Risks Involved with Systematic Investment Strategies

Lectures in Entrepreneurial Leadership, ETH Zurich, D-MTEC, February 5, 2008
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Mittelmeergefühle in Zürich.
Endlich sind die Umbauarbeiten am Zürcher-Limmatquai abgeschlosen. Der Sandstrand ist ab sofort für gross und klein offen. Das Meer lädt mit einer Temperatur von 26° C zum baden und verweilen ein.

When developing and investing in a Systematic Investment Strategy there are particular issues that are to be addressed in addition to the financial risk and return

For a Systematic Investment Strategy that relies on models or predefined rules and on the assessment of the market environment in order to derive investment decisions the issues are:

- Robustness of the models against slow or sudden changes of the environment
- Availability of measures to identify the prevailing environment and to monitor the quality of the models and their robustness in this environment
- Availability of trigger levels that allow to define actions that are to be taken once these levels have been reached, before the model's quality has become insufficient
- Ability of the models themselves to identify changes in the environment and to adjust their own model parameters in case the environment has changed

→ A Systematic Investment Strategy needs to be consistently monitoring its environment and itself in order to be viable for the long term

Agenda

- **Introduction**
- Preeminent risks of Systematic Investment Strategies
- Challenge Loop for Systematic Investment Strategies
- Implementation and Conclusion

Definitions of a Systematic Investment Strategy

- A Systematic Investment Strategy is characterised by the exclusive use and reliance on defined rule sets and/or mathematical models
- The rule sets and mathematical models are designed to be employed without discretionary input by an investment manager
- The Systematic Investment Strategy is generally designed to operate under certain, predefined market conditions
- The robustness of the Systematic Investment Strategy is a measure for the region of the market conditions under which the strategy may operate stable
- The risks involved with Systematic Investment Strategies are not only of financial nature but there are substantial additional risks

Stylized Facts

Equities

- Volatility is dynamic and appears in clusters
- Returns exhibit extreme-events and heavy-tails
- Correlations are dynamic

Bonds

The five major risks:

- Migration and Default Risk
- Recovery Risk
- Spread Risk
- Liquidity Risk
- Market Risk

FX

- FX overlays and alpha trading
- No buy and hold
- Volatility is dynamic
- Trading is usually supported by quantitative models

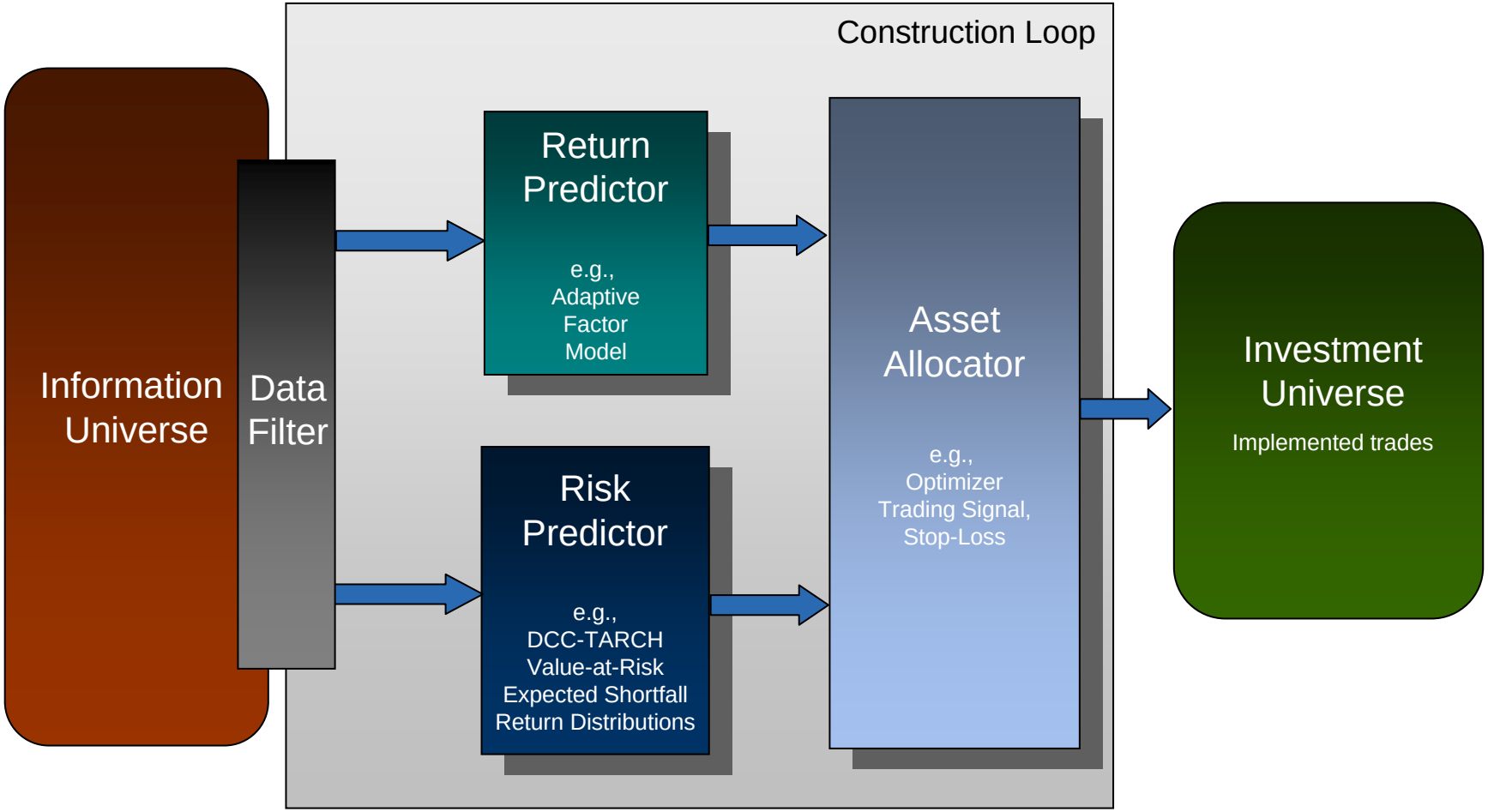
Hedge Funds

- Large spectrum of quantitative properties
- Time-varying exposure to traditional assets
- Key success factor: quantitative and qualitative due

Key Success Factors for Portfolio Optimization

Accurate measurement of idiosyncratic risks
Robust modeling of asset-dependence, also for the extreme case
Avoidance of the constraint satisfaction case
Choice of suitable risk measure
Awareness of over-optimization
Risk and Performance Attribution

The architecture for a Systematic Trading Strategy is based on independent elements performing specialised tasks, each generating a part of overall performance

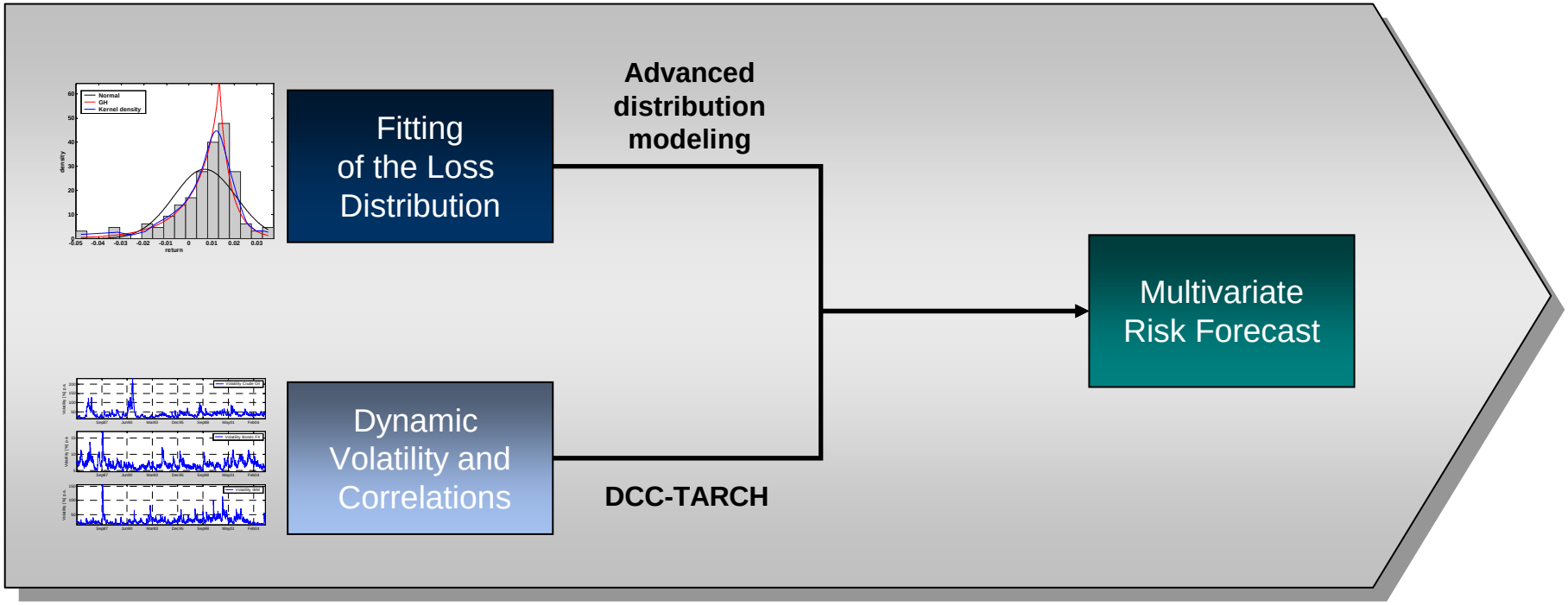


Risk predictor with dynamic volatility and correlations models enable consistent multivariate non-normal risk forecasts

Exemplary

Modeling of the return distributions of the strategy

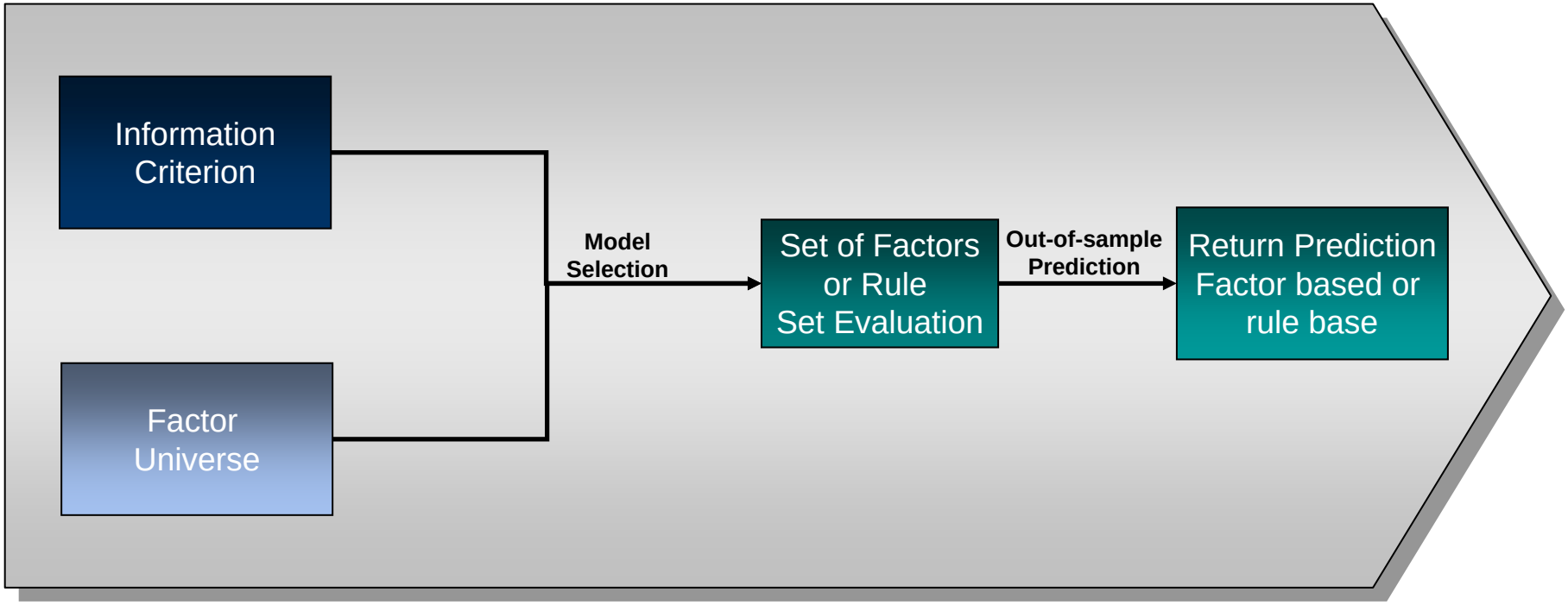
- Returns of single assets: dynamic, fat-tailed and skewed
- Dependence of various assets: dynamic, tail-dependent



Return predictor using adaptive factor models or set of predefined rules to identify and forecast the expected future returns

Exemplary

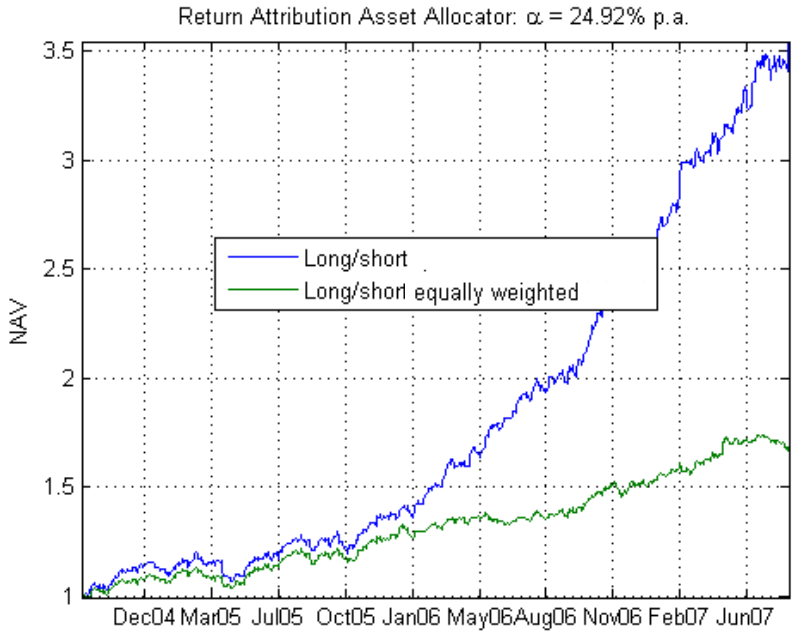
- Multifactor model or set of predefined rules to predict the returns of the assets at a given frequency
- Online monitoring of prediction quality and model quality
- Factor list or rule set review after predefined periods of time

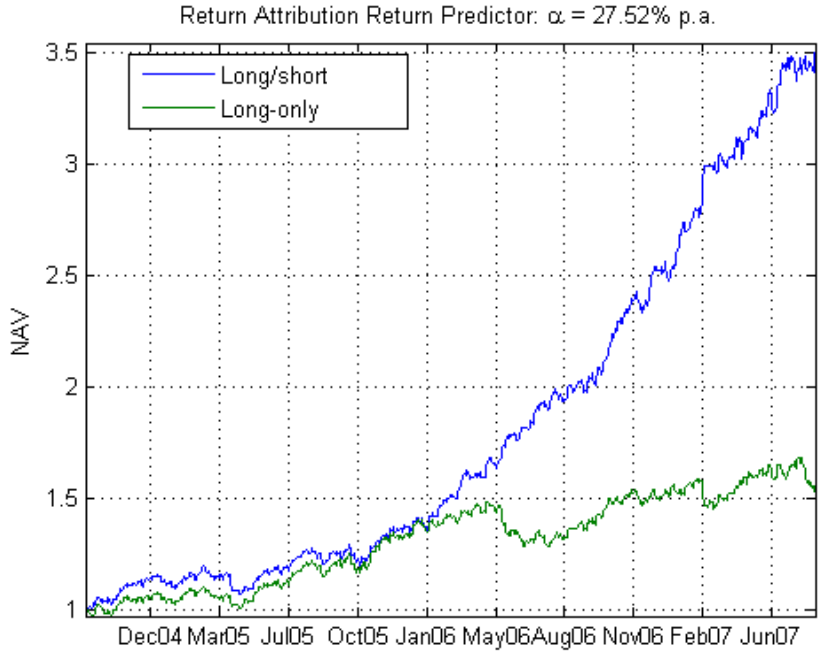


The elements of the Systematic Investment Strategy each individually are performance generators and their individual performance is monitored against overall Strategy performance

Asset allocator is measured against equally weighted allocation in order to monitor the performance derived from correct allocation decisions

Return predictor is measured against long only allocation in order to monitor the performance derived from correct prediction of the direction of the returns





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In addition to financial risks there are several risks specific to Systematic Trading Strategies that have an impact on the viability of the strategy

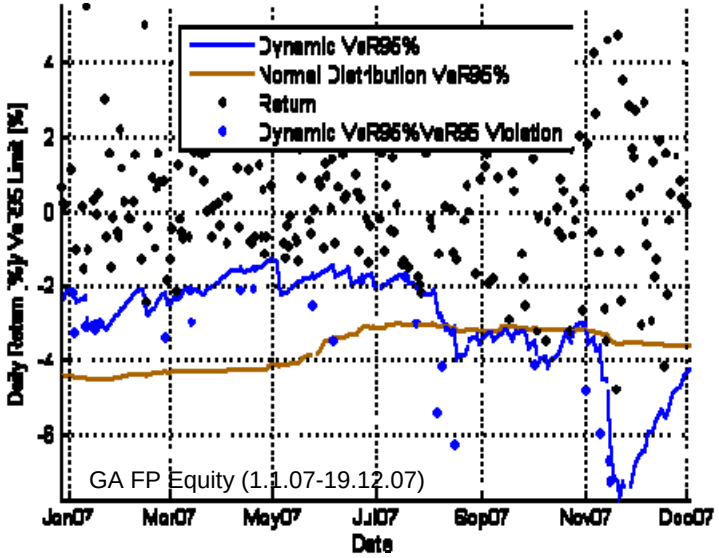
Preeminent risks	Examples
Model risk	Volatility model choice
Stability/Robustness risk	Parameter significance
Solvability risk (of mathematical models)	Optimisation outcome
Implementability risk	Scalability and liquidity
Data quality risks	Availability and revision of data

Model risk is to be monitored by verification of the stylised facts on which the model is based on and by ensuring the significance of the model parameters

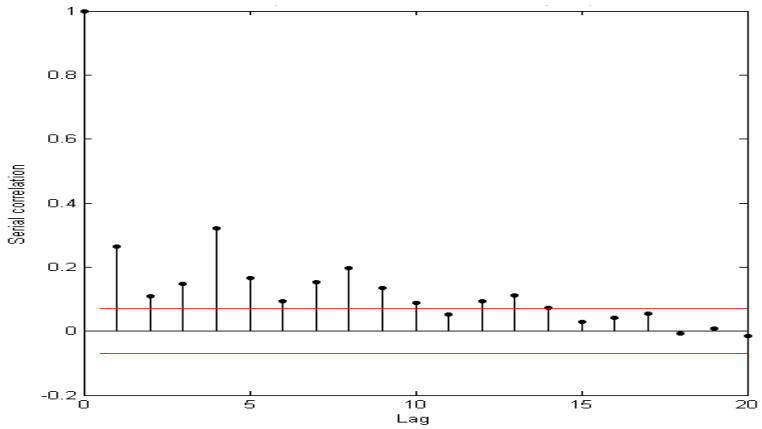
Example:
Risk forecast is calculated by means of a Value at Risk model. If a dynamic model has been chosen which is based on the stylised fact of autocorrelation of squared returns the model is to be monitored

- In order for the risk forecast to be valid, a significant autocorrelation of squared returns is to be measured
- Once the model for the risk forecast has been fitted to the data, the model parameter's significance is evaluated
- With a validated model the risk forecast can be used

Choice of VaR Model: Standard Model vs. Dynamic for a Stock



S&P500 data (1999-2007): serial correlations of squared returns



Robustness of the model is to be evaluated by varying the model´s parameters and evaluating the subsequent variation in the performance of the overall strategy

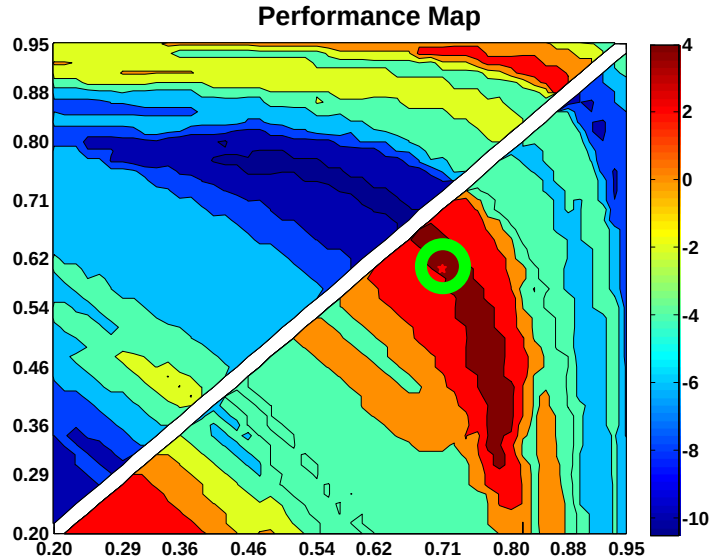
Example:
Trend detection based on a pair of exponentially weighted moving averages is used to invest in the direction of the detected trend

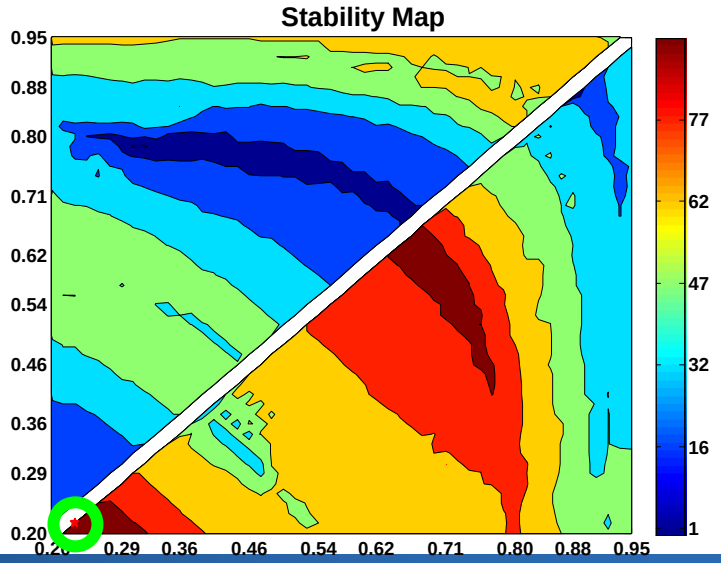
- In order for the strategy to be viable the choice of parameters of the exponentially moving averages is to be verified

- a) The evaluation of the obtained performance for various pairs of parameter settings allows to identify the settings needed for highest performance (see Performance Map)

  b) The stability is determined by trading off the performance of a given point and the change of performance to the neighbouring points (see Stability Map)

- With a validated stability of the parameters the trend detection with exponentially weighted moving averages can be used



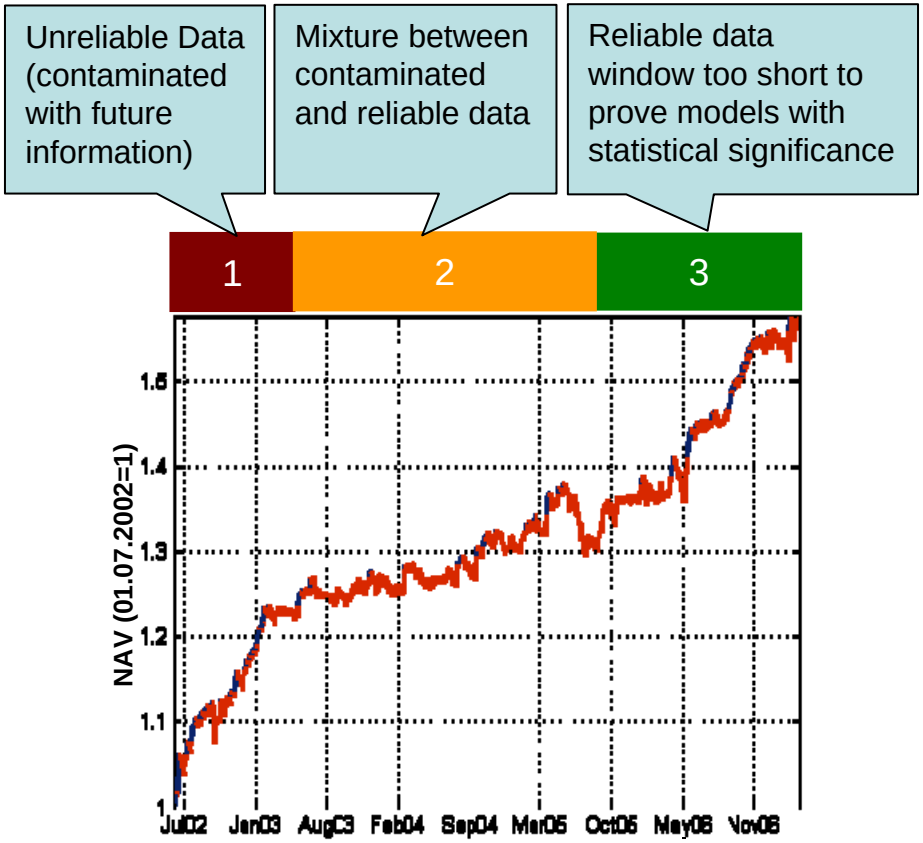


Data integrity is to be monitored with regard to data availability and retrospective changes and revisions of historical data

Data integrity is monitored by the data filter on a day-to-day routine

Funktion	TW Wert
Vollständigkeits-Check Faktoren	<1 ; <3 ; >3
Vollständigkeits-Check Assets	==0 ; ==0 ; >0
Rollender-Check Faktoren	<0.002 ; <0.003 ; >0.003
Rollender-Check Assets	<0.002 ; <0.003 ; >0.003
Rollender-NaNCheck Faktoren	==0 ; <3 ; >3
Rollender-NaNCheck Assets	==0 ; ==0 ; >0
Vortages-Check Faktoren	>=187/<125/==31 ; <=125/>187/==31 ; -/-/>31
Vortages-Check Assets	>=4/<3/==0 ; <=3/>4/==0 ; -/-/>0
Vorzeichen-Check Faktoren	==0 ; <3 ; >3
Vorzeichen-Check Assets	==0 ; ==0 ; >0
Kontraktgrösse-Check	==0 ; ==0 ; >0

Data integrity is particularly filtered when used for backtesting



Return predictor module bears model risks, optimization risk, robustness risk and data risk that are all interconnected

Robustness of regression

- Evaluation and testing of regression methods under robustness objectives

Monitoring of prerequisites

- Verification of mathematical properties (linearity-check; normality-check)
- Montioring of significance of filter mapping

Return Predictor

Over-fitting of the regression

- Conditioning of factor sets insuring exclusion of market and regime fitting
- Verification of over-fitting measure and model cross validation (leave one out)

Conditioning of return predictor

- Factor properties (statistical properties, data type)

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- **Challenge Loop for Systematic Investment Strategies**
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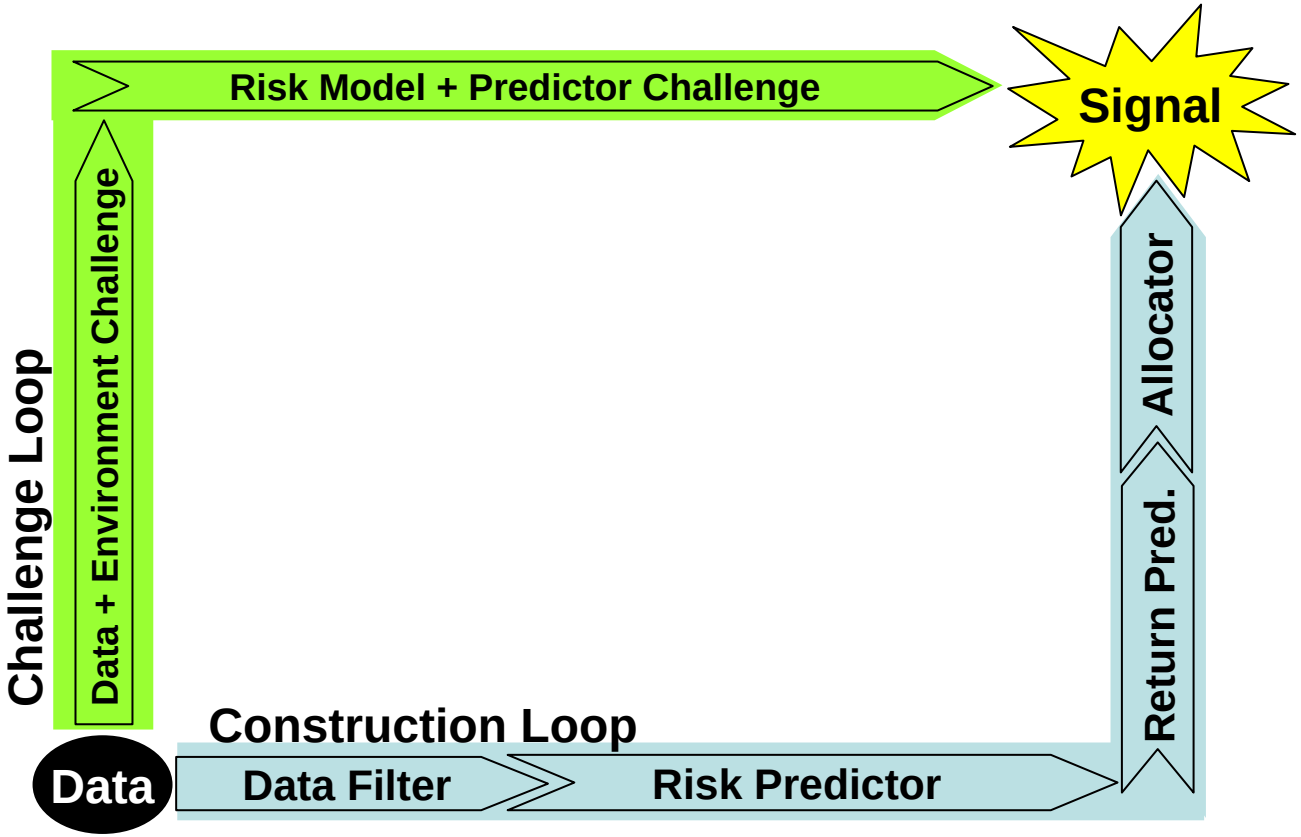
The Challenge Loop is designed to give a second opinion and to monitor the viability of the signal generated by the Construction Loop

- The Construction Loop is designed to produce the trading signal
- The Challenge Loop monitors the signal generation, i.e., data availability, market environment, risk model suitability and return predictor conditioning



In order to overcome the slowness of statistical measures the Challenge Loop analyses are designed to keep the time until any issues are detected a short as possible

- The major issue of the Challenge Loop is instantaneous detection of data issues, model deficits or insufficient mathematical conditioning
- The outcome of the model itself is to be measured with statistical measures
- Statistical measures need a certain amount of data in order to be calculated, let alone be significant
- In case of a model deficit there therefore may be a major time lag between it appearing and it being noticed by monitoring the outcome

⇨ Challenge loop depends on improved instantaneity of measures

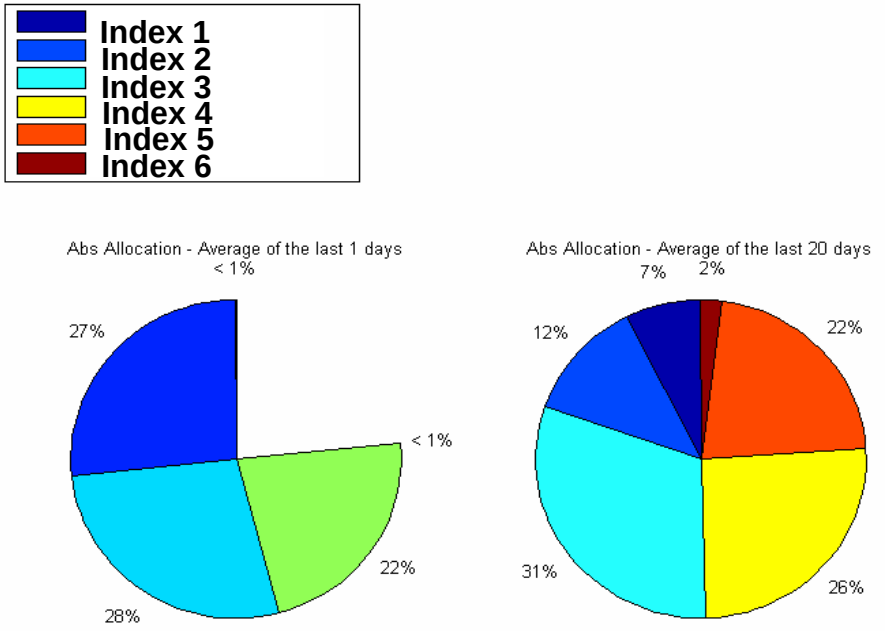
In addition to financial risks there are several risks specific to Systematic Investment Strategies that have an impact on the viability of the strategy

Challenge Loop	Examples
Allocation monitoring	Balanced Diversification
Performance monitoring	Balanced Perf. Contribution
Regime monitoring	Prediction quality
Risk violation monitoring	VaR Violation Monitoring

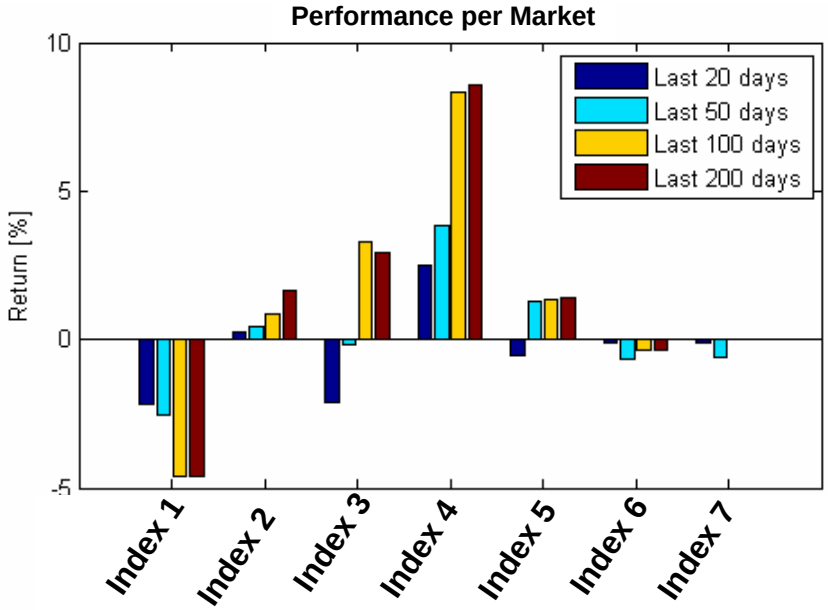
Allocation and performance attribution are monitored over both, long periods and also short time horizons in order to deliver a clearer picture

- For the analysis of the properties of the average allocations and the performance attribution long term and instantaneous measures are used in parallel
- The instantaneous measures serve as an instant pointer to any potential model insufficiencies, the long term averages show a more stable view and therefore point to design deficits

Example 1: Asset Allocation 1 day and average 20 days

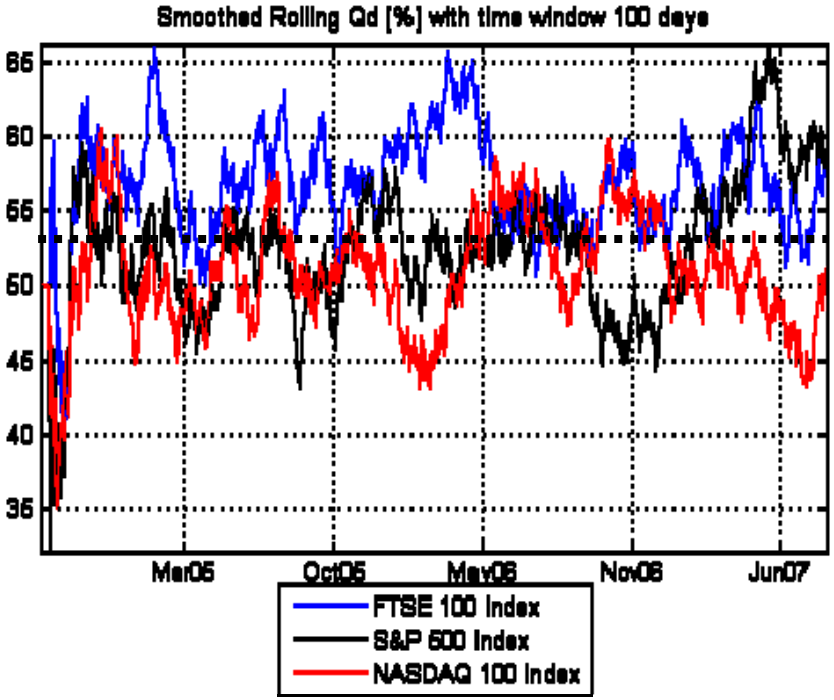


Example 2: Performance per Market

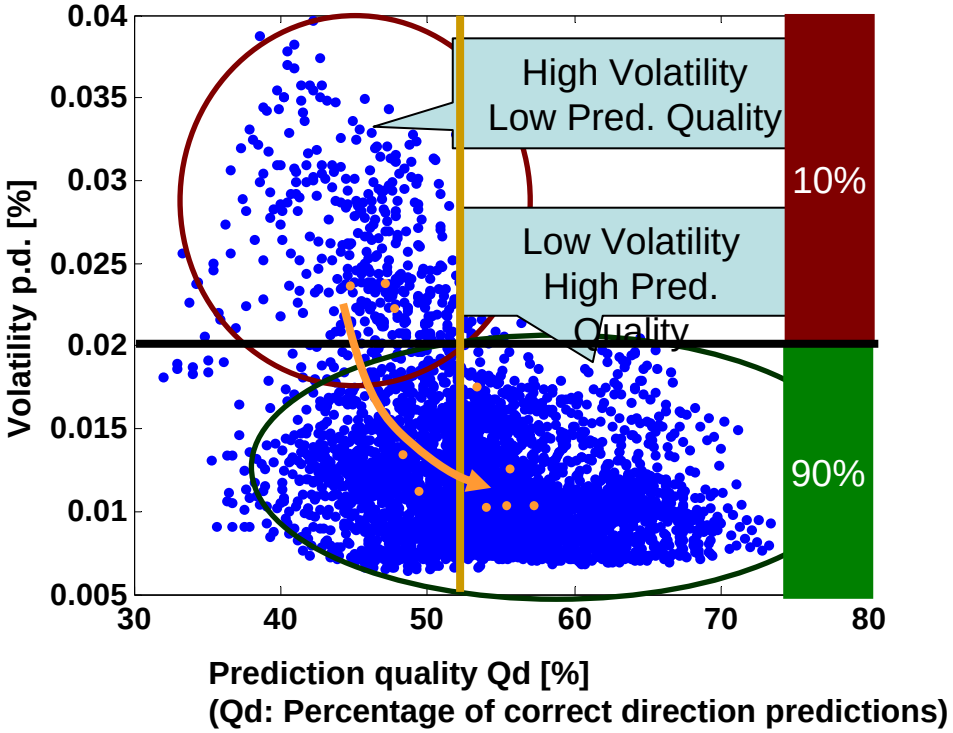


Prediction quality measures enable monitoring of model quality and model's ability to adapt throughout changing market regimes

Directional quality indicates the amount of correctly predicted directions over the past number of days. Challenge Loop monitors directional quality and stops signal or prompts manager to take action if it is below target level



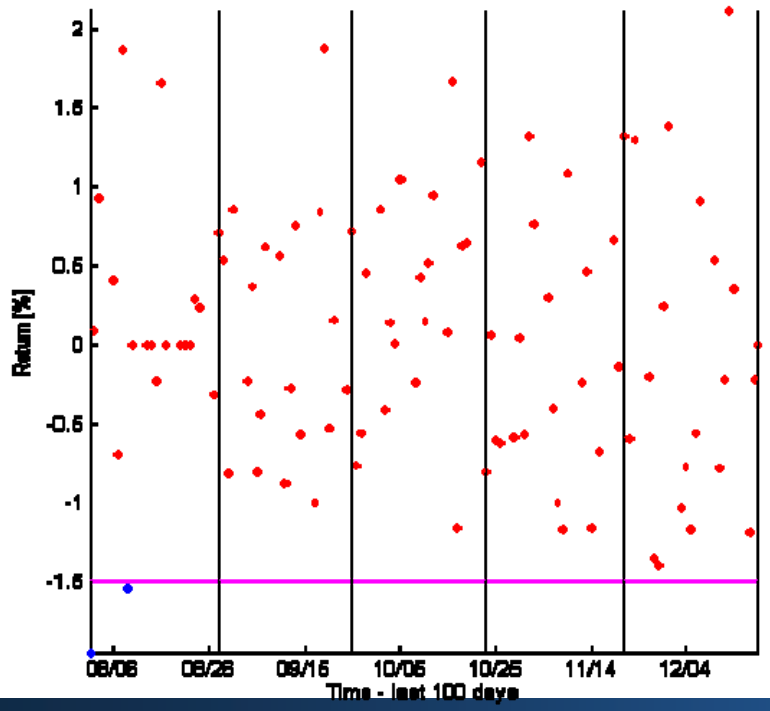
Prediction quality is lower in high volatility regimes. Visualisation of most recent outcomes of the model (orange dots) indicates the model adaptability to regime changes



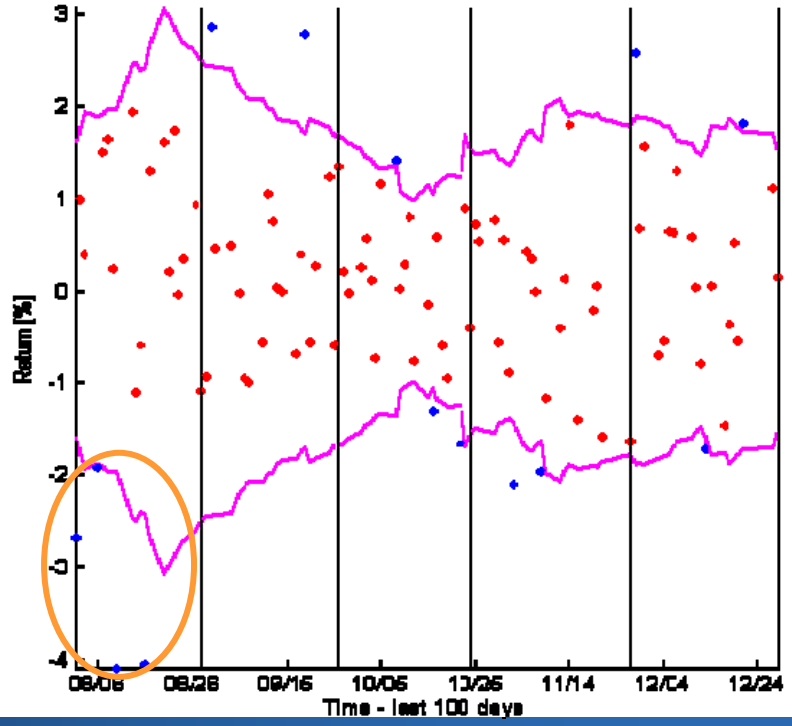
Instantaneous measures are created by breaking the needed observation period into shorter periods and finding clusters within the shorter periods

- The Value at Risk violations may not be sufficient to indentify a deficit of the models since the measure itself needs many observations
- Use Value at Risk clustering over short periods of time to get an instant idea of the model quality and shortcomings

Strategy VaR Violations with daily VaR-Limit -1.5%

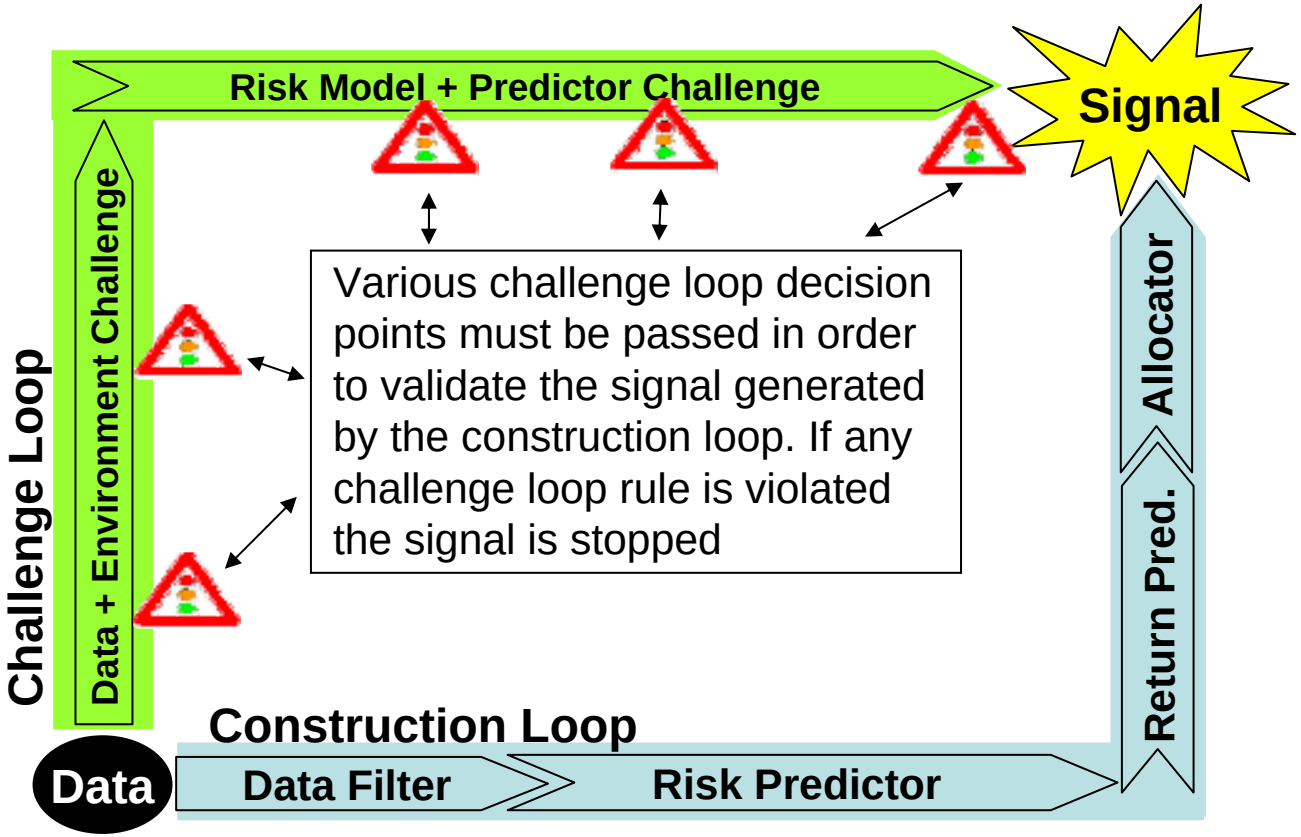


S&P500 daily VaR 95% Estimation and Violations



The Challenge Loop is used to validate the signal and to guarantee correct functioning of the models and the correct positioning of the Strategy and its models with regard to the prevailing environment

- The Challenge Loop becomes an integral part of the Systematic Investment Strategy and is responsible for reducing the preeminent risks of Systematic Investment Strategies



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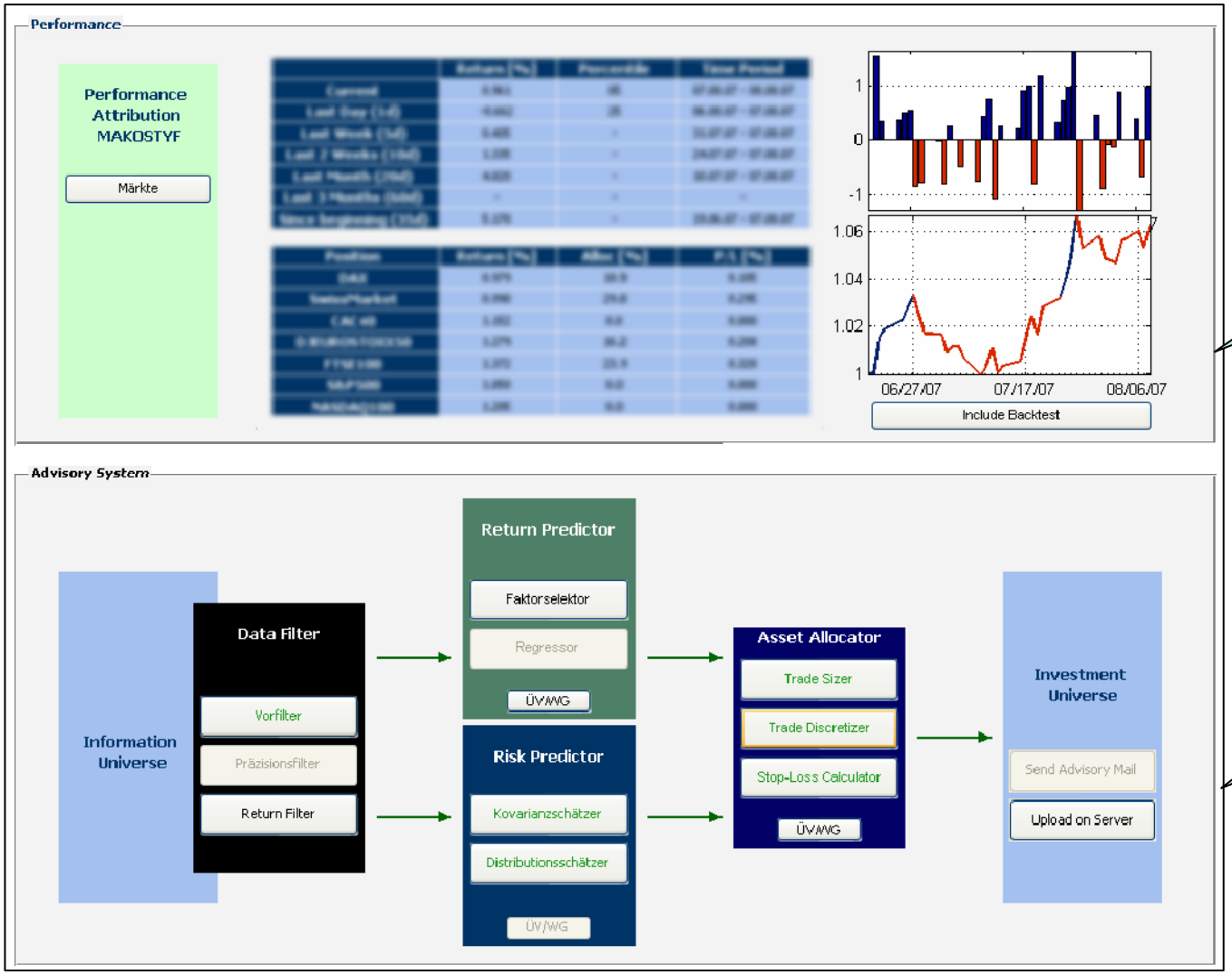
Implementation of the Construction and Challenge Loops: Cockpit for Systematic Investment Strategies



Construction Loop
Calculation of Trading Signal and Performance Monitoring

Challenge Loop
Module by module check of basic assumptions and model integrity

With the Challenge Loop the main issues of Systematic Investment Strategies relying on predefined rules and mathematical models are addressed

- Robustness of the models against slow or sudden changes of the environment is monitored with robustness measures and instantaneous measures of the environment and the behaviour of the strategy in the prevailing environment

- Measures to identify the prevailing environment are to be found based on the stylised facts of the models

- Trigger levels are set in order for the Challenge Loop to be effective. Furthermore they are to be set to give the investment manager sufficient reaction time to take corrective measures before the Challenge Loop stops the signal from being accepted

- Models using instantaneous quality measures are used to adapt as early as possible to new environments. If the model becomes invalid the signal is stopped by the Challenge Loop

→ The Challenge Loop is an instrument for consistently monitoring of the Systematic Investment Strategies environment and itself in order to ensure long term operation of the strategy

Conclusions

- There are several risks taken into account when using Systematic Investment Strategies
- A Systematic Investment Strategy needs an observation and challenging mechanism to identify any model outcome that was not intended
- When combining the Construction Loop that derives the investment signals with an independent Challenge Loop that challenges the construction loop, the signal is verified by a second opinion before being implemented
- Signal quality and confidence in the Systematic Investment Strategy is improved by systematically challenging the signal generation before implementing it
- The Challenge Loop becomes an integral part of the Systematic Investment Strategy and is responsible for reducing the preeminent risks of Systematic Investment Strategies

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  - Systematic Trading Signals, and
  - Comprehensive Risk Management
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- a privately owned company incorporated 2005
- an official spin-off from ETH Zürich.

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