Team Belvedere: Spring 2020

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Abstract

This semester's project was a continuation of last semester's, who were tasked with finding and visualizing future contracts relationships with one another throughout a given time period via the implementation of graphical models.

This semester's team was tasked with identifying unique market features which have a significant impact in improving several models' prediction accuracy of both correlation values (calculated by last semester's team) as well as closing prices of future contracts in specific market environments.

Our work will assist Belvedere's trading team in hedging their investment, as well as validate, and possibly even improve, existing pricing models.

Data-Overview and Wrangling/Cleaning

Belvedere Trading provided us with minute by minute data from 2015 to 2017 on 28 different futures. Each future contained open, close, high, and low price data and the volume traded for every given minute.

Since the data only contained values for minutes which trading occurred, we backfilled every missing minute with the next minute's corresponding price and set volume traded to 0.

Timestamp	ZS_OPEN	ZS_CLOSE	ZS_HIGH	ZS_LOW	ZS_TRADED_VOLUME
2015-01-02 08:40:00	1170.8	1170.8	1170.8	1170.8	0
2015-01-02 08:41:00	1171.5	1171.5	1171.6	1170.5	2
…	…	…	…	…	…
2017-12-31 16:59:00	1171.6	1171.7	1171.7	1171.4	5

Table 1. Data Example

Feature Engineering

Primarily used TA-Lib, an open-source library for technical analysis of market data.

Indicator Groups:
- Momentum: Moving Average Convergence/Divergence, Relative Strength Index, …
- Volume: On Balance Volume, Chaikin A/D Oscillator, …
- Volatility: Average True Range, Bollinger Bands, …
- Cycle: Hilbert Transform (Dominant Cycle, Phasor Components), …

Additional Features engineered by hand (including lagged features).

Selected Strong features via a combination of autoregression, visualizations, lasso, and recursive feature elimination.

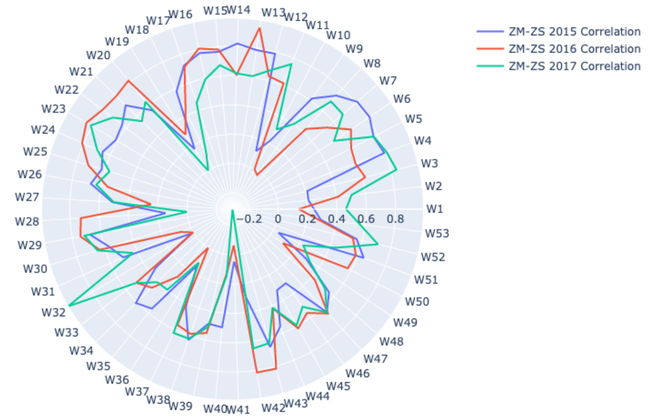

Figure 1. Weekly Correlations – Soybean Meal vs Soybeans

Data Exploration

Created Five Grouping of Future Contracts
- Soybean Products
- Livestock
- Energy
- Agriculture
- Metals

Among other visuals used when exploring the data, we used polar visualizations to interpret cyclical trends in the data (reference Figure 1) and heat maps to preliminarily identify important features in future contract groupings (reference Figure 2).

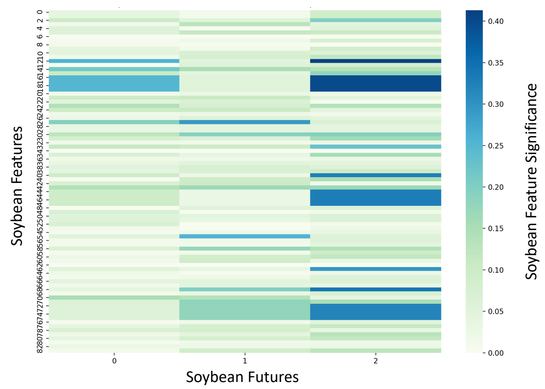

Figure 2 Heatmap of Correlation Differences vs Features (Slopes: Abs Values) for Soybean Products

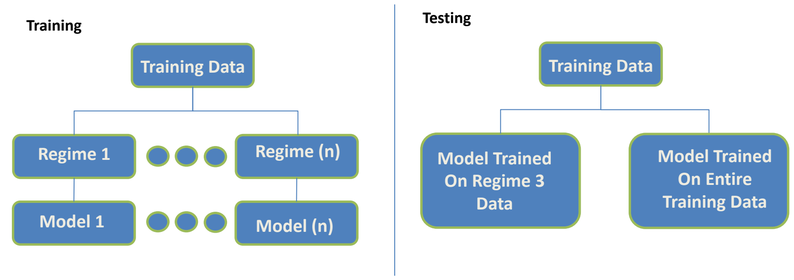

Chart 1. Regime Switching Lasso Visualization (Regime 3)

Modeling – Machine Learning Models, LASSO

Machine Learning Models
1. Hidden Markov Model
   - Sperate Data into training and testing with rolling predictions
   - Specified the number of hidden states
2. Classification Models
   - Naïve Bayes, Radial Basis SVM, Random Forest, Gradient Boost, Decision Tree
   - Specified the number of components

Regime Switching LASSO Regression
Purpose:
1. Price Predictor in timed (minute, daily, weekly, monthly) intervals
2. Validation of the predicted correlation regimes

Model Validation
1. Hidden Markov Models: R2 Score (Coefficient of Determination), MSE (Mean Squared Error)
2. Classification Models: Percent Accuracy
3. LASSO: R2 Score, MSE

Conclusions

Our team is currently compiling the results from the various models used for the final report. We are varying the number of specified components (or hidden states) for each model and exploring their respective accuracy and features selected for different groupings of futures.

The final report will reveal for each groupings of futures:
- The model that most accurately predicted next periods closing prices
- The corresponding features selected by that model with LASSO

Our report will paint a clear picture of the interconnectedness of the financial futures market and the significance of having the capability of identifying next period's market condition when hedging a portfolio against adverse price movements.

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