha



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Bootstrap Assessment of the Premium of Levered Risk Parity Over the Market: Alpha



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High Volatility can Reverse the Performance of Strategies over Decades

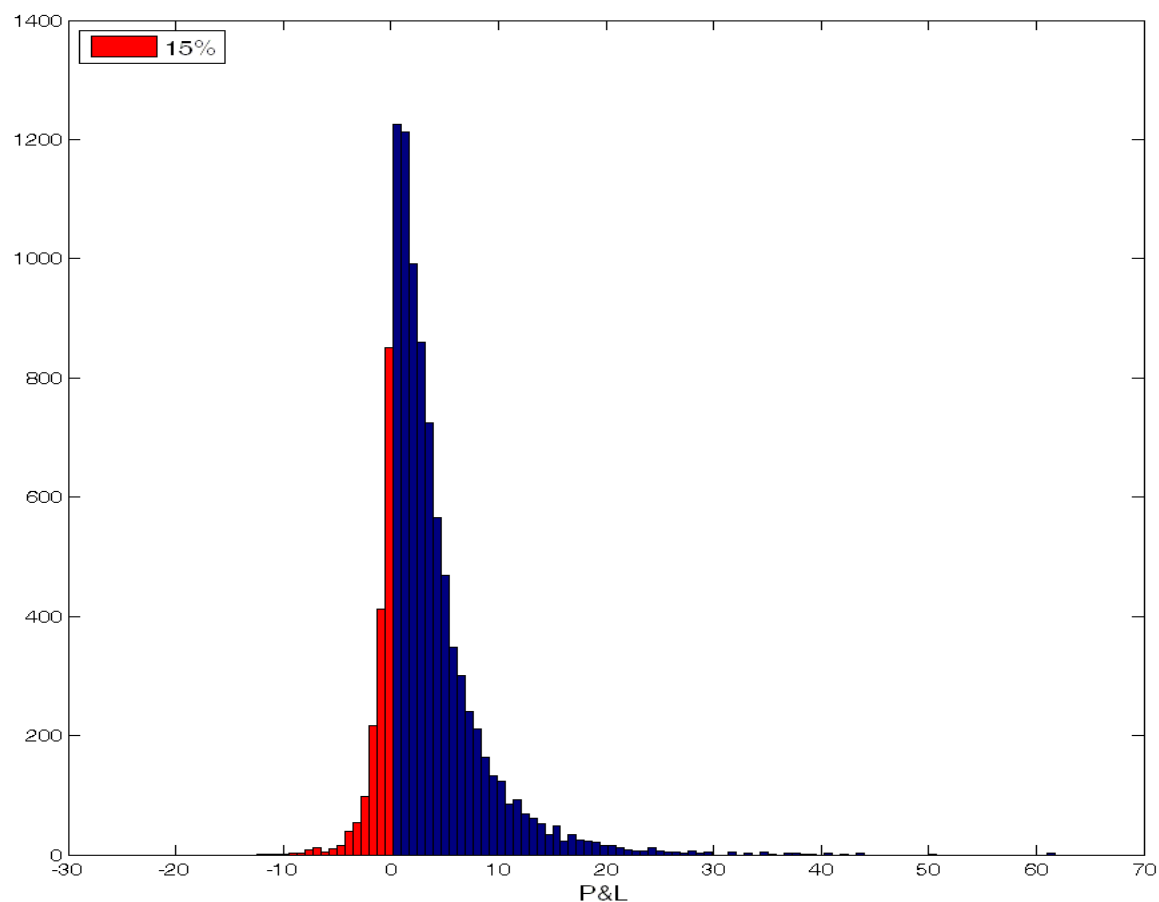


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Probability that the Market Outperforms Levered Risk Parity

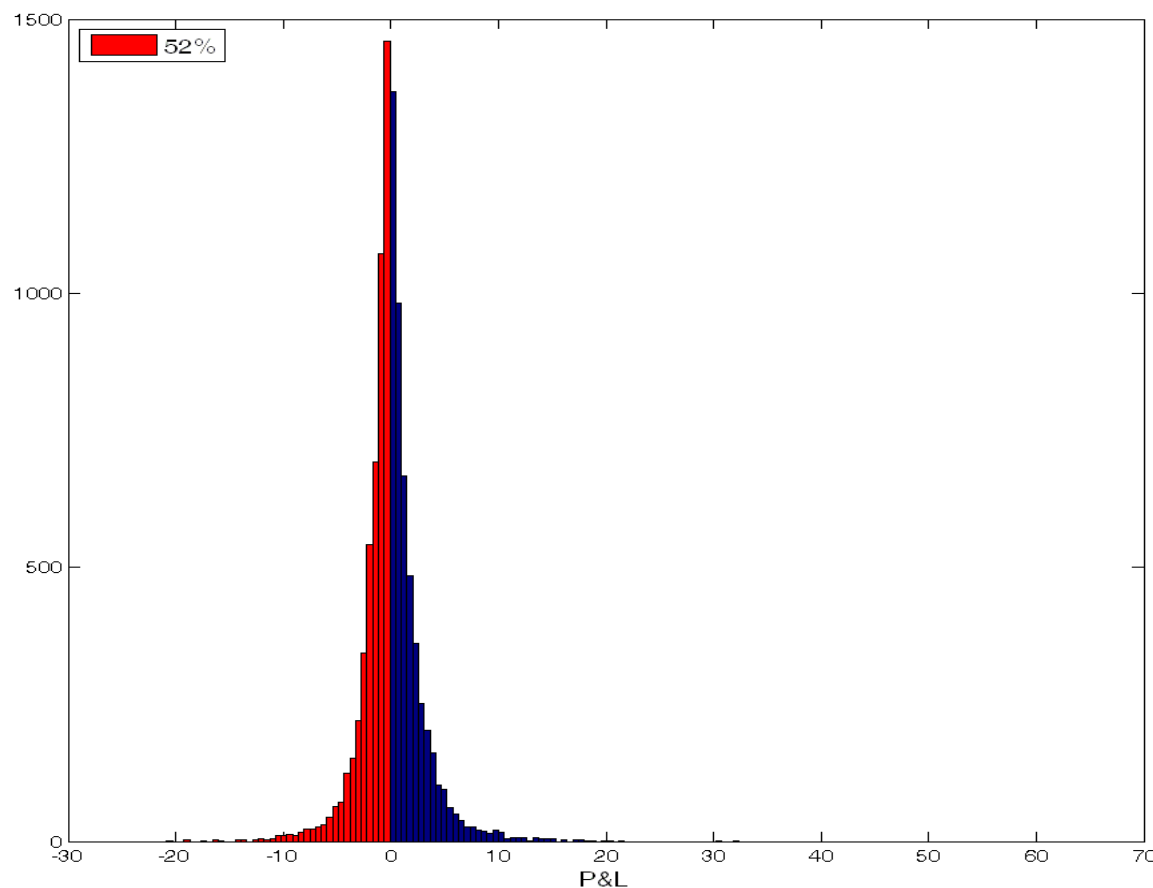
	Over the next 20 years	Over the next 50 years
Financed at the risk-free rate, not adjusted for trading costs	15%	5%
Financed at the Eurodollar rate and adjusted for trading costs	52%	54%

Bootstrap Difference Between Cumulative Returns to Levered Risk Parity and the Market: Twenty Year Horizon



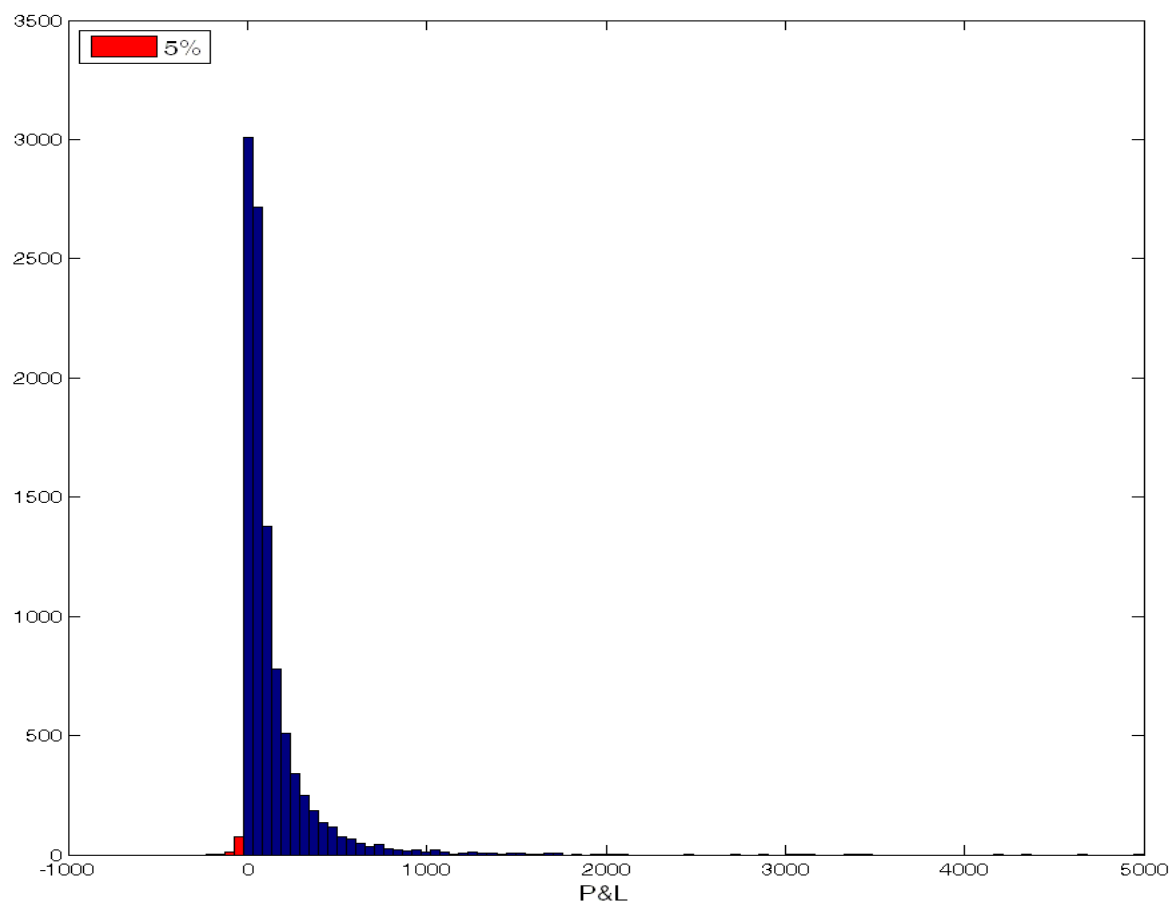
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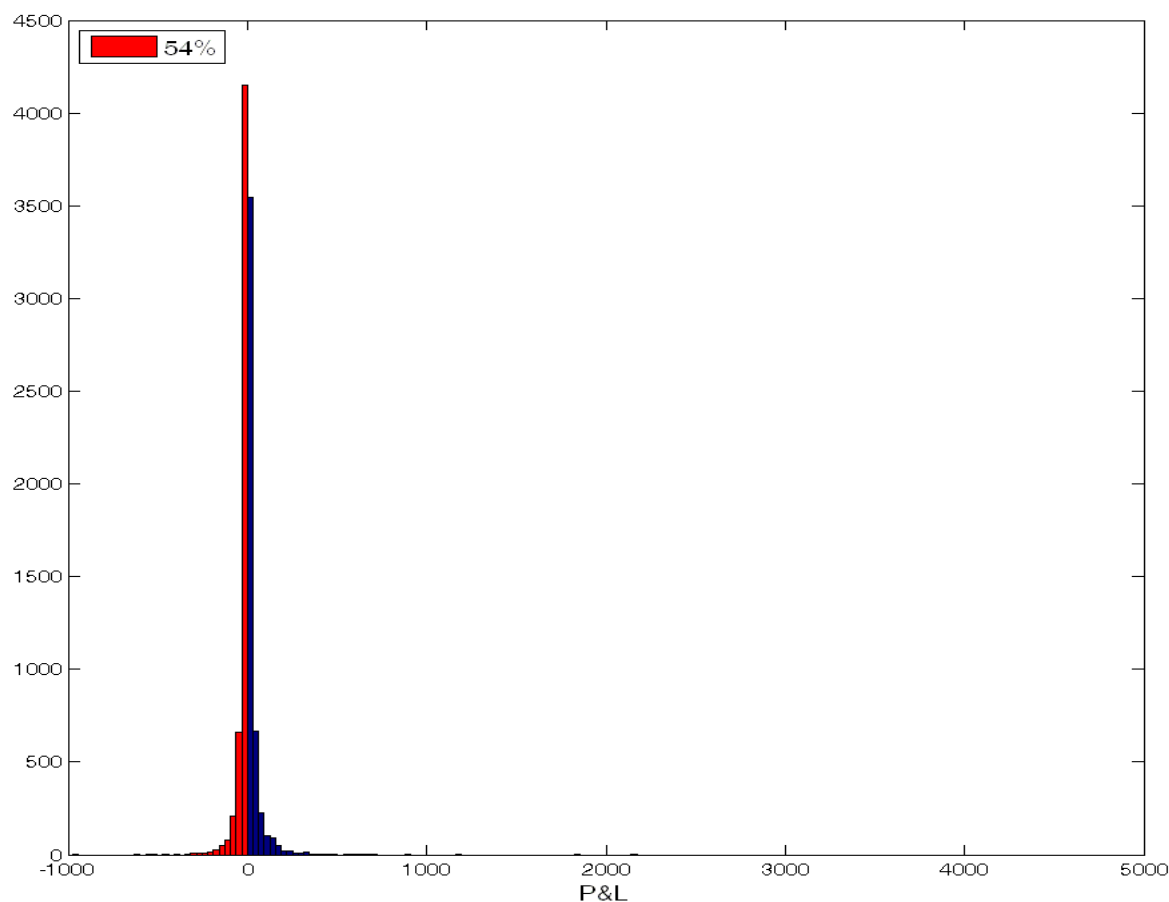
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Bootstrap Difference Between Cumulative Returns to Levered Risk Parity and the Market: Fifty Year Horizon



- Financed at the Eurodollar rate and adjusted for trading costs