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Technical Analysis with a Long-Term Perspective:

Trading Strategies and Market Timing Ability

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The paper in a nutshell

- Goals of the paper
  - Provide new empirical evidence on the profitability of technical analysis, in particular a new set of trading rules based on moving averages.
  - Analyze if the use of leverage (with debt or options) improves the performance of these strategies.
  - Provide a new test of market timing

- Results and contributions
  - Trading rules are simulated on daily returns of the S&P 500 over the period 1990-2008.
  - Complex trading rules limit the impact of data-snooping problems, outperform the simple buy-and-hold strategy and are consistent with bull and bear markets.
  - Optimal lag of the long moving average is much longer than those usually investigated in the literature (400 days).
  - Leverage with debt improves the performance. With options the results are mitigated.

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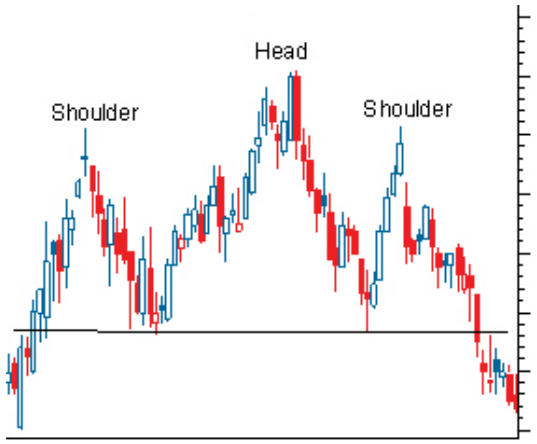
Motivation

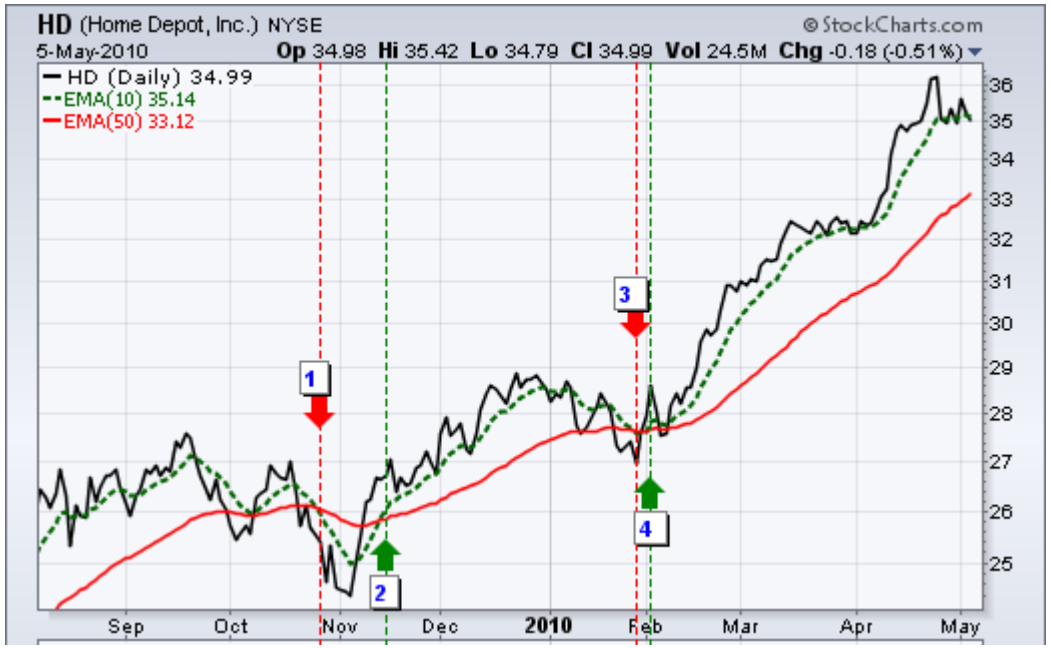
- Technical analysis encompasses a wide range of techniques that are supposed to be able to predict the future evolution of asset prices.
- These techniques are widely used by market participants, in particular in equity and forex markets.
- These techniques can be divided in two groups:
  - Charting trading systems, based on the occurrence of specific figures in charts of the evolution of past stock prices.
  - Example: Head-and-shoulder figure



Source: Chart by MetaStock

Motivation (cont'd)

- Technical trading systems, quantitative rules trying to filter past prices to identify future trends
- Example: (Double) Moving averages (MA)



source:StockCharts.com

- Do these rules provide accurate forecasts and do they help to generate abnormal profits/returns?

Literature

- Academic literature is very skeptical about the usefulness of these methods:
  - No theoretical justification
  - Difficult to understand, specific vocabulary/expression
  - Difficult to refute since the choice of parameters is subjective
  - Exact opposite of the weak-form market efficiency

- Early literature 1960-1990 generally concluded that these techniques (trading rules) are not able to forecast future prices and generate abnormal profits.

- Lo, Mamayski, Wang (2000) investigate charting methods, have some forecasting ability but not enough to generate abnormal profits.

Literature (cont'd)

- Brock, Lakonishok and LeBaron (1992) analyze 26 simple MA rules over 100 years of Dow Jones prices and find that they have predictive power and are able to generate abnormal returns.

- These results were criticized on the grounds that:
  - They don't consider transaction costs (Bessembinder and Chan(1998).
  - They are subject to data-snooping bias (Sullivan, Timmermann and White (1999).

- ….and are therefore impossible to achieve from an investor point of view.

Literature (cont'd)

- The impact of data-snooping can be reduced in different ways:
  - With tests methodologies that directly take into account the data-snooping problem (White (2000), Romano and Wolf (2005) and Hsu, Hsu and Kuan (2010)).
  - With an out-of-sample approach initiated by Lukac, Irwin and Brorsen (1988) and Sullivan, Timmermann and White (1999).
  - Use complex rules, that combine different MA parameterizations on objective grounds as proposed by Skouras (2001) and Hsu and Kuan (2005).

MA rules

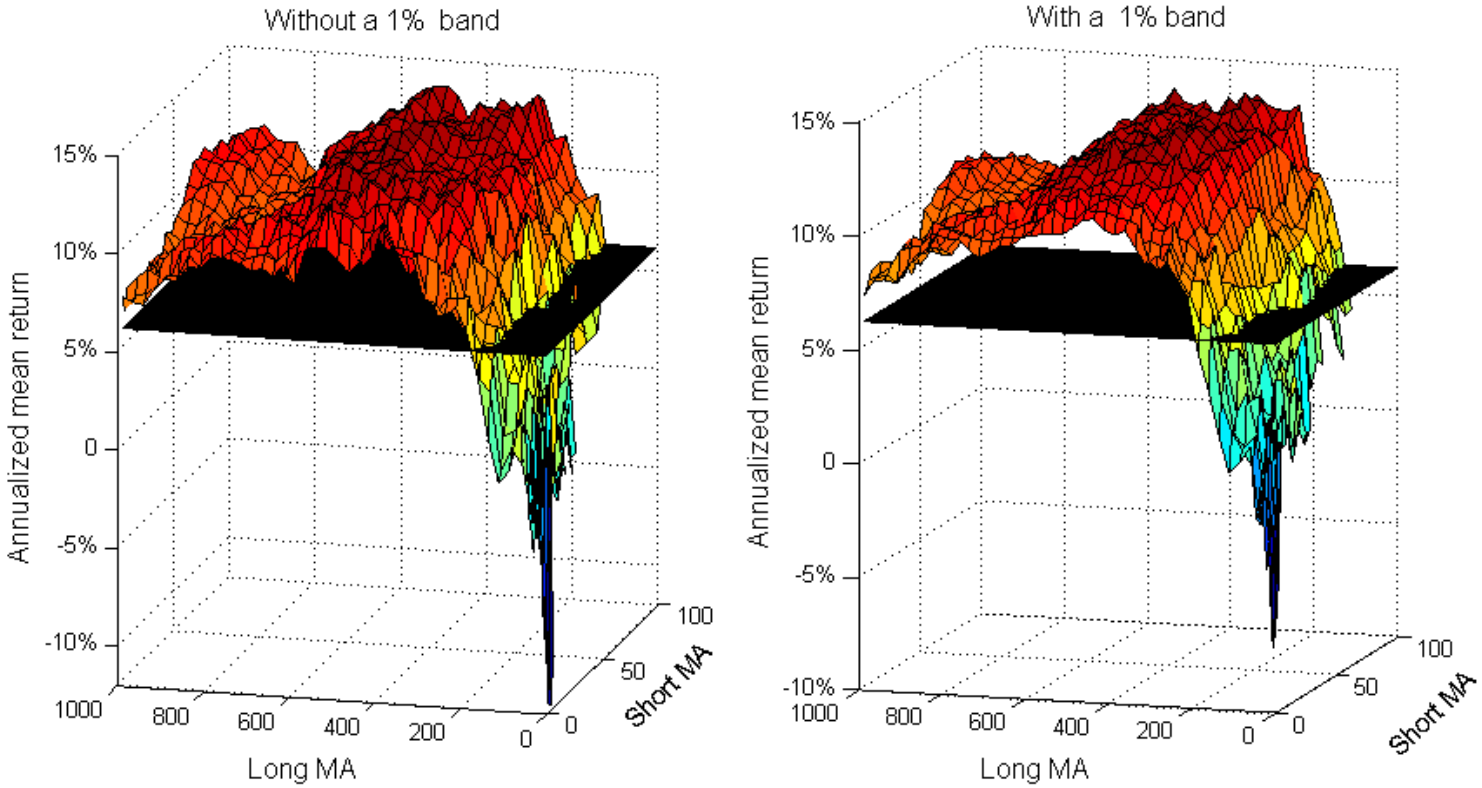
- Our paper investigates the profitability of complex trading rules based on MA on the S&P 500 index over the period 1990-2008

- The trading rule is the following:
  - Each day we compute two MA: a long MA (e.g. 200 days) and a short MA (e.g. 50 days).
  - If the short MA>long MA -> a buy signal is generated for the next day.
  - If the short MA<long MA -> a sell signal is generated for the next day.

- We investigate 1876 different combinations of parameters for the short and long MA.

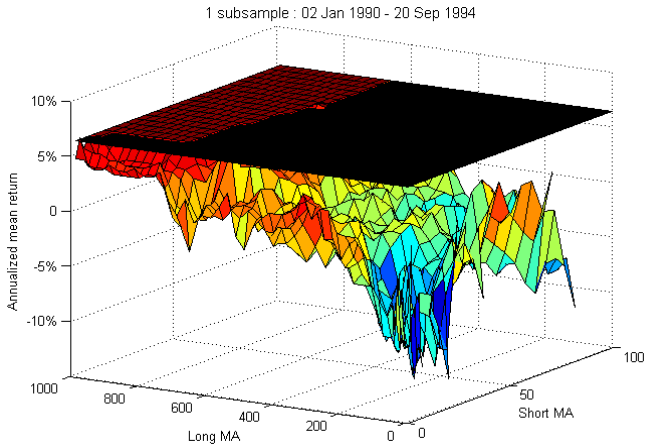
Preliminary results

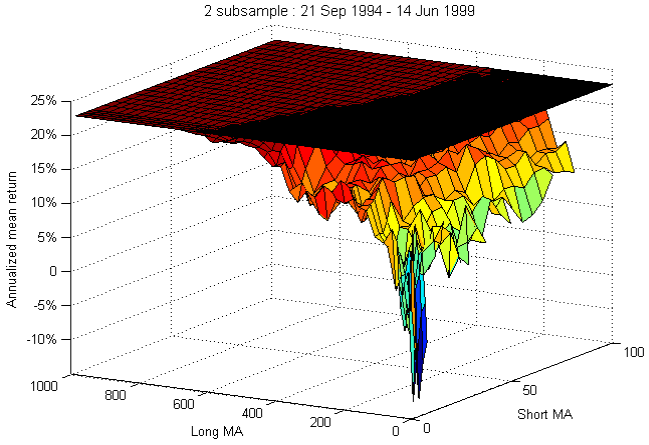
- (in-sample) Performance of simple MA rules

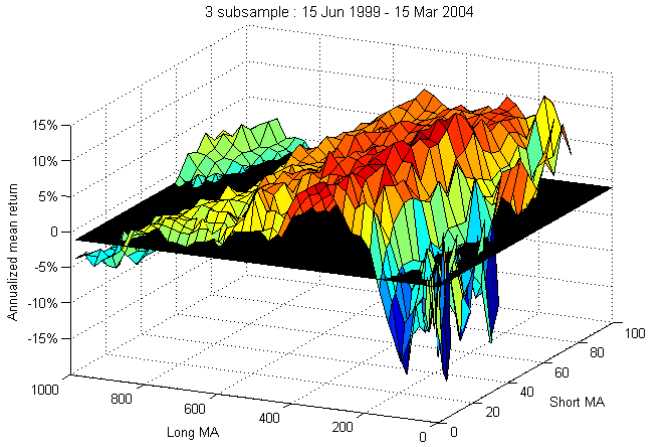


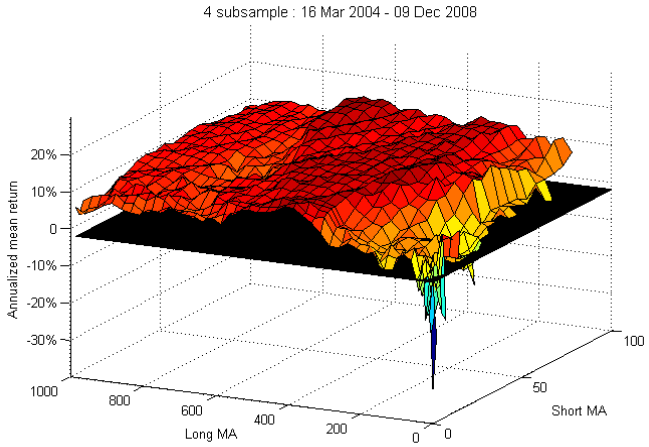
Preliminary results (cont'd)

- (in-sample) Performance of simple MA rules over sub-samples









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The trading systems

- We allow the long MA to take values up to 4 years (990 days) in order to capture long-term trends since:
  - They might be easier to discover and to take advantage than short-term trends
  - Might correspond to the strategy of a long-term investor

- We use an out-of-sample approach that has four set of periods:

	Selection period	Evaluation period
Set 1:	Jan. 1990-Jan. 1994	Jan. 1994-Dec. 1997
Set 2:	Jan. 1994-Dec. 1997	Dec. 1997-Jan. 2002
Set 3:	Dec. 1997-Jan. 2002	Jan. 2002-Jan. 2006
Set 4:	Jan. 2002-Jan. 2006	Jan. 2006-Dec. 2008

The trading systems (cont'd)

- We investigate 4 trading systems that combine simple MA rules
  - OPT-ALL
    - It is a continuous recursive process, that computes each day the cumulative return of the 1876 rules and selects the best one.
  - OPT-4
    - Selects the rule with the highest cumulative return over the selection period and keeps it over the whole evaluation period
  - VOTE
    - Counts the number of buy, sell and neutral signals of trading that had a higher cumulative returns than the buy-and-hold over the selection period and takes the position with the highest number of "votes".
  - PARTIAL
    - Same as VOTE but with a partial investment according to the number of votes

- We compare them to the buy-and-hold (BH), random walk (RW) and BEST, best in sample rule (465,60).

Results

- Performance of complex trading rules

	BH	RW	BEST	OPT-ALL	OPT-4	VOTING	PARTIAL
Nb Buy	3761	1999	2893	2907	2872	2924	2924
% Right Buy	0.531	0.513	0.546	0.542	0.547	0.544	0.544
Nb Sell		1758	868	853	889	837	837
% Right Sell		0.446	0.518	0.505	0.517	0.511	0.511
% Right Strategy	0.531	0.482	0.540	0.534	0.540	0.537	0.537
Strategy	0.062	-0.086	0.143	0.107	0.146	0.120	0.115
t-statistics		*-2.10*	*1.16*	*0.65*	*1.20*	*0.83*	*0.78*
Strategy Compounded	0.044	-0.099	0.133	0.093	0.136	0.107	0.103
Nb Trades	1	3895	7	39	11	7	11.54
Break Even TC		-0.001	0.174	0.017	0.115	0.125	0.069
Volatility Strategy	0.192	0.192	0.192	0.192	0.192	0.192	0.183
Beta	1.00	-0.15	-0.08	-0.04	-0.09	-0.03	-0.03
t-statistics		*-9.07*	*-4.68*	*-2.75*	*-5.74*	*-2.12*	*-1.92*
Alpha		-0.110	0.116	0.079	0.120	0.092	0.087
t-statistics		*-2.25*	*2.35*	*1.59*	*2.42*	*1.85*	*1.83*
Sharpe Ratio	0.168	-0.599	0.594	0.404	0.609	0.472	0.467

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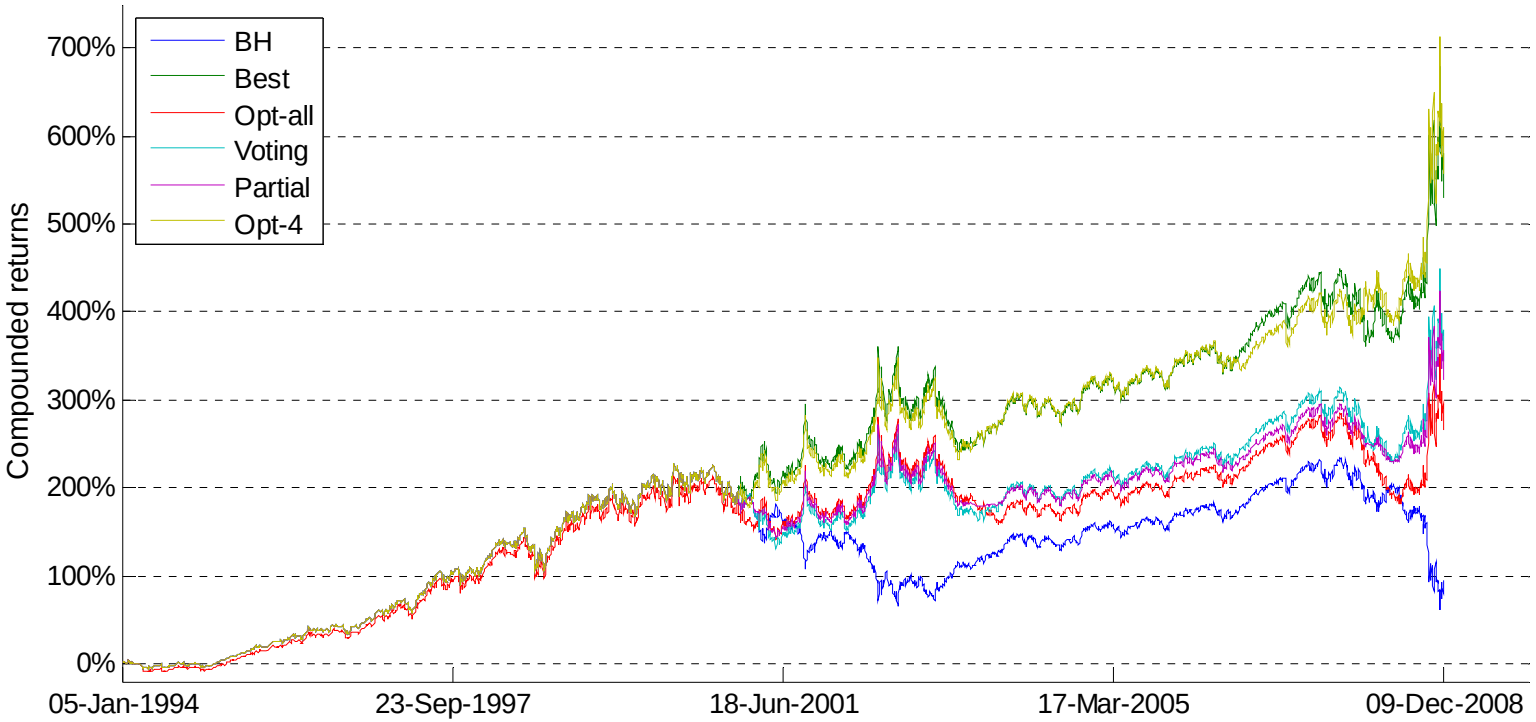
Results (cont'd)

- Complex rules compounded returns



Results

- Out of sample performance of the OPT-4 strategy

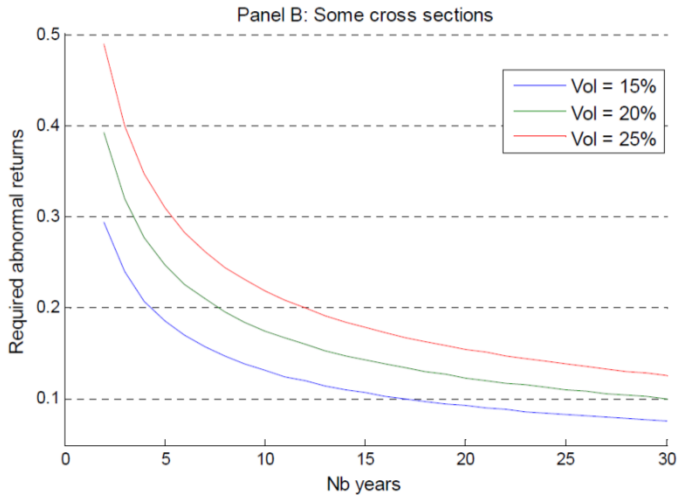
	01.1994-12.1997	12.1997-01.2002	01.2002-01.2006	01.2006-12.2008
Long MA	665	515	415	240
Short MA	65	35	25	50
Selected Rule	0.187	0.129	0.104	0.120
Mean Others	0.156	0.068	0.051	0.074
% High	0.001	0.089	0.027	0.026
% Low	0.557	0.909	0.972	0.973

A new test of market timing

- Current tests, more specifically (Student t) tests on means difference may lack power.

$$\frac{\overline{r_{strategy}} - \overline{r_{benchmark}}}{\sqrt{2 \cdot \frac{Var}{N}}} = \frac{\overline{r_{strategy}} - \overline{r_{benchmark}}}{\sqrt{2 \cdot \frac{0.0001461}{3761}}} = 1.96 \rightarrow \overline{r_{strategy}} - \overline{r_{benchmark}} = 0.0005463$$

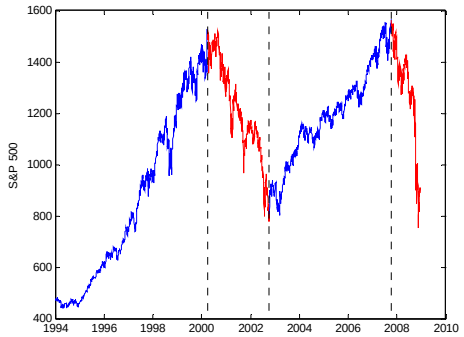
$$\rightarrow 0.000546 \times 252 = 13.75\%$$



A new test of market timing (cont'd)

- We propose a new test to identify whether the strategy generates signals that correspond to the market phase.

- We first identify peak and throughs of the market evolution with the Pagan-Sossounov (2003) procedure.



- We then compute the % of right (buy-bull, sell-bear) signals according to these phases. This percentage is block-bootstrapped to find p-values.

Results

- Market-timing tests results

	BEST	OPT-ALL	OPT-4	VOTING	PARTIAL
Nb Buy	2892	2906	2871	2923	2923
Nb Sell	868	853	889	837	837
% Buy-Bull	0.924	0.902	0.930	0.918	0.918
p value 1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
p value 2	*0.111*	*0.145*	*0.091*	*0.123*	*0.137*
% Sell-Bear	0.702	0.619	0.740	0.650	0.650
p value 1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
p value 2	*0.015*	*0.042*	*0.007*	*0.045*	*0.045*
% Right	0.869	0.832	0.883	0.852	0.852
p value 1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
p value 2	*0.000*	*0.009*	*0.001*	*0.002*	*0.001*
% Wrong	0.131	0.168	0.117	0.148	0.148
p value 1	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*
p value 2	*1.000*	*0.991*	*0.999*	*0.998*	*0.999*

Note: p-value 1 (2) is for a block bootstrap of 40 (470) days

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Use of leverage

- If trading strategy has some predictive power, the use of leverage should provide higher returns.
- Leverage is used in practice (e.g. CTAs) and allows to take advantage of positive returns
- We use:
  - Debt leverage (investment of 200% if buy signal with 100% borrowed, and -200% if sell signal)
  - Options (5%,10%,15% of the capital invested in call/put options according to the signal).

Results

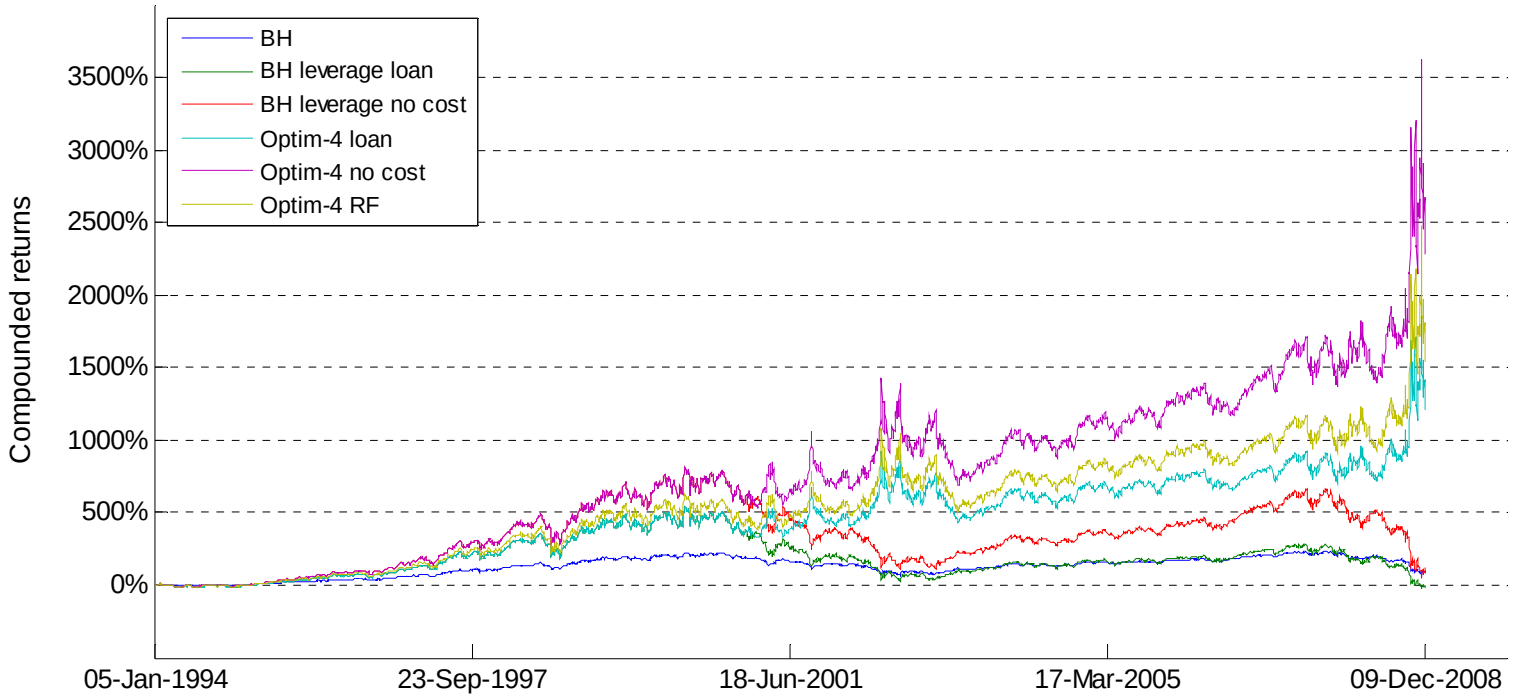
- Debt leverage (borrowing rate US bank prime rate)

Panel A: Borrowing rate = US Bank prime loan

	BH	OPT-ALL	OPT-4	VOTING	PARTIAL
Strategy	0.073	0.162	0.249	0.197	0.187
t-statistics		*0.63*	*1.25*	*0.88*	*0.83*
Strategy Compounded	0.000	0.092	0.191	0.130	0.127
Volatility Strategy	0.384	0.384	0.383	0.384	0.367
Beta	2.000	-0.09	-0.186	-0.069	-0.06
t-statistics	*22418*	*-2.75*	*-5.73*	*-2.12*	*-1.92*
Alpha	-0.020	0.136	0.226	0.169	0.160
t-statistics	*-75*	*1.37*	*2.28*	*1.71*	*1.68*
Sharpe Ratio	0.115	0.346	0.573	0.436	0.430

Results (cont'd)

- OPT-4 strategy compound returns with debt leverage



Results (cont'd)

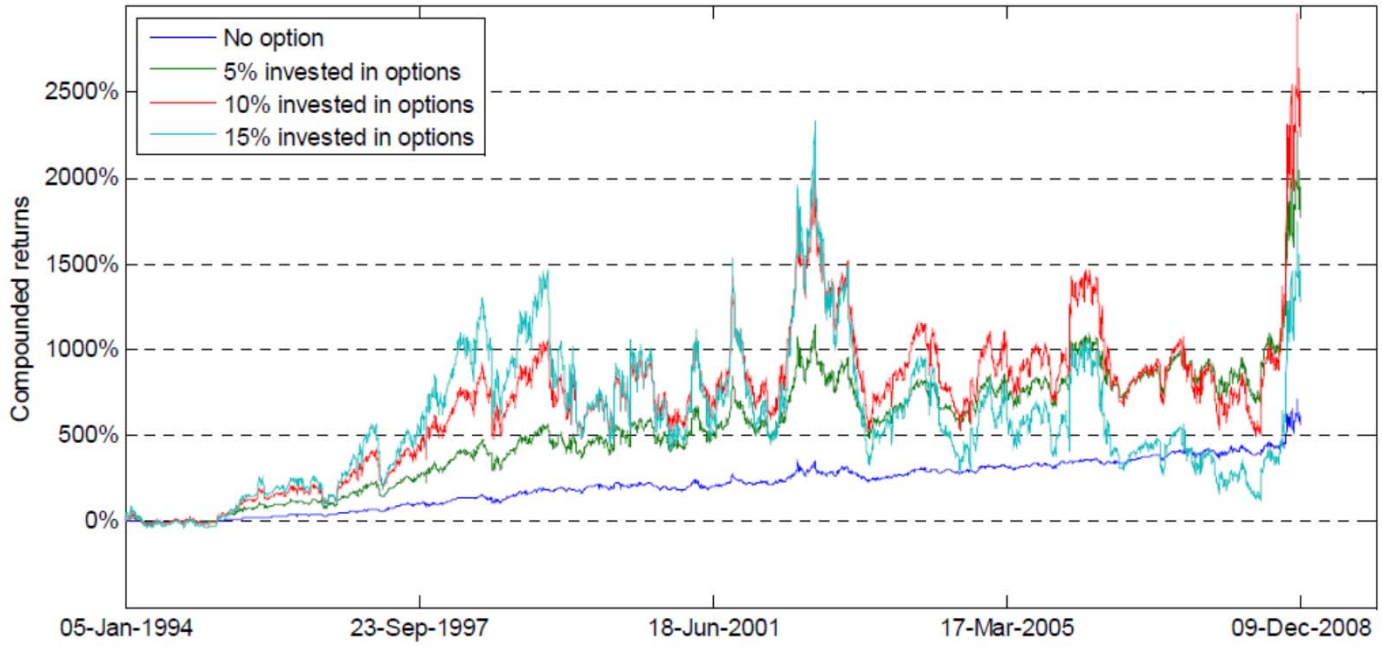
- Leverage with 15% of options

Panel C: 15% of options

	BH	OPT-ALL	OPT-4	VOTING	PARTIAL
Strategy	0.098	0.298	0.536	0.380	0.379
Strategy Compounded	-0.242	-0.059	0.192	0.007	0.066
Volatility Strategy	0.909	0.890	0.893	0.914	0.832

Results (cont'd)

- OPT-4 strategy compound returns with option leverage



Alternative performance measures

$$\beta^{-} = \frac{\operatorname{cov}\left(R, R_{BH} \,|\, R_{BH} < 0)\right)}{\operatorname{var}\left(R_{BH} \,|\, R_{BH} < 0\right)}, \tag{7}$$

$$\beta^{+} = \frac{\operatorname{cov}\left(R, R_{BH} \,|\, R_{BH} > 0)\right)}{\operatorname{var}\left(R_{BH} \,|\, R_{BH} > 0\right)}, \tag{8}$$

$$Sortino = \frac{\bar{R}}{\sqrt{\sum_{t=1}^{N}\left(R_t \,|\, R_t < 0\right)^2 \Big/ \sum_{t=1}^{N}\mathbf{1}\{R_t < 0\}}}, \tag{9}$$

$$cosk = \sum_{t=1}^{N}\left(R_t - \bar{R}\right)\left(R_{BH,t} - \bar{R}_{BH}\right)^2 \Big/ N, \tag{10}$$

$$cosk^{-} = \sum_{t=1}^{N}\left[\left(R_t - \bar{R}\right)\left(R_{BH,t} - \bar{R}_{BH}\right)^2 \,|\, R_{BH,t} < 0\right] \Big/ \sum_{t=1}^{N}\mathbf{1}\{R_{BH,t} < 0\}, \tag{11}$$

Alternative performance measures: Results

		β^-	β^+	Sortino	Cosk	Cosk$^-$
Standard	BH	1.00	1.00	0.310	–0.007	–0.250
	OPT-ALL	–0.05	–0.04	0.543	–0.024	0.179
	OPT-4	–0.12	–0.06	0.608	–0.020	0.188
	VOTING	–0.05	–0.02	0.745	–0.026	0.176
	PARTIAL	–0.04	–0.02	0.612	–0.023	0.177
Debt Borrowing cost	BH	2.00	2.00	0.186	–0.013	–0.499
	OPT-ALL	–0.10	–0.08	0.413	–0.048	0.359
	OPT-4	–0.25	–0.12	0.500	–0.040	0.378
	VOTING	–0.09	–0.05	0.638	–0.051	0.352
	PARTIAL	–0.09	–0.03	0.500	–0.045	0.355
Options 15%	BH	3.18	3.92	0.138	0.169	−0.464
	OPT-ALL	0.24	1.19	0.437	0.213	0.484
	OPT-4	−0.10	1.05	0.557	0.212	0.534
	VOTING	0.20	1.25	0.802	0.223	0.488
	PARTIAL	0.28	1.22	0.600	0.199	0.476

Summary and conclusions

- Complex trading rules based on MA rules have good forecasting ability that leads to high performance on the S&P 500 over the period 1990-2008 (where simple MA rules have been shown to be unprofitable).
- Optimal length of the long MA is always above the standard 200 days.
- Leverage with debt improves the profitability while leverage with options only partially because of the high volatility.
- Results are a challenge to weak-form market efficiency.
- May be due to the fact that most market participants have a short-term horizon are not able (or not willing) to exploit these long-term inefficiencies.