

Finding, Exploring, and Refining Trading Strategies: A Case Study

QuantCon, New York, 3.14.15

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FROM IDEA TO EXECUTION

- ▶ What makes a good idea? (And where do good ideas come from?)
- ▶ How to decide if an idea is worth researching?
- ▶ How to move from idea to a trading strategy
- ▶ How to move from a trading strategy into execution

As a researcher, your most valuable asset is your time.

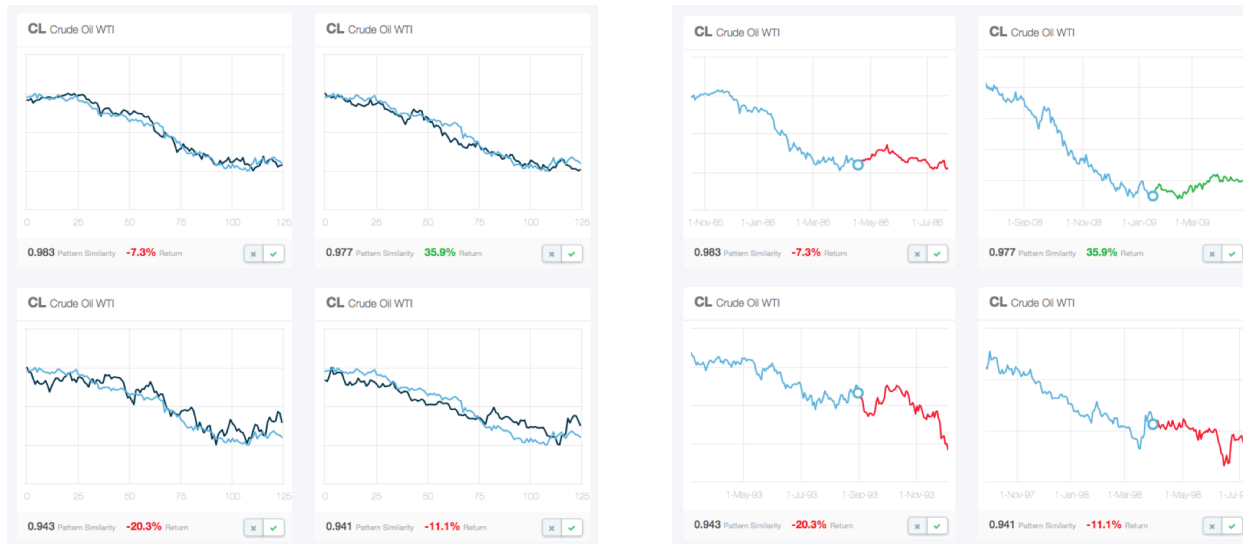
Invest it like you invest your money: thoughtfully and carefully.

GOOD IDEAS

- ▶ Usually some nub, often non-linear
- ▶ An ounce or two of evidence that it might actually work
- ▶ Plus some logic / some believable story for why it working would make sense

Here's the story of Eido as a trading strategy ...

EIDOSEARCH AT A GLANCE



- ▶ A web-based tool for facilitating historical pattern searches
- ▶ Looks for similar patterns in the past to generate a distribution of future returns
- ▶ A generalized expression of technical analysis



HOW DO WE KNOW IF THE CONCEPT WORKS?

- ▶ Jump right into back-testing trading rules incorporating the signals?
 - A common but mostly suboptimal practice
- ▶ Establish a precise mathematical definition of the “concept”
 - What are the parameters and inputs (what’s the difference?)
 - What are the outputs?

$$ES_{\theta}(\mathbf{t}: \text{ticker}, \mathbf{p}: \text{pattern}, \mathbf{f}: \text{forecast})$$

- ▶ Articulate what it means for the concept to “work”
 - In the strictest sense:

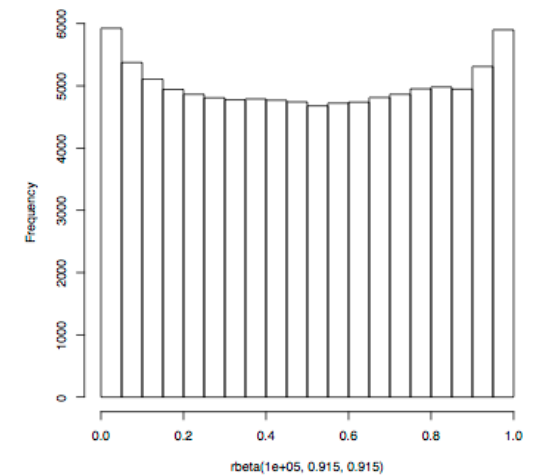
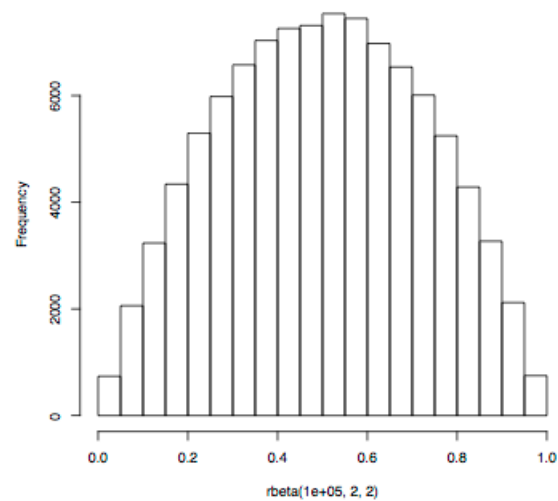
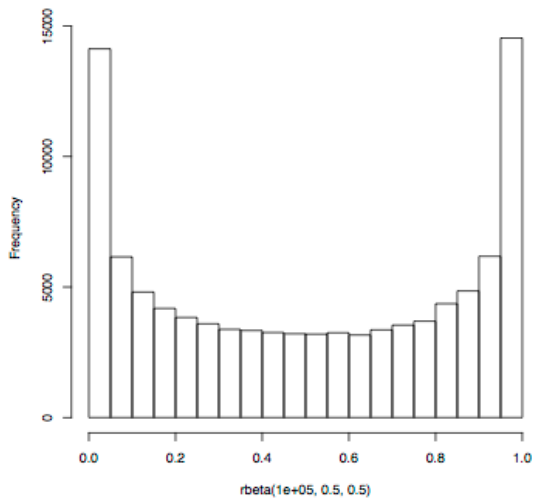
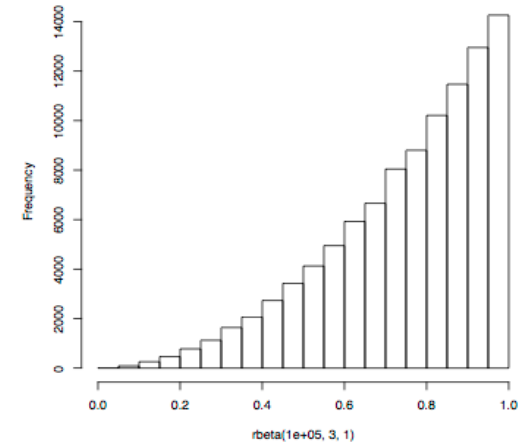
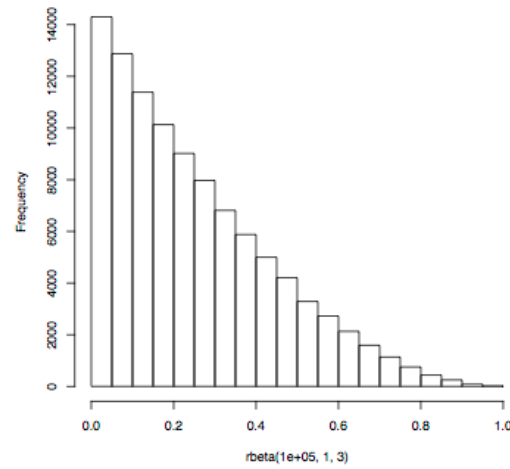
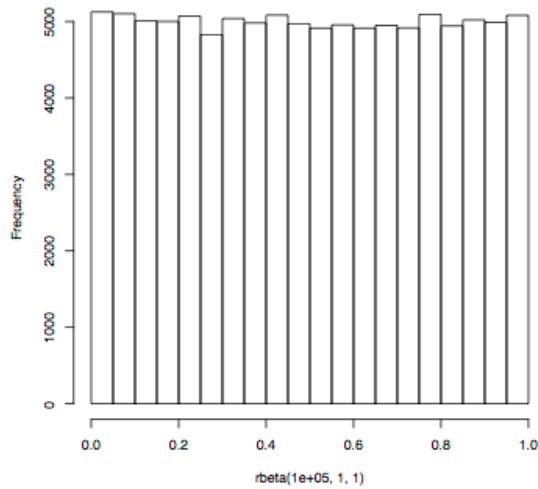
$$H_{ij} : \exists \tilde{\theta} \in \Theta, \text{ s.t. } r(t, f_j) \sim ES_{\tilde{\theta}}(t, p_i, f_j), \forall t \in T$$

- In a less strict sense, the empirical distribution may be usable even with certain biases
- Even if $ES_{\tilde{\theta}}$ is the *true* distribution, we won’t make money on every signal

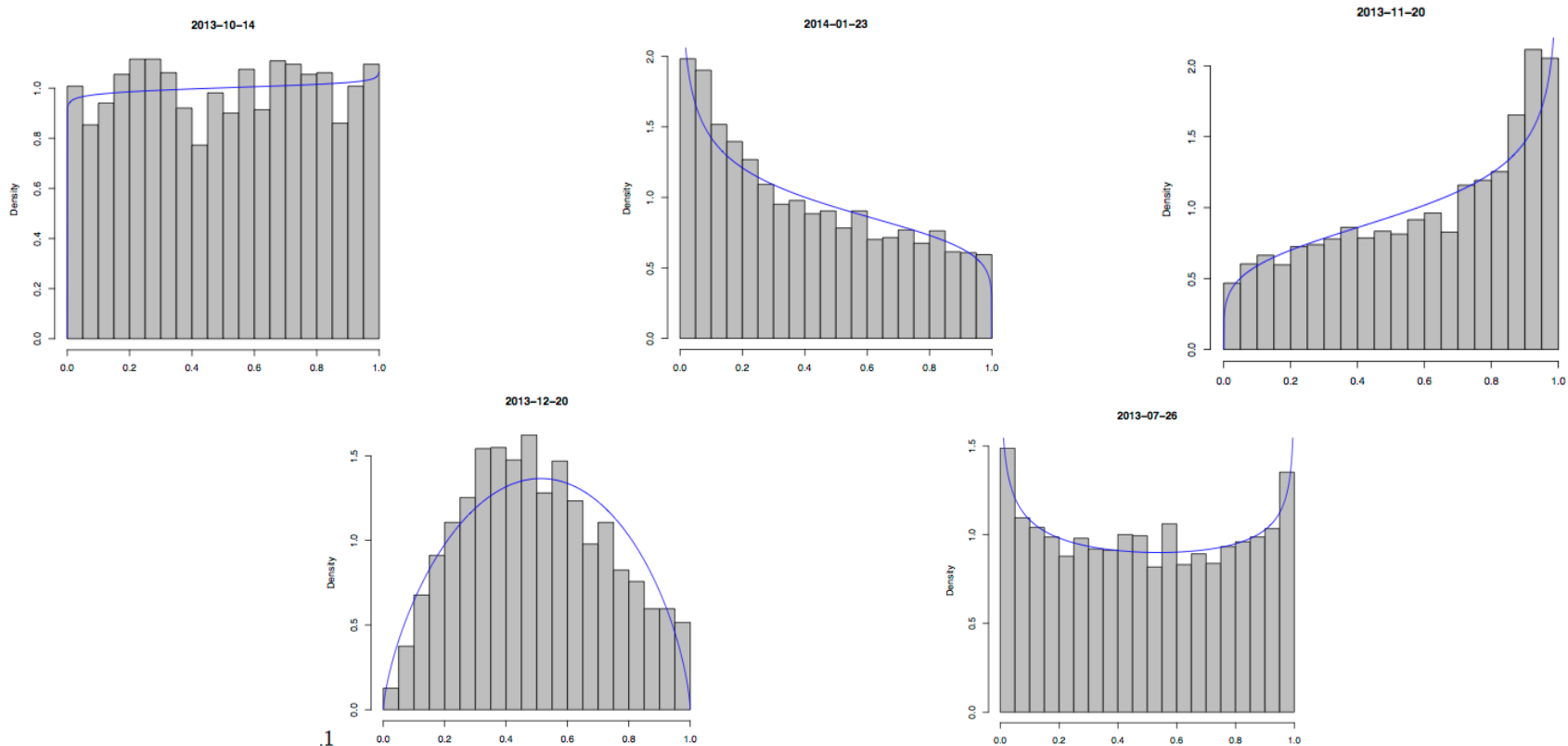
A STRINGENT CHI-SQURE TEST

- ▶ Estimate the parameters and fix the domain of inputs
- ▶ For each pattern window and forecast horizon, generate the empirical distribution for every ticker each day.
- ▶ Calculate the cumulative probabilities $ES_{\tilde{\theta}}(t, p, f)(r(t, f)) \in (0, 1)$
- ▶ Count the number of observations falling into $(0, \frac{1}{k}), (\frac{1}{k}, \frac{2}{k}), \dots, (\frac{k-1}{k}, 1)$
- ▶ For each pattern window and forecast horizon, calculate $Q = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i}$ where $E_i = \frac{n}{k}$. Under the null hypothesis: $Q \sim \chi_{k-1-m}^2$, hence $p\text{-value} = \mathbb{P}(\chi_{k-1-m}^2 > Q)$
- ▶ Penalize p-values for multiple testing across numerous pattern windows and forecast horizons (FWER, FDR, etc.)
- ▶ Analyze the times series of correlated p-values and draw conclusions

A GRAPHICAL INTERPRETATION

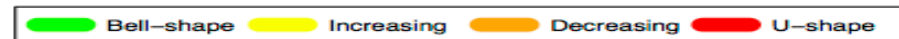
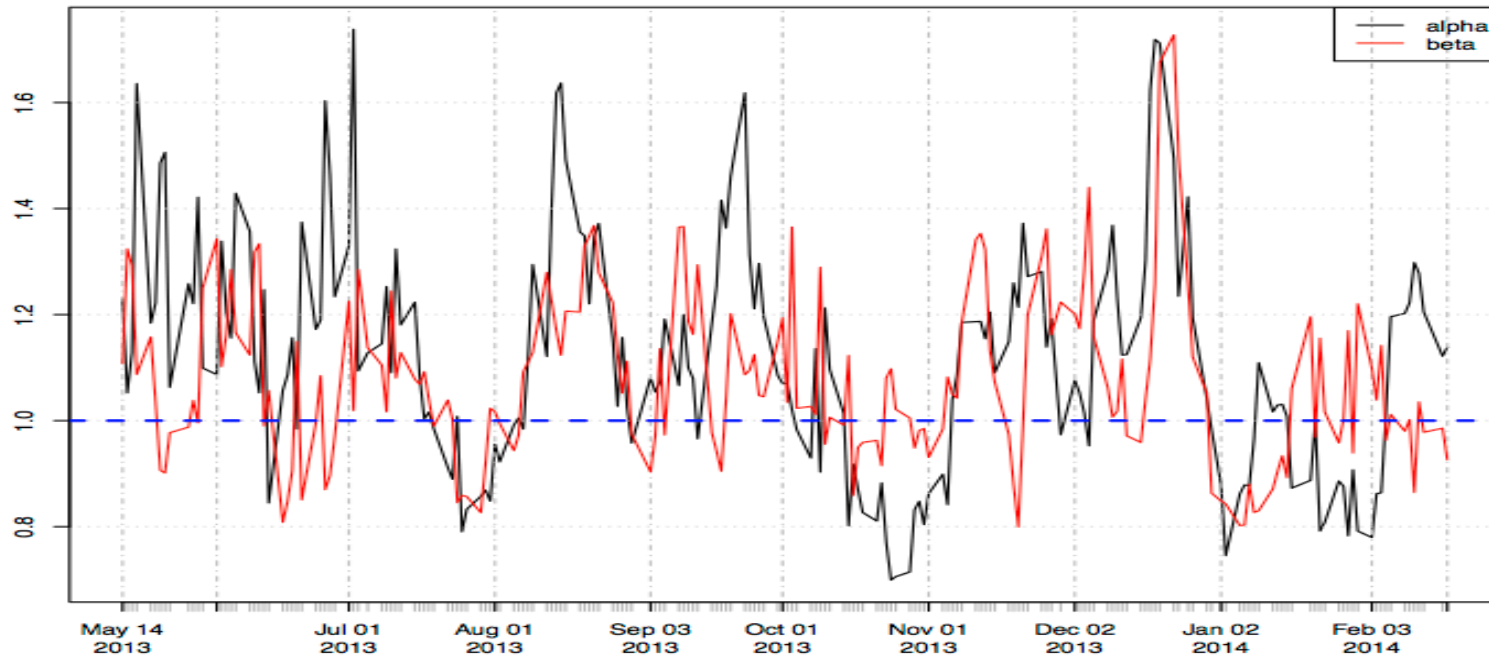


ANYTHING-BUT-U-SHAPE! TEST DESIGN



- ▶ Repeat the first four steps of the Stringent Chi-Square Test
- ▶ On each day, fit a $\text{beta}(a,b)$ distribution using maximum likelihood
- ▶ ... and test the loosened null hypothesis: $a < 0.95$ and $b < 0.95$

ANYTHING-BUT-U-SHAPE! TEST RESULTS



► COOL! But, what now?

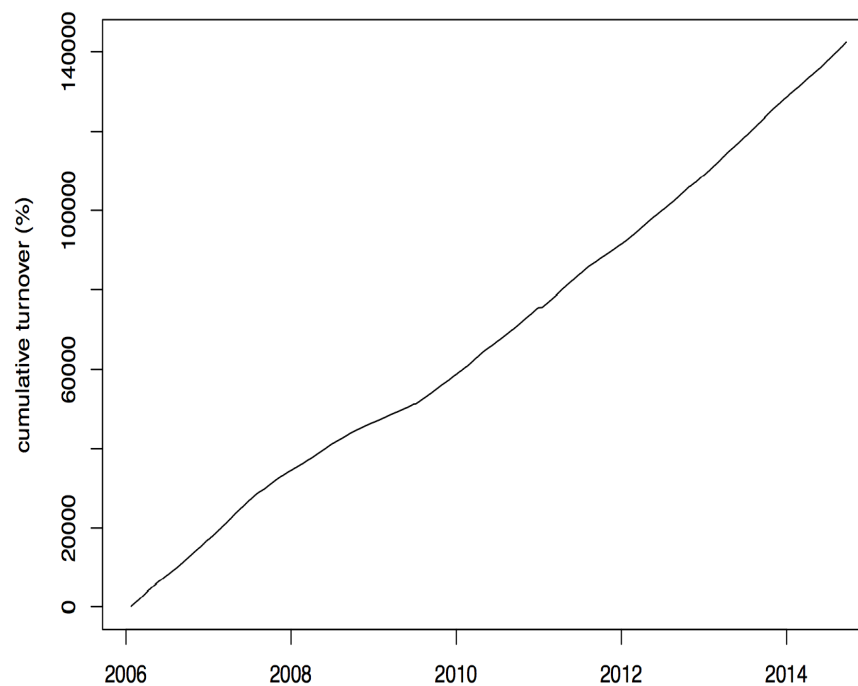
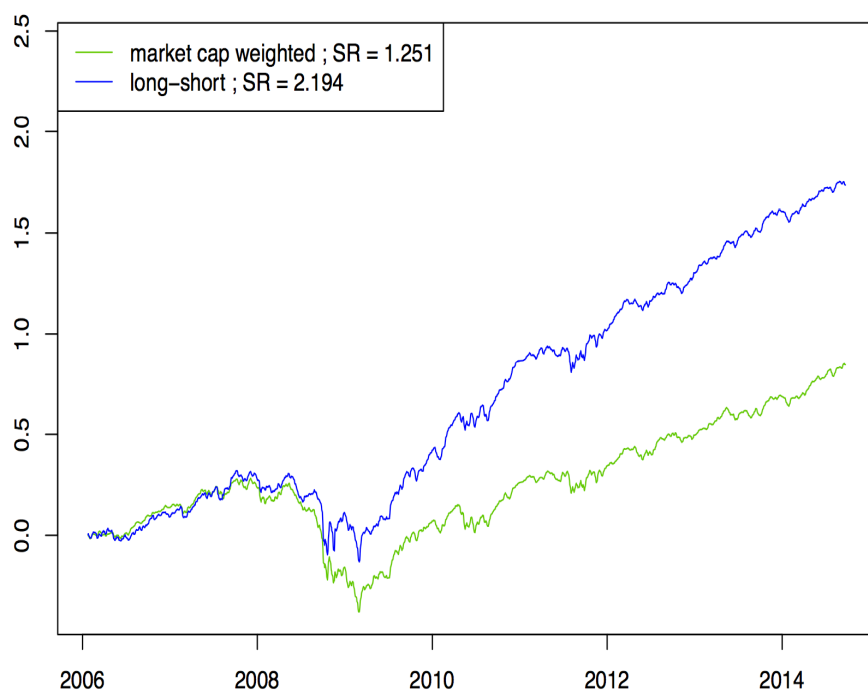
FROM SIGNAL TO STRATEGY

- ▶ You've decided to invest further in an idea; next step is to find a sensible trading strategy
- ▶ Dimensions to think about:
 - ▶ Whether to go long, short, or both
 - ▶ What basket of assets to trade
 - ▶ How strong a signal to require
 - ▶ How many trades to make
 - ▶ What time horizon to hold over
 - ▶ What performance criteria to prioritize
- ▶ Almost always wrong to test everything; possible strategies should be driven by a deep understanding of why you think the strategy works

$$\begin{aligned} &\text{minimize} && \omega^T \Sigma \omega - \gamma \mu^T \omega \\ &\text{subject to} && \sum_i \omega_i = 0 \end{aligned}$$

FIRST LET'S JUST GO WILD!

Cumulative raw return (non-compounded)

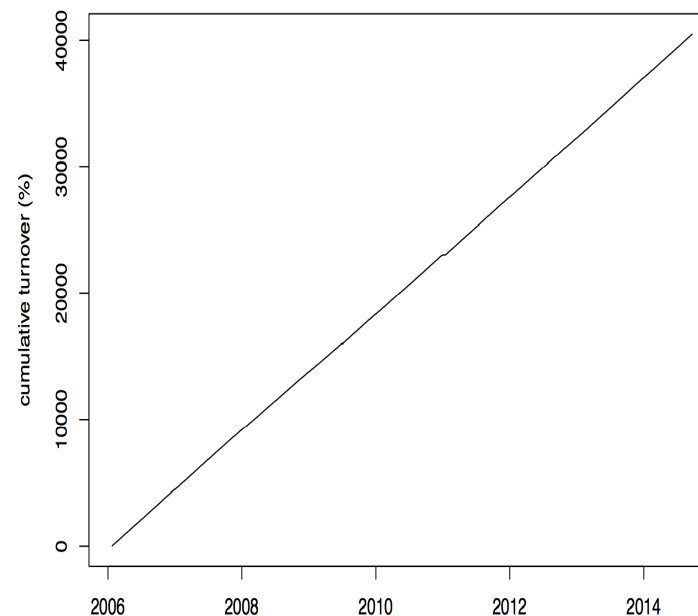
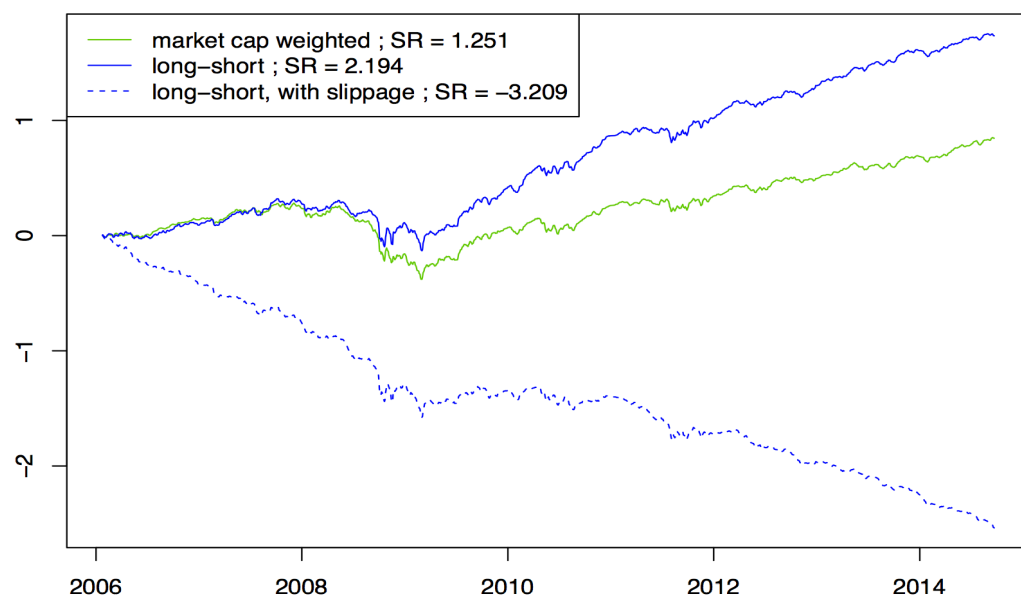


- ▶ Set the base case for portfolio optimization: long-short unconstrained
- ▶ Transaction costs, market frictions, and shattered dreams

$$\begin{aligned} &\text{minimize} && \omega^T \Sigma \omega - \gamma \mu^T \omega \\ &\text{subject to} && \sum_i \omega_i = 1, \omega_i \geq 0, \forall i \end{aligned}$$

BACK-TESTING SHORT SELLING IS DICEY...

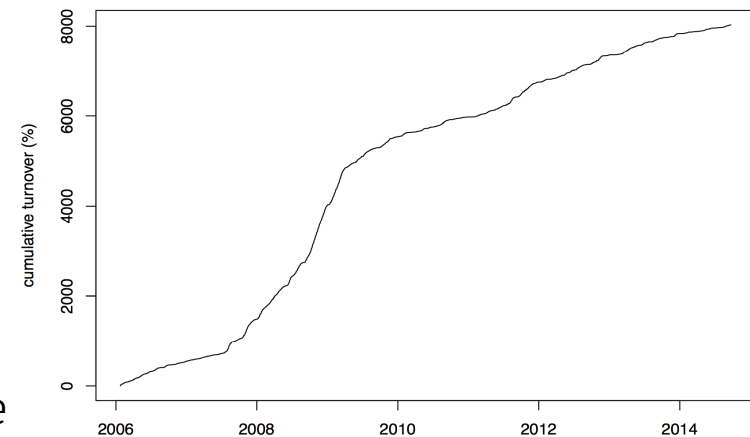
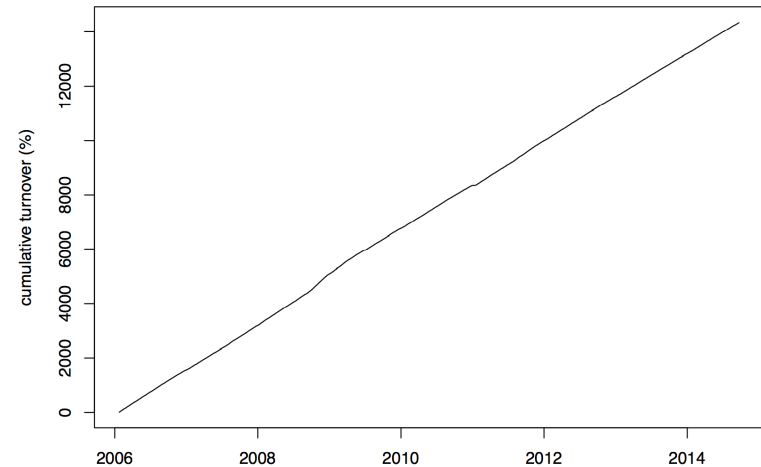
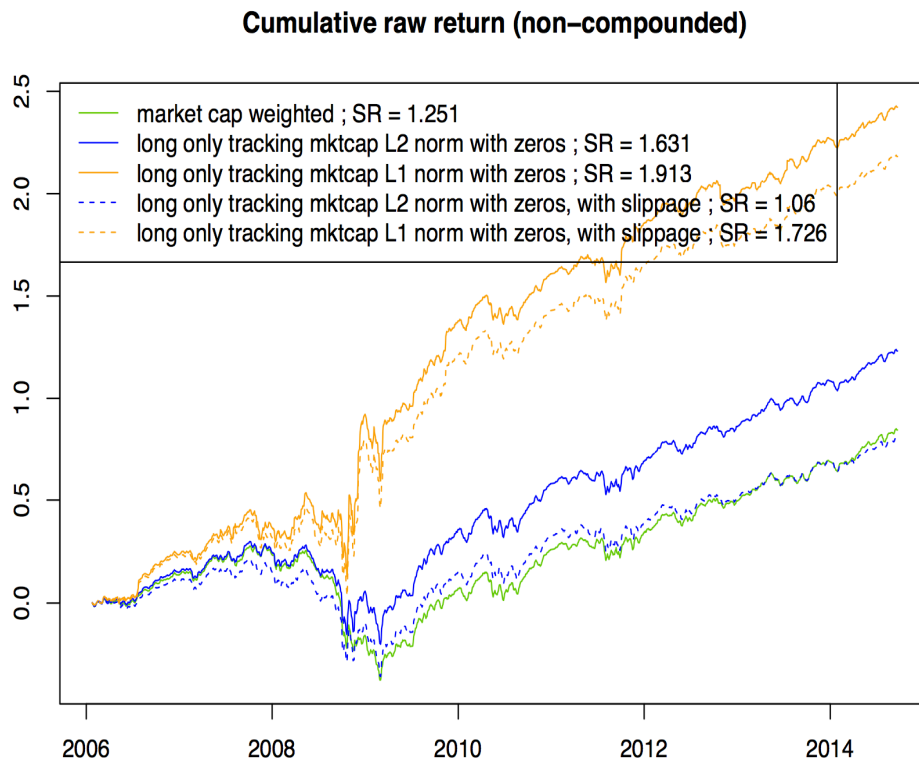
Cumulative raw return (non-compounded)



- ▶ Without reliable securities-lending data, it's difficult to estimate P&L of shorts
- ▶ The easiest workaround is to restrict all portfolio weights to be non-negative
- ▶ ... or only allow shorts in the most liquid securities like benchmark index ETFs

$$\begin{aligned} &\text{minimize} && \omega^T \Sigma \omega - \gamma \mu^T \omega + \xi \cdot \|\omega - \omega^*\|_r^r \\ &\text{subject to} && \sum_i \omega_i = 1, \omega_i \geq 0, \forall i \end{aligned}$$

BACK TO REALITY: CONTROL TURNOVER

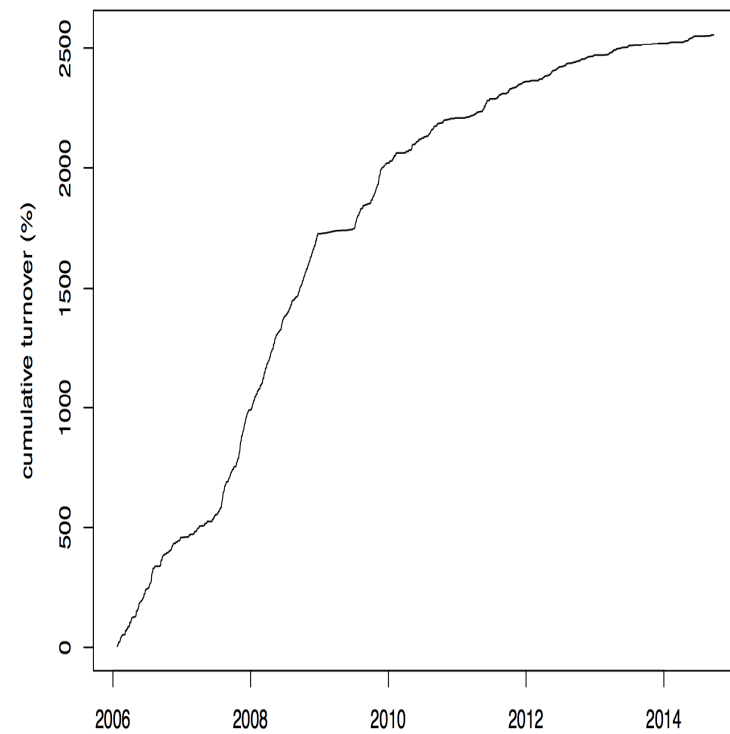
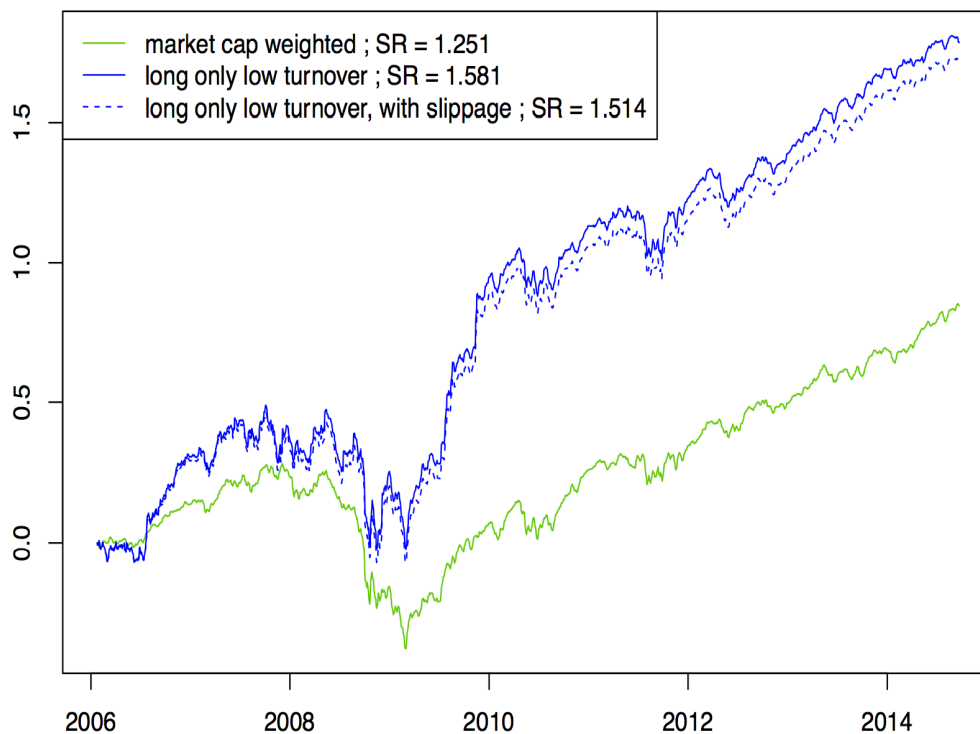


- ▶ Many ways to penalize turnover and slippage
- ▶ Either model slippage roughly and conservatively or very meticulously

$$\begin{aligned} & \text{minimize} && \omega^T \Sigma \omega - \gamma \mu^T \omega + \gamma \xi_1 \cdot \|\omega - \omega^*\| \\ & \text{subject to} && \sum_i \omega_i = 1, \omega_i \geq 0, \forall i \end{aligned}$$

IMPORTANCE OF INTUITION

Cumulative raw return (non-compounded)



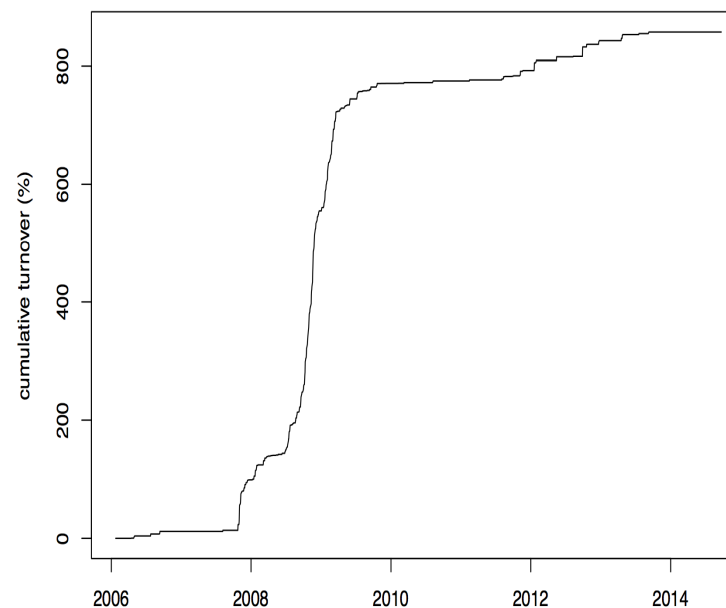
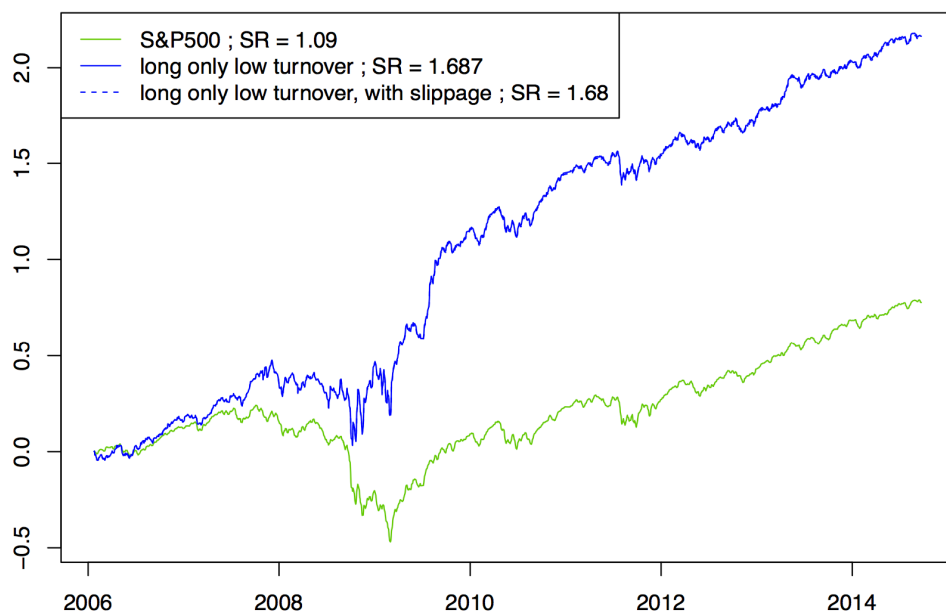
► Equivalent expression:

$$\begin{aligned} & \text{minimize} && -\mu^T \omega + \xi_1 \|\omega - \omega^*\| \\ & \text{subject to} && \omega^T \Sigma \omega \leq \gamma^*, \sum_i \omega_i = 1, \omega_i \geq 0, \forall i \end{aligned}$$

$$\begin{aligned} & \text{minimize} && \omega^T \Sigma \omega - \gamma \mu^T \omega + \gamma \xi_1 \cdot \|\omega - \omega^*\| \\ & \text{subject to} && \sum_i \omega_i = 1, \omega_i \geq 0, \forall i \end{aligned}$$

MOMENT OF TRUTH: TOP 500 MARKET CAP ONLY!

Cumulative raw return (non-compounded)



- ▶ Restricting the universe to the most liquid securities makes for the smoothest transition from back-testing to live trading
- ▶ But the more liquid a securities is, the more difficult it is to eek out an edge. Mounds of fool's gold to be found in back-tests with illiquid securities.

IMPLEMENTING THE STRATEGY

- ▶ This is where we are now ...
- ▶ In honor of our host, I will tell you that we are using Fetcher to pull our signals into Quantopian and then execute in IB.
- ▶ As a principle it's always good to get to this stage as quickly as possible ... nothing matters until you're touching the money