

Patterns in Macroeconomic Variables & S&P 500 Forward Return: Structure & Modeling Dilemmas

Wes Aull

Open-Source Data

surveys^{of} consumers
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Leading Indicators of Economic Activity



*1950's through 1980's -
Present*

- ✓ Change in Labor Market Conditions Index (1976 – Present)
- ✓ Treasury Yield Curve (and Its Inversion): 10-Year Treasury Rate - Fed. Funds Rate
- ✓ Working-hour, Overtime, and Order/Sales Surveys for Manufacturing & Non-Manufacturing Sectors



CAPE



1918 - Present

- ✓ Cyclically-Adjusted Price to Earnings Ratio
 - ✓ Analyzed and published for the S&P 500 by nobel laureate Robert Shiller (*Market Volatility*)
 - ✓ Notion of cyclically adjusted earnings for stock analysis popularized by Ben Graham in *Intelligent Investor & Security Analysis*.

Consumer & Investment Sentiment

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1978 - Present

- ✓ What do you expect business conditions to be in the next 12 months?
- ✓ How does your financial condition compare to last year?
- ✓ How much do you expect prices to change in the next year?

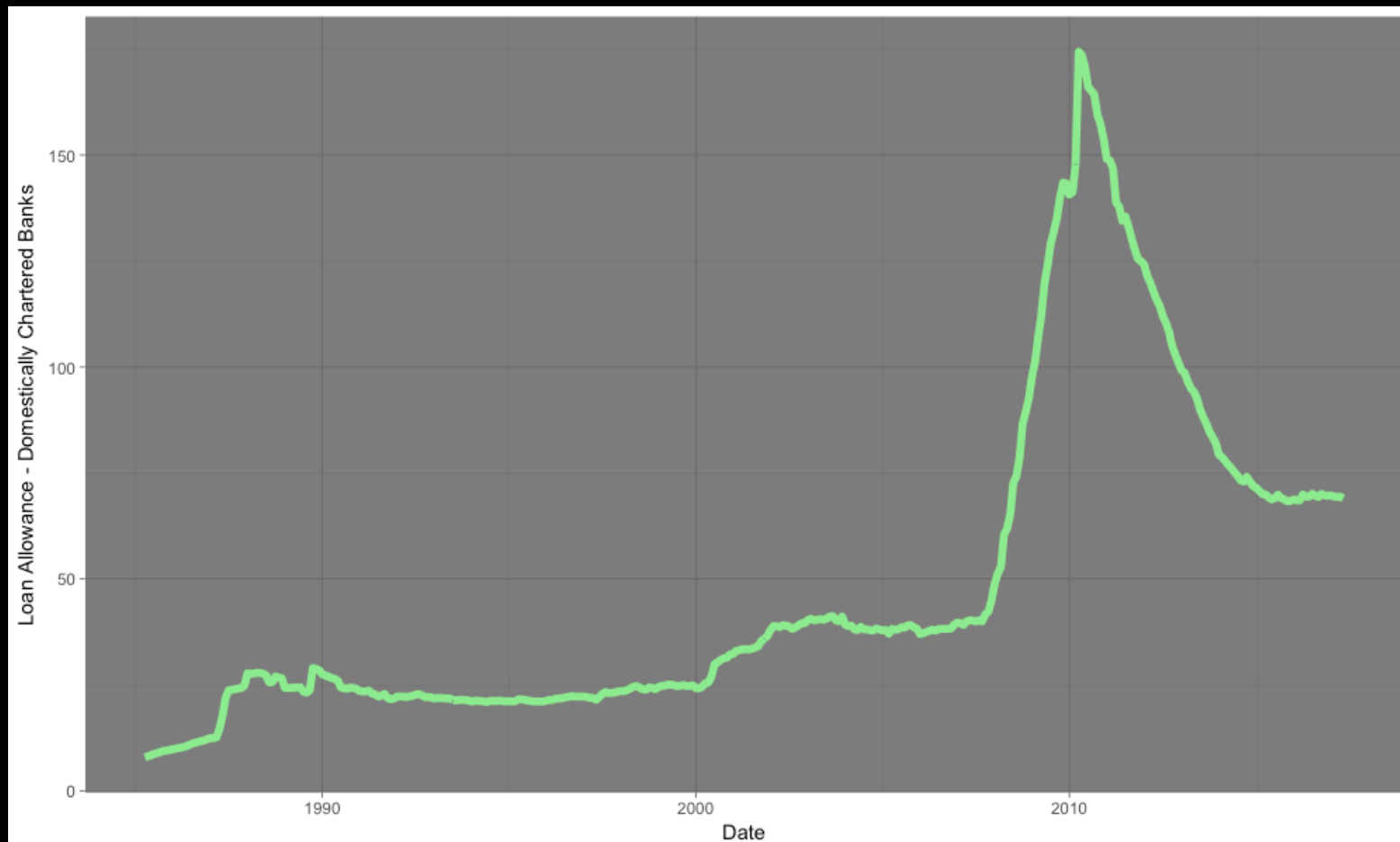


1987 - Present

- ✓ Do you feel the direction of the market over the next six months will be:
 - up (bullish)?
 - no change (neutral)?
 - or down (bearish)?

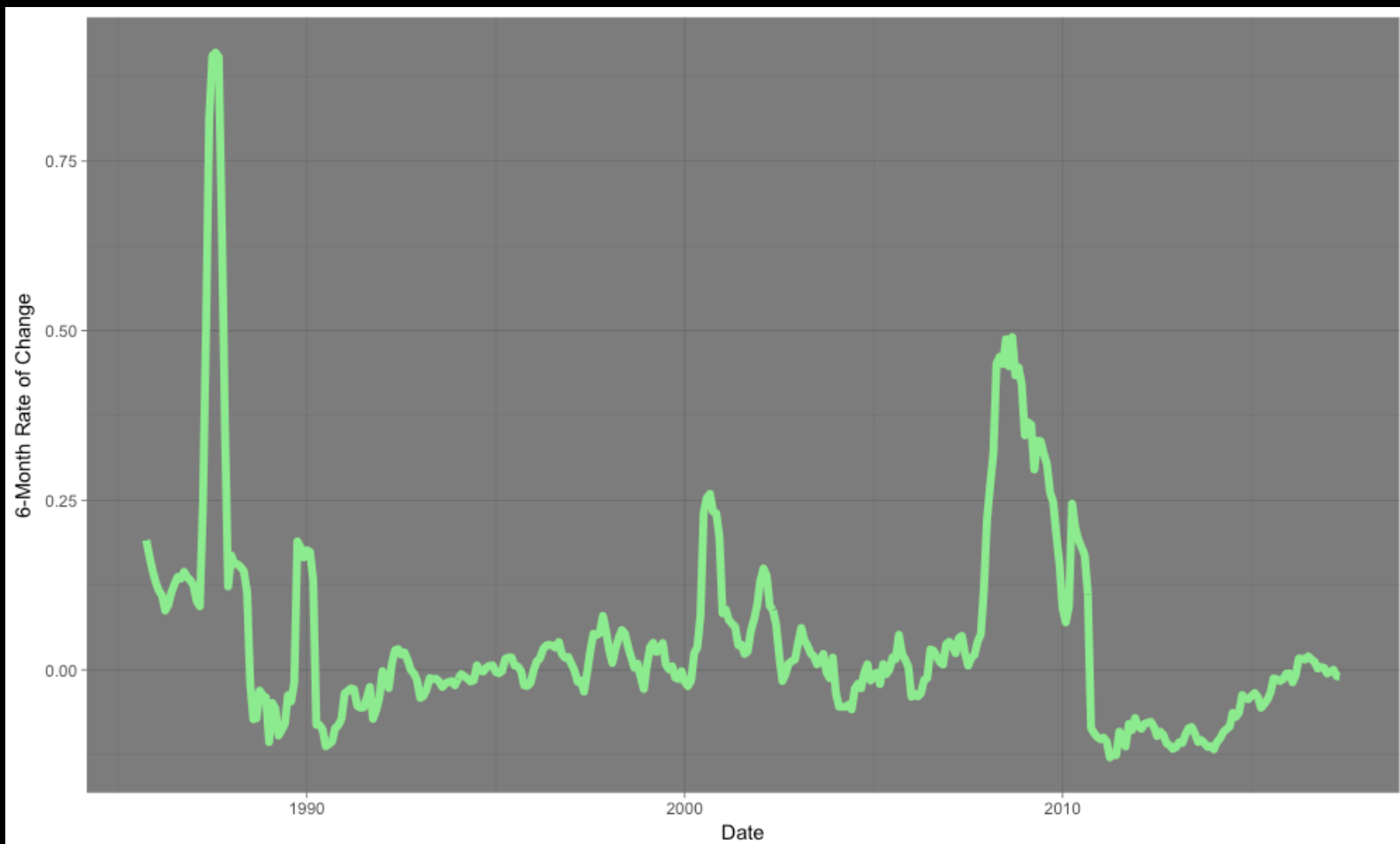
Heteroskedasticity, Non-Stationarity, & Signal

Loan Allowance (Bad Debt) Surveyed from Large Domestic Chartered Banks



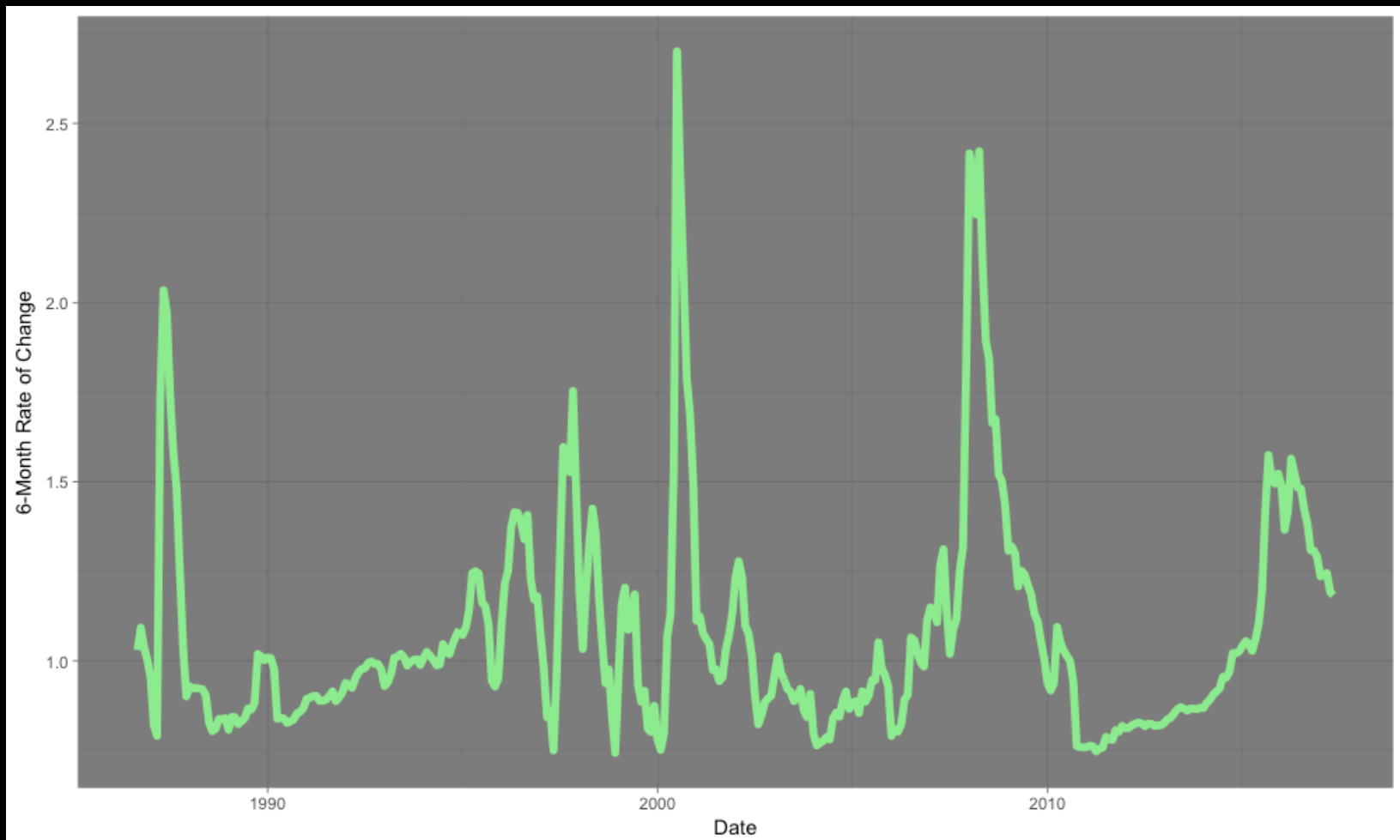
Heteroskedasticity, Non-Stationarity, & Signal

Loan Allowance- 6 Mo. Discrete Rate of Change

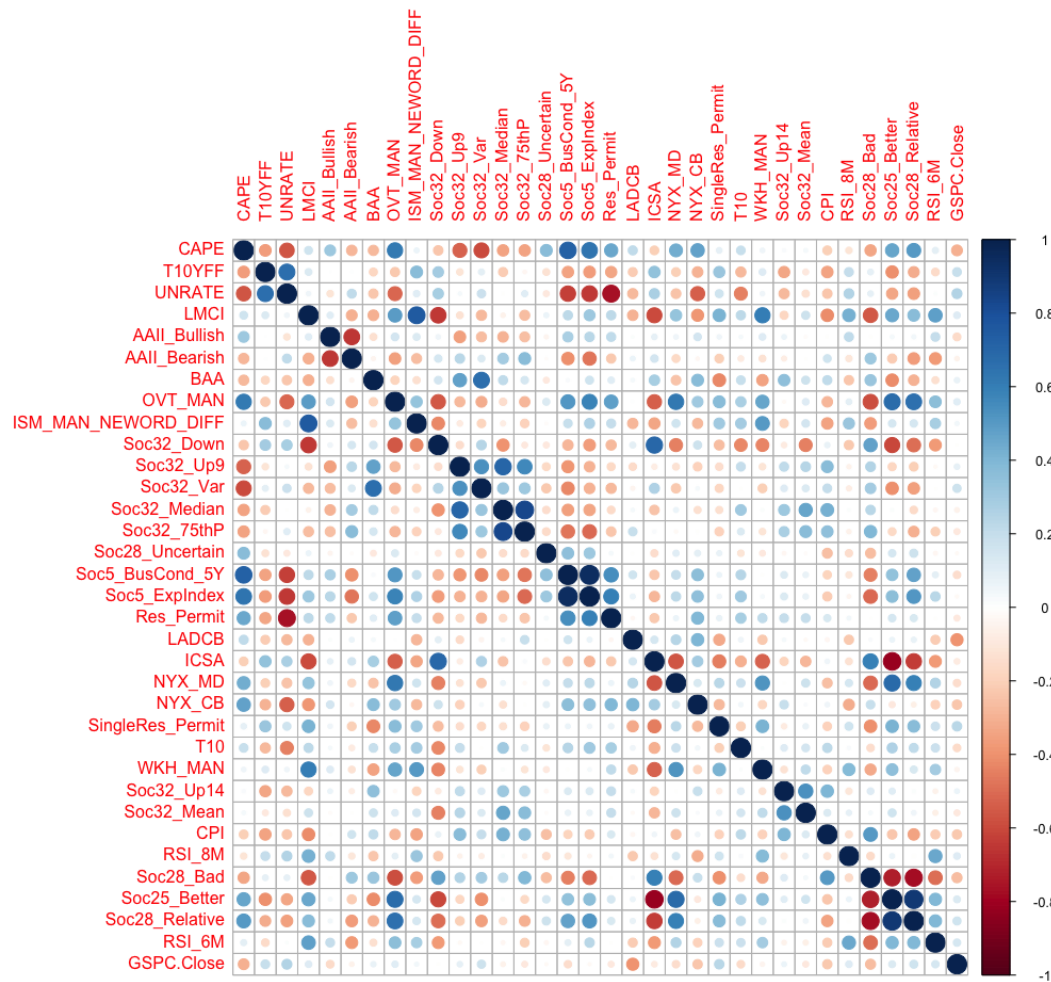


Heteroskedasticity, Non-Stationarity, & Signal

Loan Allowance- 6 Mo. Rate of Change – Rolling 60 Mo. Standardization



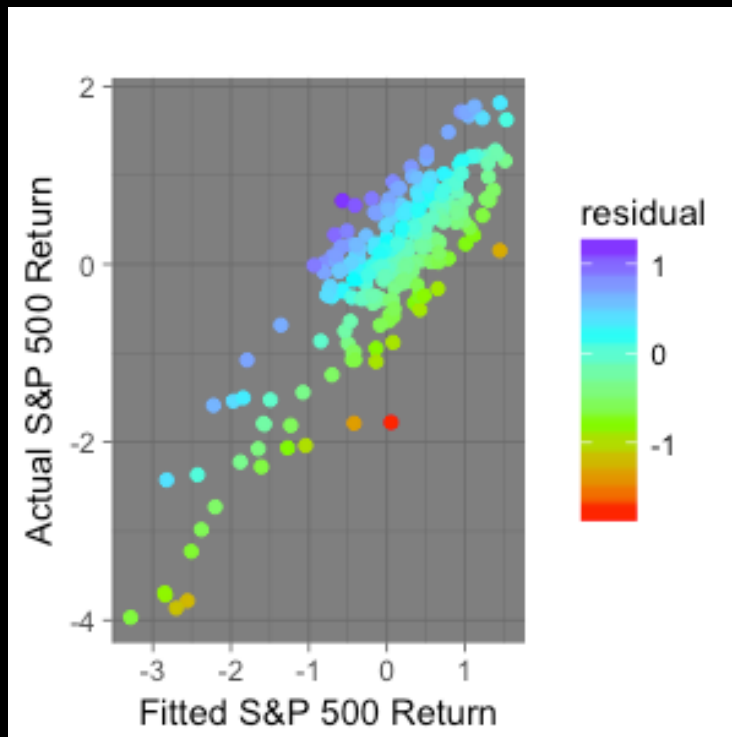
Dilemmas of Data – Collinearity & Dimensionality



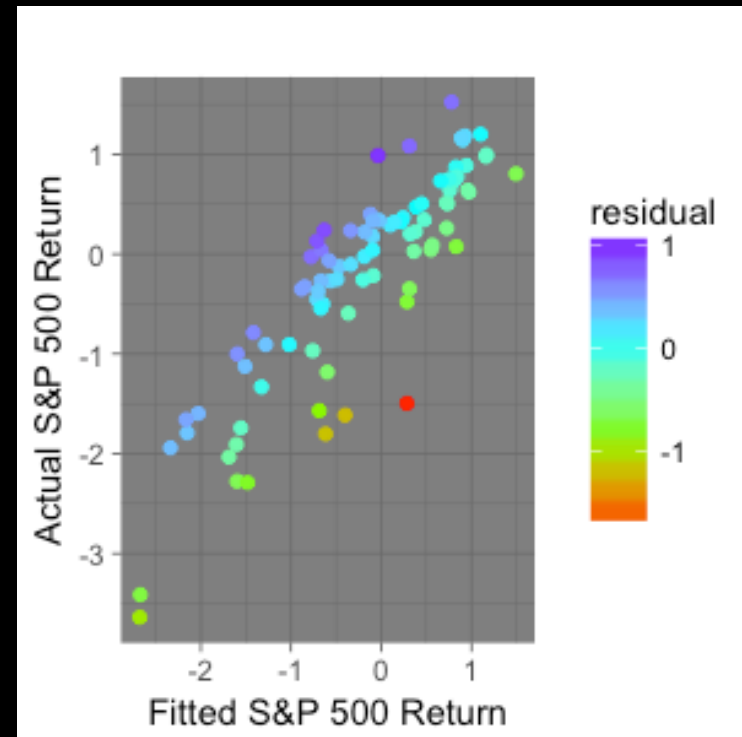
- ✓ Dimension reduction from 74 to 33 variables:
 - ✓ rooted out collinearity
 - ✓ issues of dimensionality for 345 month sample (Jul. 1987 – Mar. 2016)

Initial Modeling Results – Linear Regression

75% Random Train Sample



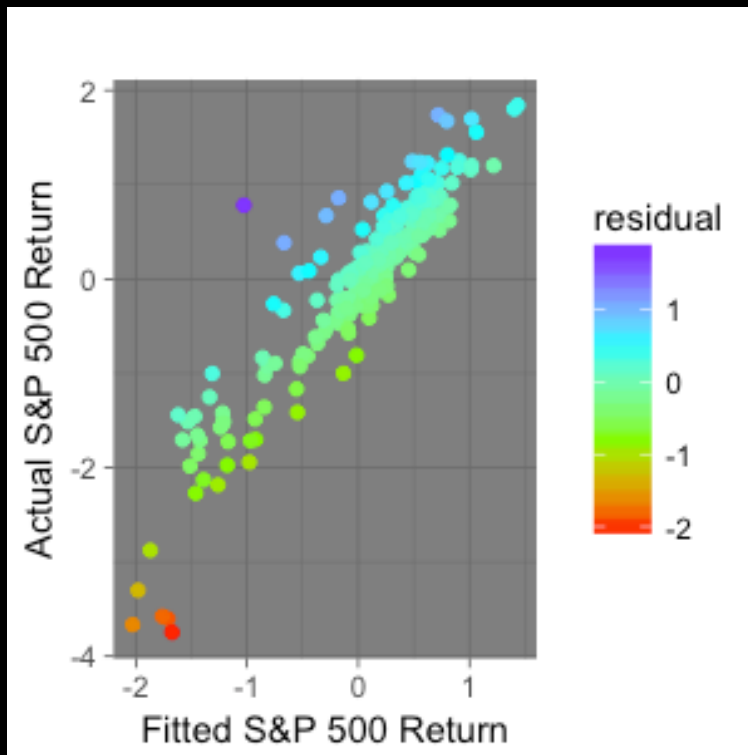
25% Random Test Sample



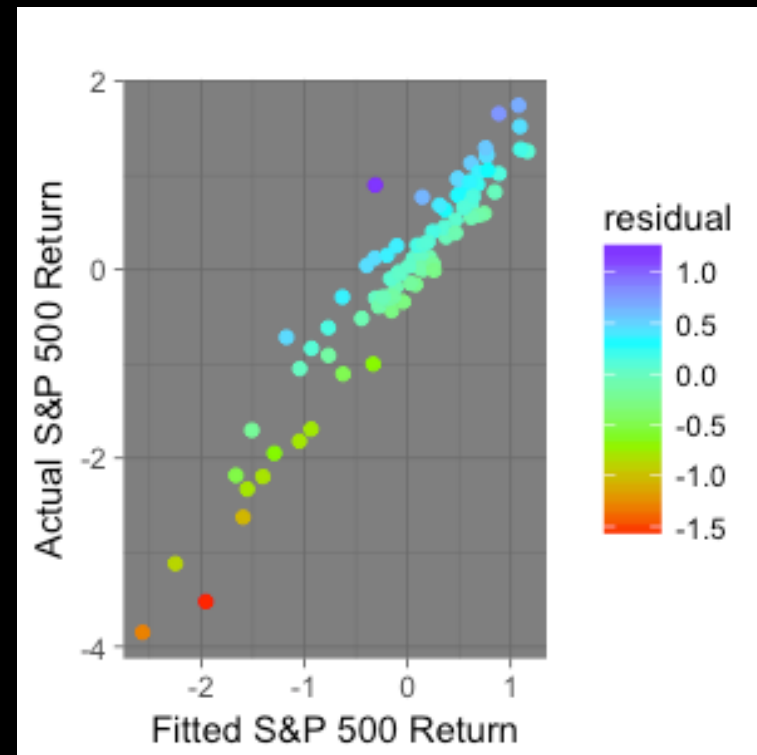
R-Squared: 70.7% - Train / Test RMSE: .50 / .59 - Train / Test MAE: .40 / .46

Initial Modeling Results – Random Forest

75% Random Train Sample



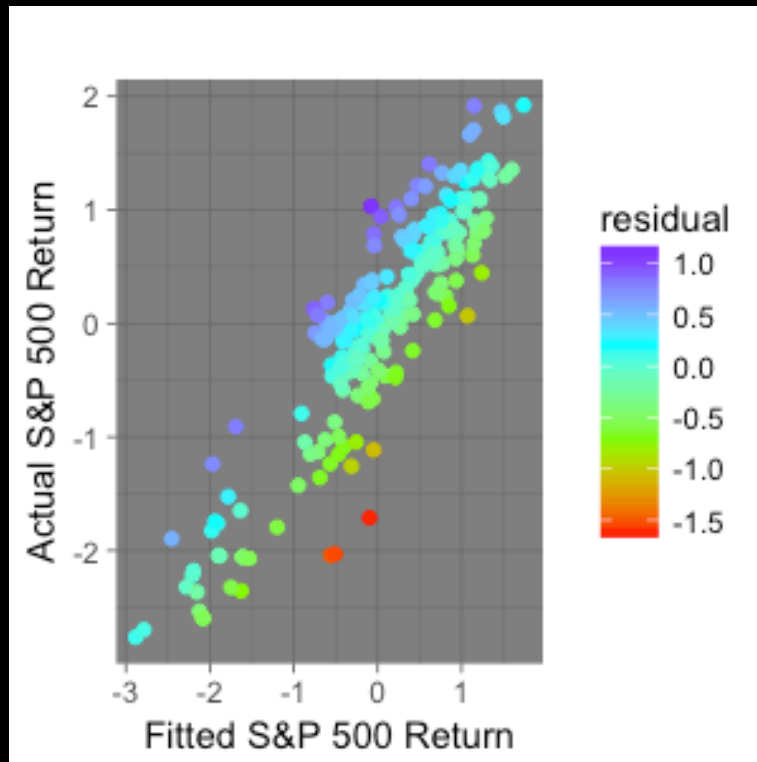
25% Random Test Sample



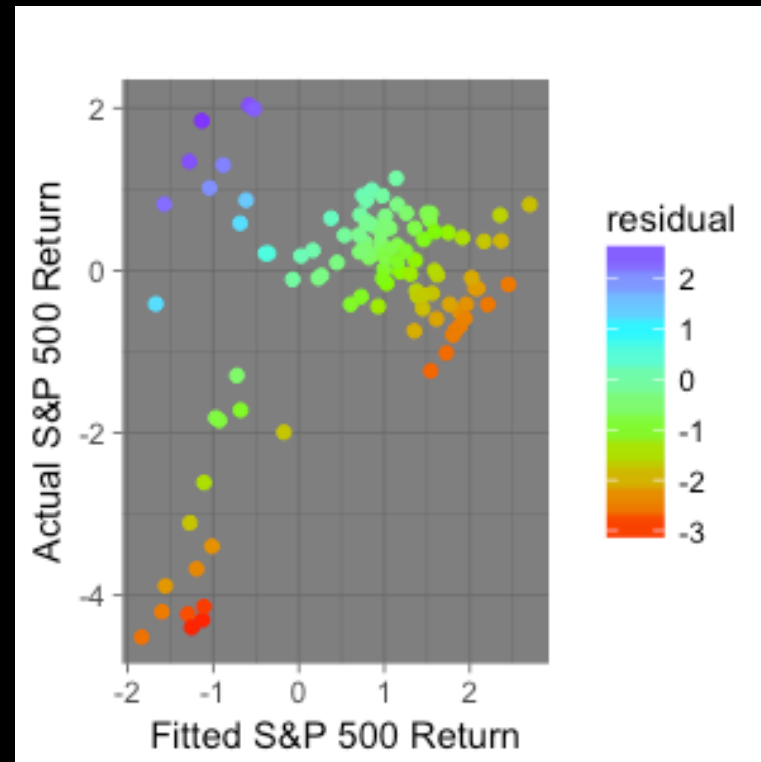
R-Squared: 79.1% - Train / Test RMSE: .18 / .44 - Train / Test MAE: .12 / .31

Final Modeling Results – Linear Regression

Train : Jul. 1987 – Mar. 2007



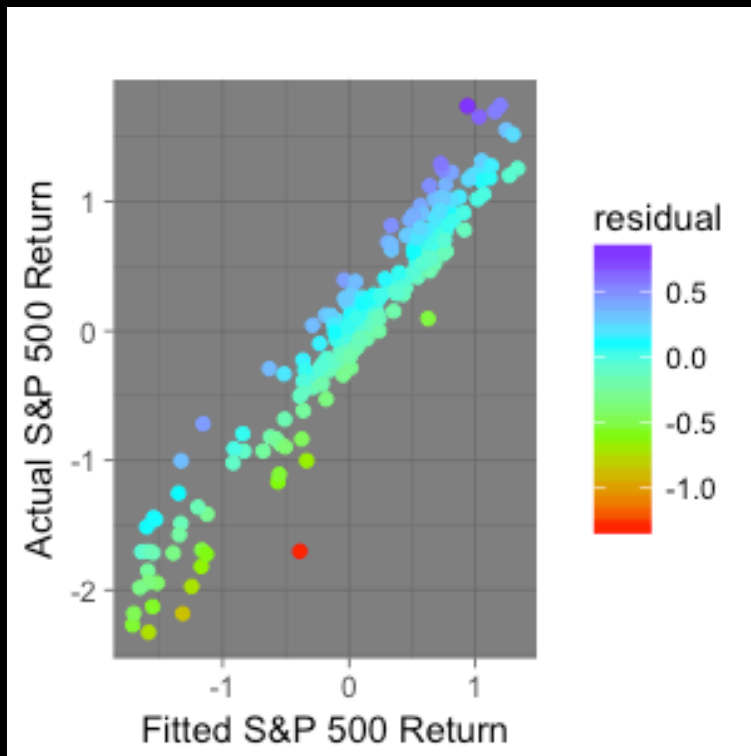
Test : Apr. 2007 – Mar. 2016



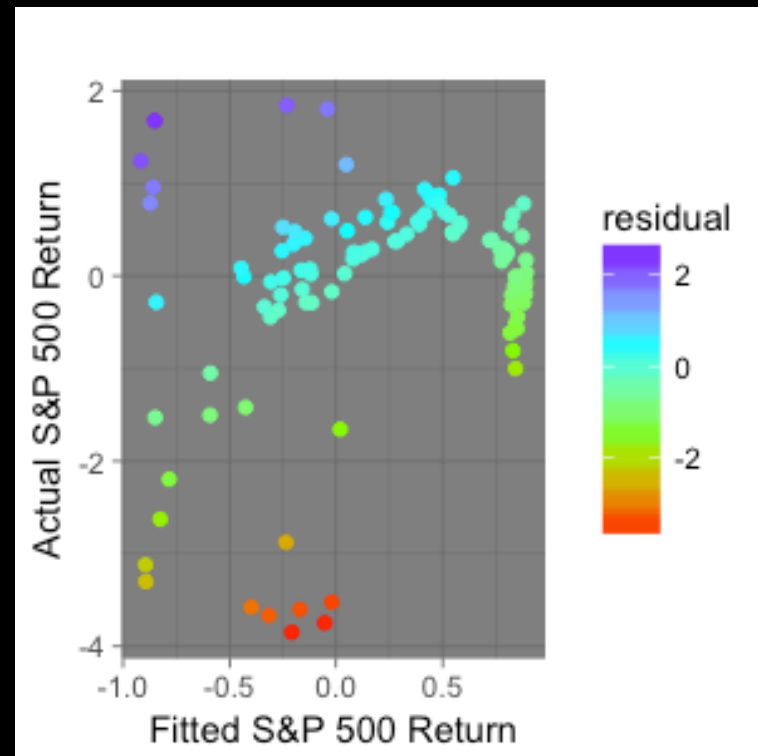
R-Squared: 77.9% - Train / Test RMSE: .43 / 1.64 - Train / Test MAE: .33 / 1.37

Final Modeling Results – Random Forest

Train : Jul. 1987 – Mar. 2007

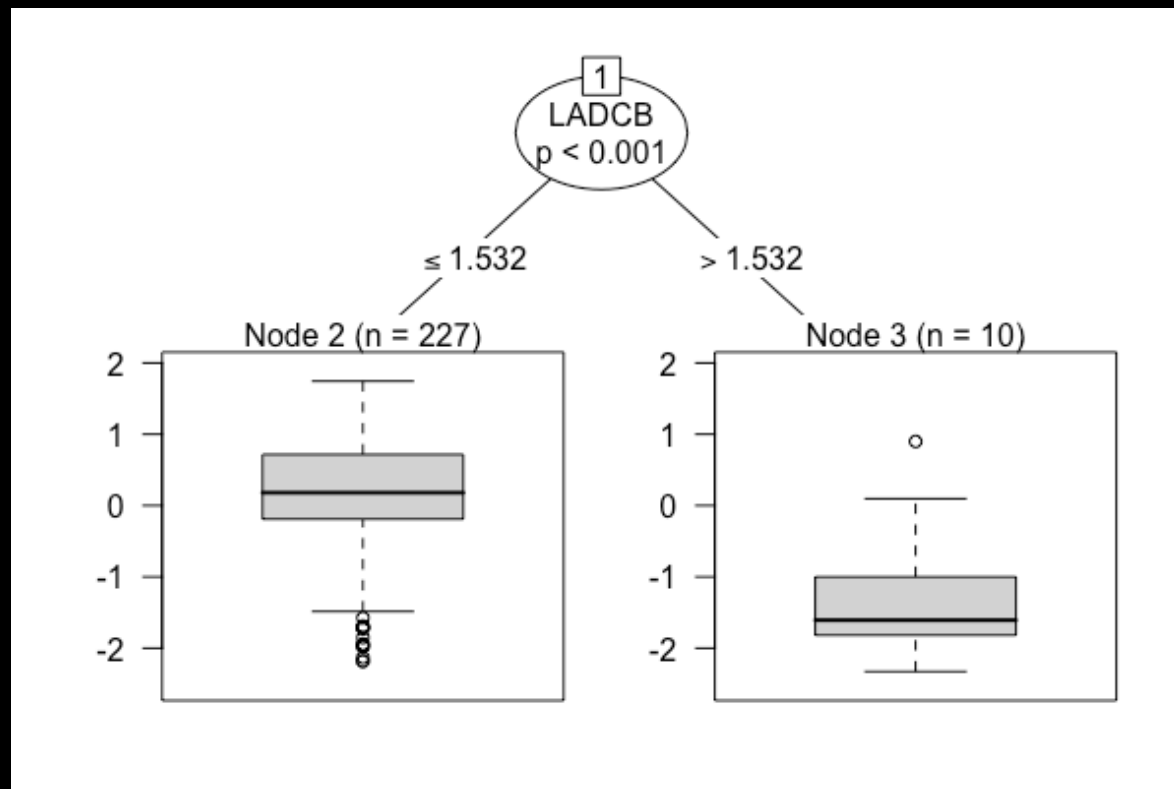


Test : Apr. 2007 – Mar. 2016



R-Squared: 90.5% - Train / Test RMSE: .11 / 1.23 - Train / Test MAE: .08 / .85

Final Model – Conditional Inference Tree

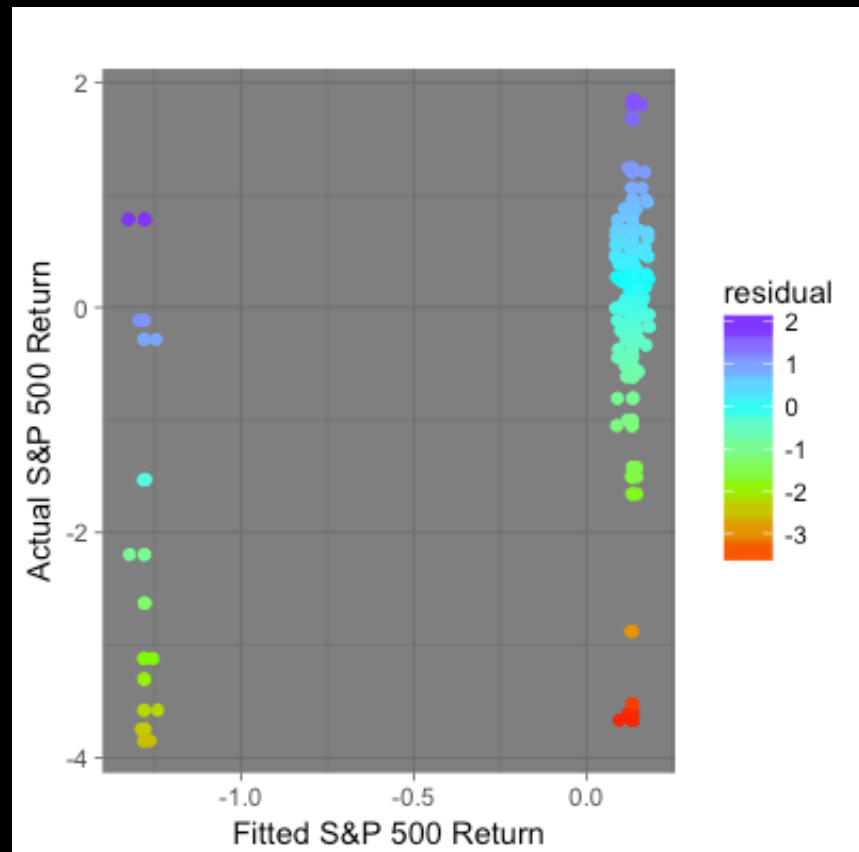
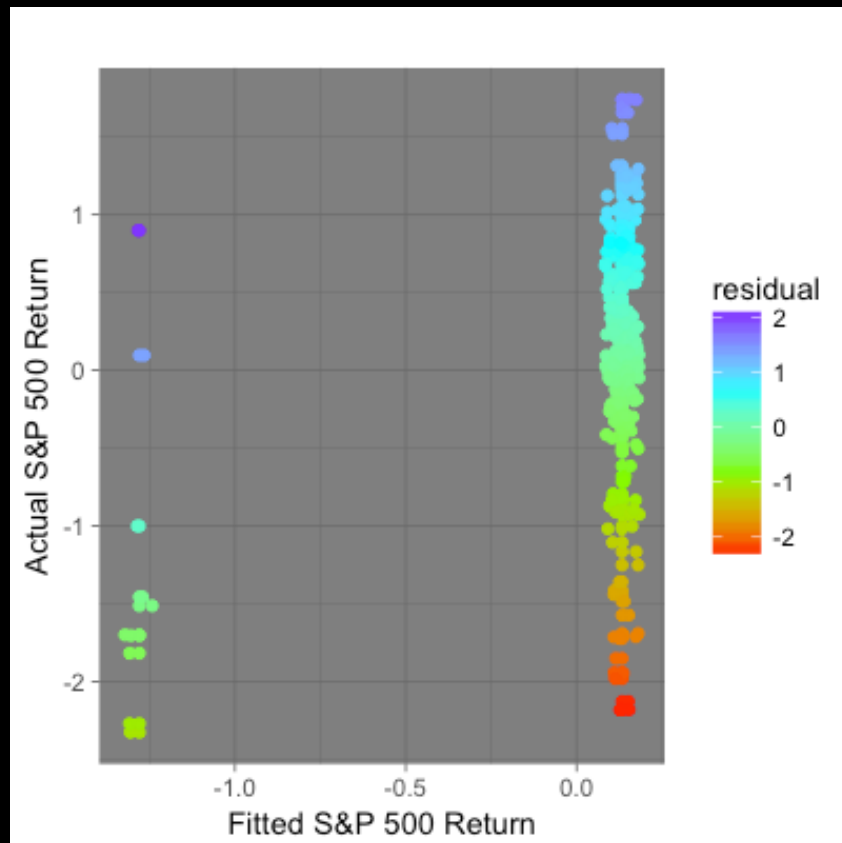


- ✓ Advantages of Conditional Inference Tree:
 - ✓ Implement splits based on p-value for partial null hypothesis vs. RSS reduction.
 - ✓ Creates splits of non-linear data that yield statistically significant regression without resorting to classification.

Final Model – Conditional Inference Tree

Train : Jul. 1987 – Mar. 2007

Test : Apr. 2007 – Mar. 2016



Train / Test RMSE: .82 / 1.06 - Train / Test MAE: .61 / .71

Take Aways & Further Work

Further Work:

- Employing categorization or feature-engineering of cycle time for time series:
 - Dealing with varying amplitude and frequency.
 - Engineering the second derivative of a variable (e.g. when unemployment accelerates away from trend while in the bottom half of the cycle).
- ARIMA and Nnetar provided powerful forecasting ability for the predictor variables, however:
 - 50-70% had exacting accuracy but were powerfully wrong 30-50% of the time.
 - Exploring how to model distribution of outcomes for independent variables in better modeling S&P 500 return.

My Experience at NYCDSA

You are an amazing group,
and I've loved my experience at NYCDSA.
Thank you!