

Insper

Strategic Rebalancing

Nicolas Granger
Man AHL

Campbell R. Harvey
Duke University

Sandy Rattray
Man Group plc

Otto Van Hemert
Man AHL

Available at SSRN 3330134

FINANCE HUB SEMINARS SERIES

Fernando Tassinari Moraes
PhD Business Economics
Insper Instituto de Ensino e Pesquisa
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Agenda

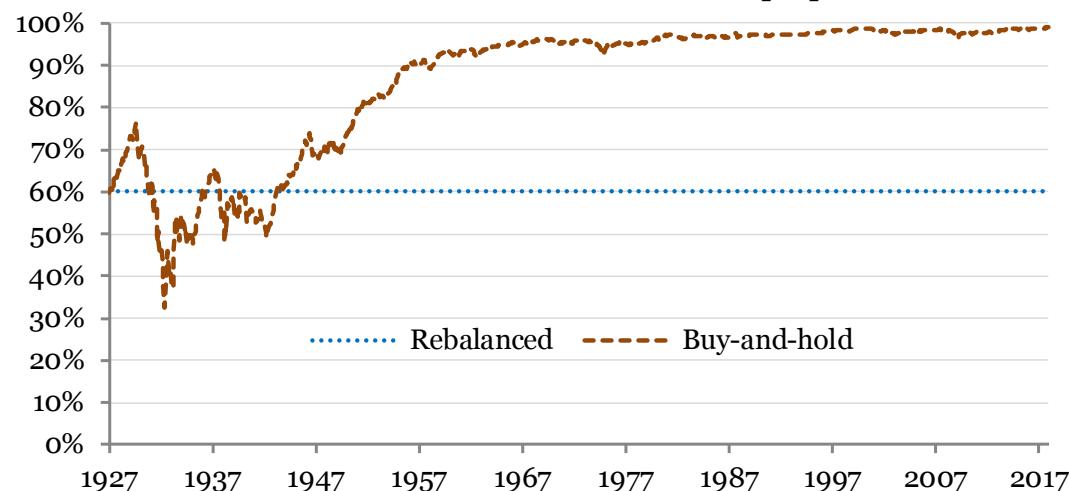
- Rebalanced vs Buy-and-Hold Portfolio Returns
- Trend Strategy Allocation
- Strategic Rebalancing Allocation
- Trend vs Strategic

Rebalanced vs Buy-and-Hold



Figure 1: Allocation to Stocks for a Monthly-Rebalanced and Buy-and-Hold Portfolio

The figure shows the percent allocated to stocks for a monthly-rebalanced and a buy-and-hold portfolio. In both cases, at the start 60% of capital is allocated to stocks and 40% to bonds. We use monthly US data from January 1927 to December 2017. The stock data are from Kenneth French's website. The bond data are from the Federal Reserve, prepended with Global Financial Data (GFD).



Rebalanced vs Buy-and-Hold



Portfolios returns:

$$1 + R^R = (1 + w^s R_1^S + w^B R_1^B)(1 + w^s R_2^S + w^B R_2^B)$$

$$1 + R^H = w^s(1 + R_1^S)(1 + R_2^S) + w^B(1 + R_1^B)(1 + R_2^B)$$

so...

$$R^R - R^H = -w^s w^B k_1 k_2, \text{ where } k_t = R_t^S - R_t^B$$

and...

$$R^R - R^H < 0 \Leftrightarrow \underbrace{(k_1 > 0 \wedge k_2 > 0)}_{\text{Momentum of Relative Performance}} \vee \underbrace{(k_1 < 0 \wedge k_2 < 0)}_{\text{Momentum of Relative Performance}}$$

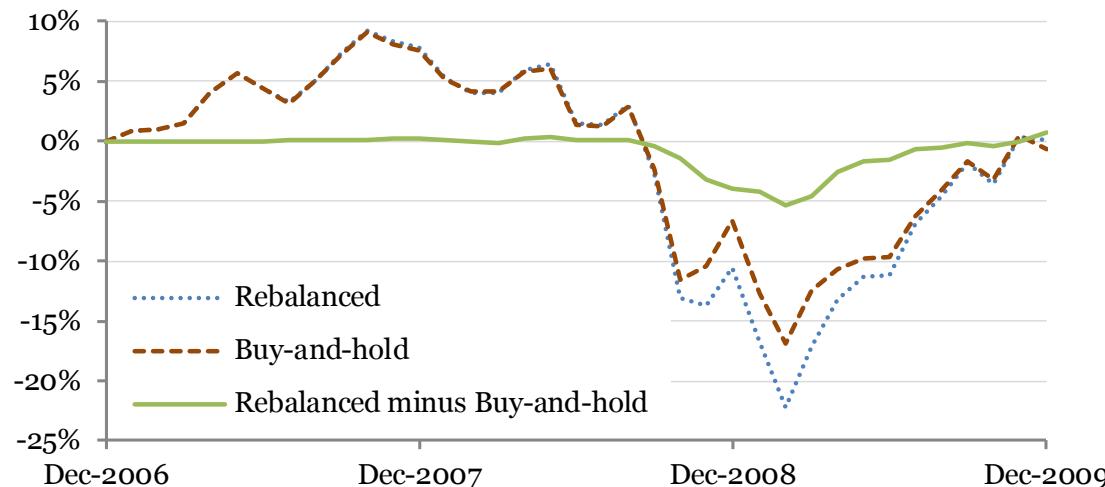
Momentum of Relative Performance

Rebalanced vs Buy-and-Hold



Figure 2: Performance Monthly-Rebalanced and Buy-and-Hold Portfolio (2007-2009)

The figure shows the cumulative return for a monthly-rebalanced and buy-and-hold performance for the 2007-2009 financial crisis period, as well as the difference. Both portfolios start with an initial 60-40 stock-bond capital allocation in January 2007.

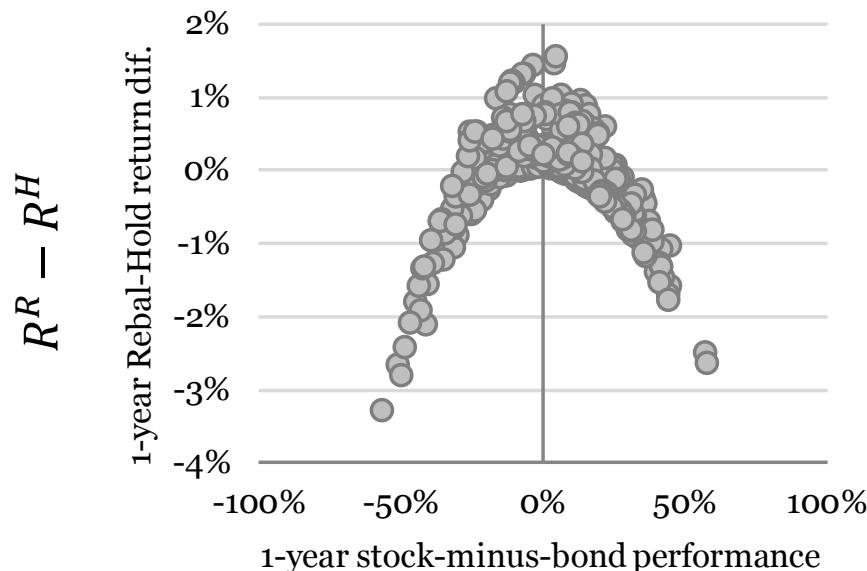


Rebalanced vs Buy-and-Hold



Figure 3: Rebal-Minus-Hold versus Stock-Minus-Bond 1-Year Returns

The figure shows the Rebal-Hold return difference when both have a 60-40 stock-bond mix at the start of the period (vertical axis) versus the stock-bond relative return (horizontal axis). Each dot in the figure corresponds to a 1-year (rolling 12-month) window, where data run from January 1960 to December 2017.



$$k_t = R_t^S - R_t^B$$

Trend Strategy Allocation



Define a simple time-series momentum (trend) signal for asset k :

- $mom_t^k(N) = \frac{\sum_{i=0}^N \tilde{R}_{t-i}^k}{\sigma_t^k \sqrt{N}}$

Putting equal risk on stocks and bonds trend, the strategy return is:

- $R_t^{mom(N)} = 0.5mom_{t-1}^S(N) \frac{\sigma^{REF}}{\sigma_{t-1}^S} \tilde{R}_t^S + 0.5mom_{t-1}^B(N) \frac{\sigma^{REF}}{\sigma_{t-1}^B} \tilde{R}_t^B + 0.8R_t^F$

Trend Strategy Allocation



Assumptions:

Trend strategy implemented with futures:

- Trading cost = 0.01%/0.005% trading notional for equities/bonds (Harvey et al. 2018)
- 20% of capital in margins (no interest), 80% earns R_t^F (T-bill returns)
- Floor and cap on signal value of -1.0 and $+1.0$
- 10%/5% floor for stocks and stocks-bond spread/bonds for annualized security volatility

Rebalancing 60-40 target portfolio:

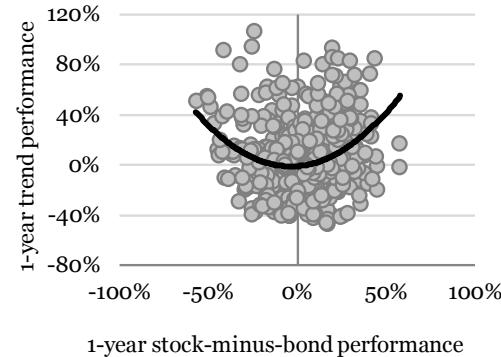
- Trading cost = 0.3%/0.13% trading notional for equities/bonds (Norges Bank 2018)

Trend Strategy Allocation

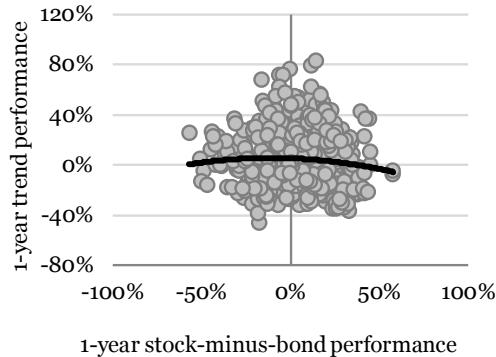
Result for the strategy with 3 month trend strategies



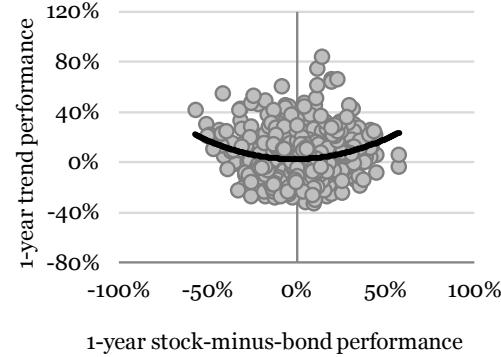
A: Stocks-only



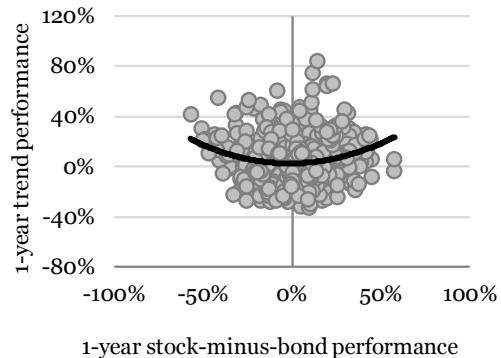
B: Bonds-only



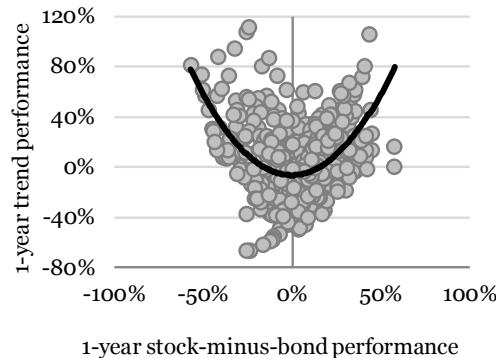
C: Stocks & bonds (equal risk)



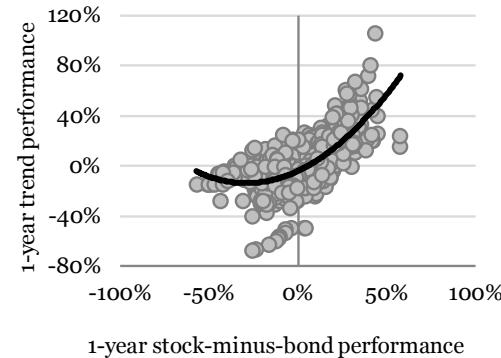
C: Stocks & bonds (equal risk)



D: Stock-bond spread



F: Stock-bond spread (if trend positive)



Trend Strategy Allocation



Monthly-rebalanced portfolio (90%) and the various trend strategies (10%)

A: Trend applied to stocks-only

	Rebal (100%)	Rebal (90%)	Rebal (90%)	Rebal (90%)
	1m trend (10%)	3m trend (10%)	12m trend (10%)	
Stock allocation (avg)	60.0%	57.7%	60.1%	64.5%
Bond allocation (avg)	40.0%	36.0%	36.0%	36.0%
Total allocation (avg)	100.0%	93.7%	96.1%	100.5%
Rebal trade (ann)	10.2%	9.1%	9.1%	9.1%
Stock fut. trade (ann)	0.0%	207.3%	106.7%	45.1%
Bond fut. trade (ann)	0.0%	0.0%	0.0%	0.0%
Cost estimate (ann)	4.4 bps	6.0 bps	5.0 bps	4.4 bps
Return, (ann)	9.1%	9.0%	9.1%	9.6%
Volatility (ann)	9.8%	8.7%	9.1%	9.7%
Ret./Vol (ann)	0.92	1.03	1.00	0.99
Sharpe ratio (ann)	0.47	0.52	0.51	0.53
ADD Jun 1970	0.0%	3.6%	1.9%	5.4%
ADD Sep 1974	0.0%	9.7%	8.9%	9.8%
ADD Nov1987	0.0%	4.9%	-0.8%	-3.0%
ADD Sep 2002	0.0%	4.2%	4.2%	6.0%
ADD Feb 2009	0.0%	6.1%	7.9%	9.0%
ADD average	0.0%	5.7%	4.4%	5.4%

B: Trend applied to bonds-only

	Rebal (100%)	Rebal (90%)	Rebal (90%)	Rebal (90%)
	1m trend (10%)	3m trend (10%)	12m trend (10%)	
Stock allocation (avg)	60.0%	54.0%	54.0%	54.0%
Bond allocation (avg)	40.0%	39.9%	41.7%	45.3%
Total allocation (avg)	100.0%	93.9%	95.7%	99.3%
Rebal trade (ann)	10.2%	9.1%	9.1%	9.1%
Stock fut. trade (ann)	0.0%	0.0%	0.0%	0.0%
Bond fut. trade (ann)	0.0%	438.0%	245.4%	111.6%
Cost estimate (ann)	4.4 bps	6.1 bps	5.2 bps	4.5 bps
Return, (ann)	9.1%	9.4%	9.1%	9.3%
Volatility (ann)	9.8%	9.2%	9.2%	9.2%
Ret./Vol (ann)	0.92	1.02	0.99	1.01
Sharpe ratio (ann)	0.47	0.54	0.50	0.53
ADD Jun 1970	0.0%	5.1%	3.5%	5.6%
ADD Sep 1974	0.0%	6.0%	5.0%	6.2%
ADD Nov1987	0.0%	0.9%	0.8%	1.1%
ADD Sep 2002	0.0%	6.4%	5.2%	7.7%
ADD Feb 2009	0.0%	2.1%	3.8%	6.0%
ADD average	0.0%	4.1%	3.6%	5.3%

C: Trend applied to stocks & bonds (equal risk)

	Rebal (100%)	Rebal (90%)	Rebal (90%)	Rebal (90%)
	1m trend (10%)	3m trend (10%)	12m trend (10%)	
Stock allocation (avg)	60.0%	55.8%	57.0%	59.3%
Bond allocation (avg)	40.0%	37.9%	38.8%	40.7%
Total allocation (avg)	100.0%	93.8%	95.9%	99.9%
Rebal trade (ann)	10.2%	9.1%	9.1%	9.1%
Stock fut. trade (ann)	0.0%	103.7%	53.4%	22.6%
Bond fut. trade (ann)	0.0%	219.0%	122.7%	55.8%
Cost estimate (ann)	4.4 bps	6.1 bps	5.1 bps	4.4 bps
Return, (ann)	9.1%	9.2%	9.1%	9.4%
Volatility (ann)	9.8%	8.8%	9.0%	9.3%
Ret./Vol (ann)	0.92	1.04	1.01	1.02
Sharpe ratio (ann)	0.47	0.54	0.51	0.54
ADD Jun 1970	0.0%	4.4%	2.7%	5.6%
ADD Sep 1974	0.0%	7.9%	7.0%	8.0%
ADD Nov1987	0.0%	2.9%	0.0%	-1.0%
ADD Sep 2002	0.0%	5.4%	4.7%	6.8%
ADD Feb 2009	0.0%	4.4%	6.5%	7.6%
ADD average	0.0%	5.0%	4.2%	5.4%

D: Trend applied to stock-bond spread

	Rebal (100%)	Rebal (90%)	Rebal (90%)	Rebal (90%)
	1m trend (10%)	3m trend (10%)	12m trend (10%)	
Stock allocation (avg)	60.0%	57.2%	59.1%	62.6%
Bond allocation (avg)	40.0%	32.8%	30.9%	27.4%
Total allocation (avg)	100.0%	90.0%	90.0%	90.0%
Rebal trade (ann)	10.2%	9.1%	9.1%	9.1%
Stock fut. trade (ann)	0.0%	200.1%	110.8%	49.7%
Bond fut. trade (ann)	0.0%	200.1%	110.8%	49.7%
Cost estimate (ann)	4.4 bps	6.9 bps	5.6 bps	4.7 bps
Return, (ann)	9.1%	9.0%	8.9%	9.1%
Volatility (ann)	9.8%	8.8%	9.0%	9.4%
Ret./Vol (ann)	0.92	1.02	0.99	0.97
Sharpe ratio (ann)	0.47	0.51	0.49	0.49
ADD Jun 1970	0.0%	3.9%	1.9%	4.9%
ADD Sep 1974	0.0%	7.9%	7.4%	6.9%
ADD Nov1987	0.0%	0.7%	-3.9%	-4.5%
ADD Sep 2002	0.0%	5.1%	6.2%	7.5%
ADD Feb 2009	0.0%	7.1%	8.2%	8.9%
ADD average	0.0%	4.9%	4.0%	4.7%

E: Trend applied to stock-bond, negative only

	Rebal (100%)	Rebal (90%)	Rebal (90%)	Rebal (90%)
	1m trend (10%)	3m trend (10%)	12m trend (10%)	
Stock allocation (avg)	60.0%	48.6%	49.2%	50.4%
Bond allocation (avg)	40.0%	41.4%	40.8%	39.6%
Total allocation (avg)	100.0%	90.0%	90.0%	90.0%
Rebal trade (ann)	10.2%	9.1%	9.1%	9.1%
Stock fut. trade (ann)	0.0%	89.6%	45.0%	18.0%
Bond fut. trade (ann)	0.0%	89.6%	45.0%	18.0%
Cost estimate (ann)	4.4 bps	5.3 bps	4.6 bps	4.2 bps
Return, (ann)	9.1%	8.4%	8.5%	8.6%
Volatility (ann)	9.8%	8.1%	8.0%	8.2%
Ret./Vol (ann)	0.92	1.04	1.06	1.04
Sharpe ratio (ann)	0.47	0.49	0.51	0.50
ADD Jun 1970	0.0%	5.2%	4.6%	6.2%
ADD Sep 1974	0.0%	9.3%	9.6%	8.5%
ADD Nov1987	0.0%	2.3%	2.3%	1.8%
ADD Sep 2002	0.0%	8.0%	7.9%	8.8%
ADD Feb 2009	0.0%	8.2%	10.7%	10.4%
ADD average	0.0%	6.6%	7.0%	7.1%

F: Trend applied to stock-bond, positive only

	Rebal (100%)	Rebal (90%)	Rebal (90%)	Rebal (90%)
	1m trend (10%)	3m trend (10%)	12m trend (10%)	
Stock allocation (avg)	60.0%	62.6%	63.9%	66.2%
Bond allocation (avg)	40.0%	27.4%	26.1%	23.8%
Total allocation (avg)	100.0%	90.0%	90.0%	90.0%
Rebal trade (ann)	10.2%	9.1%	9.1%	9.1%
Stock fut. trade (ann)	0.0%	110.5%	65.8%	31.7%
Bond fut. trade (ann)	0.0%	110.5%	65.8%	31.7%
Cost estimate (ann)	4.4 bps	5.6 bps	4.9 bps	4.4 bps
Return, (ann)	9.1%	9.1%	8.9%	9.1%
Volatility (ann)	9.8%	9.5%	9.8%	10.0%
Ret./Vol (ann)	0.92	0.95	0.91	0.91
Sharpe ratio (ann)	0.47	0.49	0.45	0.46
ADD Jun 1970	0.0%	1.5%	0.2%	1.5%
ADD Sep 1974	0.0%	2.0%	1.4%	1.8%
ADD Nov1987	0.0%	0.1%	-4.4%	-4.5%
ADD Sep 2002	0.0%	-0.3%	0.8%	1.3%
ADD Feb 2009	0.0%	1.7%	0.4%	1.3%
ADD average	0.0%	1.0%	-0.3%	0.3%

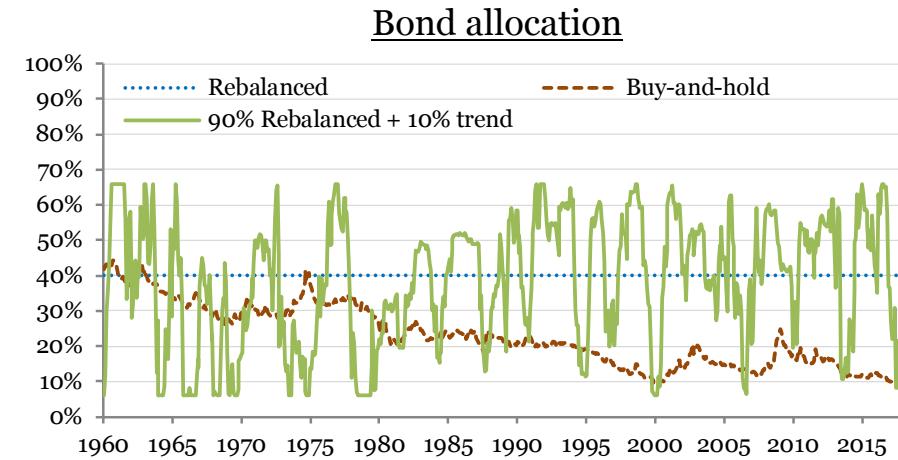
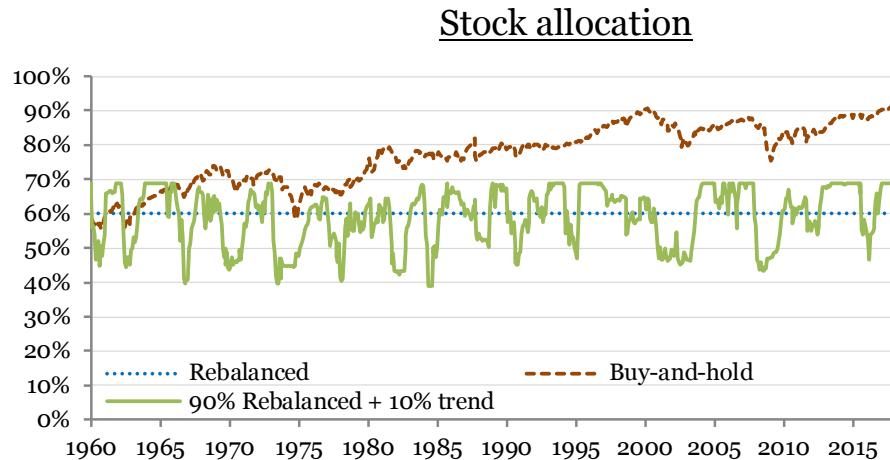
Trend Strategy Allocation



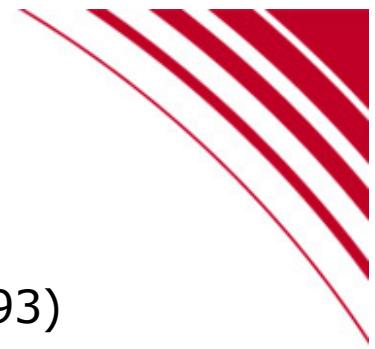
Monthly-rebalanced portfolio (90%) and the various trend strategies (10%)

Figure 6: Allocation to Stocks and Bonds for the Various Portfolios Considered

In this figure, we show the (index plus futures) allocation to stocks (left panel) and bonds (right panel) for a monthly-rebalanced 60-40 stock-bond portfolio, a buy-and-hold portfolio that starts with the same allocation mix, and a 90% monthly-rebalanced and 10% 12-month (equity & bond, equal risk) trend strategy combination. Data run from 1960 to 2017.



Strategic Rebalancing Allocation



Commonly-used heuristics and trend-based rules (Arnott & Lovell 1993)

- Rebalancing With Frequency (monthly, quarterly and annually)
- Fraction of stocks is outside of the $60\pm2\%$ and $60\pm4\%$ range
- Rebalance only when the trend direction now is in the opposite direction of a t months ago (1, 3 and 12 months)

Strategic Rebalancing Allocation



Table 2: Rebalancing With Frequency- and Threshold Rules

We show results for frequency- (monthly, quarterly, annual) and threshold-based ($60\pm2\%$ and $60\pm4\%$) rebalancing rules. We consider a full, half, or quarter rebalancing toward the 60-40 capital allocation mix. We report in the different blocks: the average and standard deviation of the stock allocation, noting that the bond allocation is 100% minus the bond allocation (block 1); the fraction of months and annualized amount of rebalancing, and annualized trading costs (block 2); the average and standard deviation of the return, as well as the ratio (block 3); and the change in the drawdown level for the five worst drawdowns (ΔDD) at the trough, compared to a 100% allocation to the monthly-rebalanced 60-40 portfolio (block 4). Data are from 1960 to 2017.

	Monthly			Quarterly			Annual			2% threshold			4% threshold		
	Full	Half	Quarter	Full	Half	Quarter	Full	Half	Quarter	Full	Half	Quarter	Full	Half	Quarter
Stock allocation (avg)	60.0%	60.1%	60.2%	60.1%	60.3%	60.6%	60.4%	61.1%	62.2%	60.2%	60.4%	60.5%	60.5%	61.1%	61.4%
Stock allocation (std)	0.0%	0.7%	1.4%	1.3%	1.7%	2.5%	2.9%	3.3%	4.1%	0.9%	1.2%	1.7%	1.7%	1.9%	2.3%
%months rebal	100.0%	100.0%	100.0%	33.3%	33.3%	33.3%	8.3%	8.3%	8.3%	15.8%	23.0%	34.5%	6.6%	9.3%	14.2%
Rebal trade (ann)	10.2%	6.2%	4.2%	6.6%	3.9%	2.5%	3.6%	1.8%	1.1%	5.2%	3.9%	3.1%	3.7%	2.6%	2.1%
Cost estimate (ann)	4.4 bps	2.7 bps	1.8 bps	2.9 bps	1.7 bps	1.1 bps	1.6 bps	0.8 bps	0.5 bps	2.3 bps	1.7 bps	1.4 bps	1.6 bps	1.1 bps	0.9 bps
Return (ann)	9.1%	9.2%	9.2%	9.2%	9.2%	9.2%	9.3%	9.2%	9.1%	9.1%	9.2%	9.2%	9.2%	9.2%	9.2%
Volatility (ann)	9.8%	9.8%	9.8%	9.8%	9.8%	9.8%	9.8%	9.8%	10.0%	9.9%	9.8%	9.8%	9.8%	9.9%	9.9%
Ret/Vol (ann)	0.93	0.94	0.94	0.94	0.95	0.94	0.95	0.94	0.92	0.93	0.94	0.94	0.93	0.94	0.94
ΔDD Jun 1970	0.0%	0.1%	0.1%	0.1%	0.3%	0.2%	0.5%	0.2%	-0.7%	-0.2%	0.0%	0.1%	-0.2%	0.2%	-0.2%
ΔDD Sep 1974	0.0%	0.2%	0.6%	0.5%	0.9%	1.3%	1.3%	1.7%	1.4%	0.0%	0.4%	0.7%	0.4%	0.4%	0.6%
ΔDD Nov 1987	0.0%	0.1%	-0.3%	0.5%	-0.2%	-1.0%	-2.3%	-2.2%	-2.4%	-0.4%	-0.2%	-0.3%	-0.7%	-0.7%	-0.7%
ΔDD Sep 2002	0.0%	0.4%	0.9%	1.2%	1.5%	1.9%	1.7%	1.9%	-0.1%	-0.2%	0.5%	1.2%	0.0%	1.1%	1.3%
ΔDD Feb 2009	0.0%	0.8%	1.8%	0.9%	2.1%	3.0%	2.8%	3.2%	2.9%	0.2%	1.1%	2.0%	0.0%	1.1%	1.9%
ΔDD average	0.0%	0.3%	0.6%	0.6%	0.9%	1.1%	0.8%	0.9%	0.2%	-0.1%	0.4%	0.8%	-0.1%	0.4%	0.6%

Strategic Rebalancing Allocation



Table 3: Strategic Rebalancing With Stock-Bond Trend Rules

We show results when rebalancing is delayed if the stock-bond trend is negative, positive, or continues to be of the same sign (in which case rebalancing only occurs if the trend just changed sign). In months with no delay, there is a rebalancing half-way toward the 60-40 asset mix. The trend direction is determined by comparing the return over the past 1-, 3-, and 12-months to the typical (average) return over 1-, 3-, and 12-month windows. We report in the different blocks: the average and standard deviation of the stock allocation, noting that the bond allocation is 100% minus the bond allocation (block 1); the fraction of months and annualized amount of rebalancing, and annualized trading costs (block 2); the average and standard deviation of the return, as well as the ratio (block 3); and the change in the drawdown level for the five worst drawdowns (ΔDD) at the trough, compared to a 100% allocation to the monthly-rebalanced 60-40 portfolio (block 4). Data are from 1960 to 2017.

	Delay if 1m trend			Delay if 3m trend			Delay if 12m trend		
	Negative	Positive	Continues	Negative	Positive	Continues	Negative	Positive	Continues
Stock allocation (avg)	59.3%	61.0%	60.0%	58.9%	61.5%	60.2%	58.1%	61.6%	59.9%
Stock allocation (std)	2.2%	1.6%	2.3%	2.6%	2.3%	2.8%	3.9%	2.5%	4.9%
%months rebal	49.3%	50.7%	48.3%	48.0%	52.0%	25.6%	42.2%	57.8%	12.6%
Rebal trade (ann)	4.0%	4.5%	3.8%	3.5%	4.4%	2.7%	4.5%	4.3%	1.7%
Cost estimate (ann)	1.7 bps	1.9 bps	1.7 bps	1.5 bps	1.9 bps	1.2 bps	1.9 bps	1.9 bps	0.7 bps
Return (ann)	9.1%	9.2%	9.1%	9.1%	9.2%	9.1%	9.0%	9.2%	9.1%
Volatility (ann)	9.6%	9.9%	9.7%	9.5%	10.0%	9.7%	9.4%	10.0%	9.7%
Ret/Vol (ann)	0.95	0.93	0.94	0.96	0.93	0.94	0.96	0.92	0.94
ΔDD Jun 1970	0.5%	-0.1%	0.3%	0.7%	-0.1%	0.4%	0.7%	0.0%	0.3%
ΔDD Sep 1974	1.6%	0.2%	1.2%	1.6%	0.1%	1.1%	3.0%	0.2%	2.5%
ΔDD Nov 1987	0.3%	-2.2%	-1.8%	0.3%	-2.2%	-1.7%	0.5%	-1.9%	-1.7%
ΔDD Sep 2002	1.8%	0.2%	1.3%	2.0%	0.2%	1.4%	5.2%	0.2%	4.8%
ΔDD Feb 2009	4.2%	0.7%	3.5%	4.8%	0.7%	3.6%	5.6%	0.8%	5.6%
ΔDD average	1.7%	-0.2%	0.9%	1.9%	-0.2%	0.9%	3.0%	-0.1%	2.3%

Trend Strategy vs Strategic Rebalancing



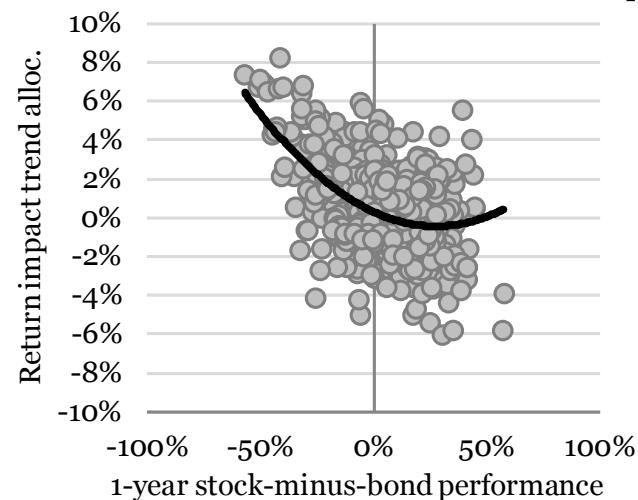
Trend Strategy:

- 1-year return with a 10% allocation to a 12-month stocks and bonds (equal risk) trend strategy

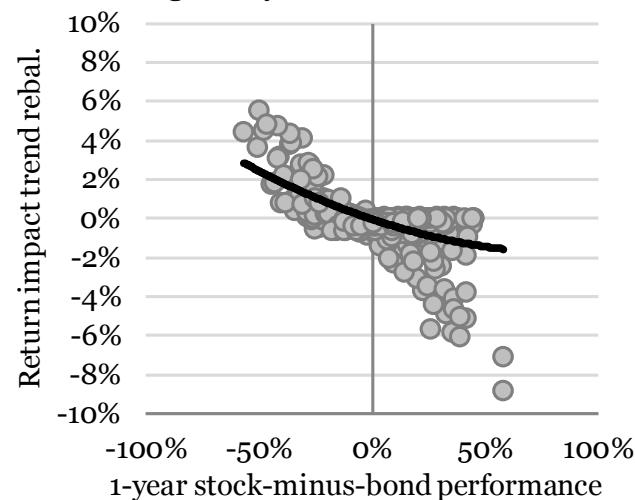
Strategic Rebalancing:

- delay rebalancing if the 12-month stock-bond spread trend is negative

Trend allocation (10% 12m trend, stock&bond equal risk)



Strategic rebalancing (delay if 12m stock-bond trend neg.)

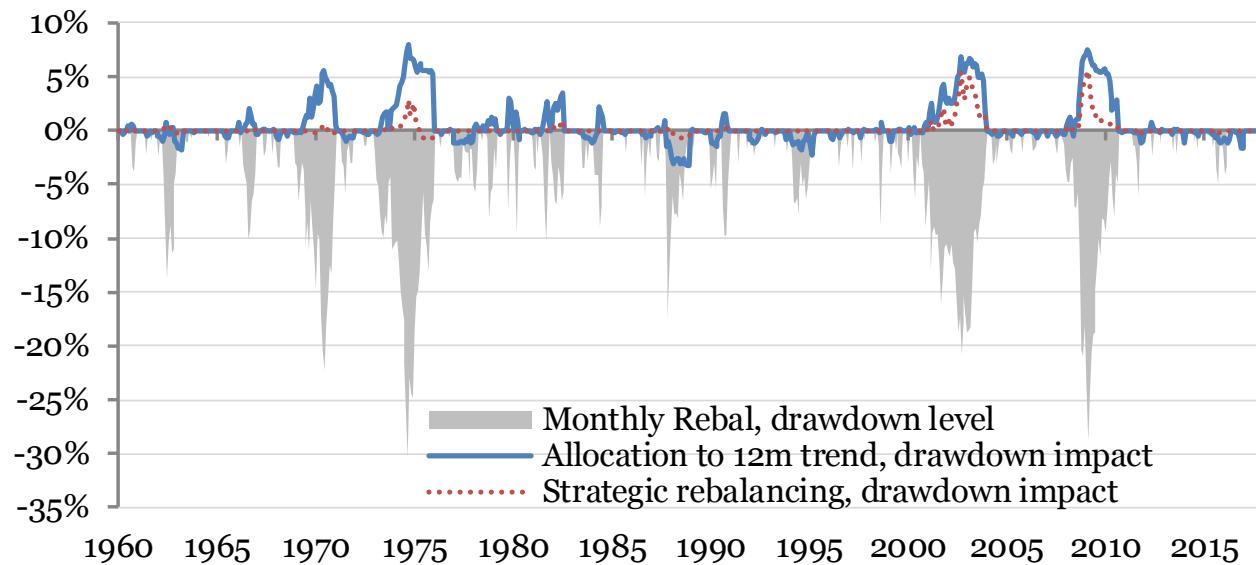


Trend Strategy vs Strategic Rebalancing



Figure 8: Impact of Adding a Trend Exposure on the Portfolio Drawdown Level

In this figure, we show the drawdown level of a monthly rebalanced 60-40 stock-bond portfolio (blue line) and the impact (change in drawdown level) when adding a trend exposure for the period 1960 to 2017. We consider a 10% allocation to a 12-month stocks and bonds (equal risk) trend strategy and a strategic rebalancing rule to delay rebalancing when the 12-month stock-bond trend is negative (i.e., the return is below the average stock-bond 12-month return). Other statistics for these trend exposures can be found in Table 1, Panel C for the trend allocation and Table 3 for the stock-bond trend rebalancing rule.



Conclusion



"We show that the negative convexity induced by rebalancing is effectively countered with a trend exposure, which exhibits positive convexity and can be either implemented as a direct allocation to a trend strategy or with a strategic trend- based rebalancing rule."