

Financial Ratios and Stock Returns

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Outline

- Motivation of research
- Data collection, cleaning, and analysis
- Results of data analysis and significance
- Limitations of research

Motivation

Whether an empirical relationship exists between financial ratios and stock price?

Return on Assets

Gross Margin

Asset Turnover

Current Ratio

Debt-to-equity ratio

...

t_0



AAPL = \$212 ± \$3

$t_0 + t$

Utilizing the knowledge of future stock price

- Profitable stock portfolio
 - Invest in stocks that you know will have a good return
- LEAPS
 - Buy call and put options that will be profitable

Data collected from Capital IQ

S&P Capital IQ

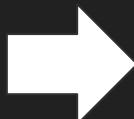
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The Walt Disney Company (NYSE:DIS) Financials > Ratios

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	Key Stats	Income Statement	Balance Sheet	Cash Flow	Multiples	Cap. Structure	Ratios	Supplemental
Restatement:	Latest Filings						Period Type: Annual	
Order:	Latest on Right						Decimals: Capital IQ (Default)	
'90 '92 '94 '96 '98 '00 '02 '04 '06 '08 '10 '12 '14								
Chart Selected Items Add Data Items			12 months Sep-30-2001		12 months Sep-30-2002			
For the Fiscal Period Ending								
Profitability								
Return on Assets %		4.0%		3.2%				
Return on Capital %		5.3%		4.2%				
Return on Equity %		0.9%		5.7%				
Return on Common Equity %		1.0%		5.4%				
Margin Analysis								
Gross Margin %		14.3%		9.4%				
SG&A Margin %		NA		NA				
EBITDA Margin %		18.2%		13.5%				
EBITA Margin %		14.3%		9.5%				
EBIT Margin %		11.3%		9.4%				
Earnings from Cont. Ops Margin %		0.9%		5.3%				
Net Income Margin %		(0.6%)		4.9%				
Net Income Avail. for Common Margin %		0.9%		4.9%				
Normalized Net Income Margin %		6.3%		4.9%				
Levered Free Cash Flow Margin %		5.6%		4.9%				
Unlevered Free Cash Flow Margin %		6.9%		6.7%				
Asset Turnover								
Total Asset Turnover		0.6x		0.5x				
Fixed Asset Turnover		2.0x		2.0x				
Accounts Receivable Turnover		8.2x		7.6x				
Inventory Turnover		13.1x		16.4x				
Short Term Liquidity								
Current Ratio		1.1x		1.0x				
Quick Ratio		0.7x		0.7x				
Cash from Ops. to Curr. Liab.		0.5x		0.3x				



For the Fiscal Period Ending	12 months	12 months	12 months
	Dec-31-2001	Dec-31-2002	Dec-31-2003
Profitability			
Margin Analysis			
Return on Assets %	4.00%	3.20%	3.40%
Return on Capital %	5.30%	4.20%	4.50%
Return on Equity %	0.90%	5.70%	6.10%
Return on Common Equity %	1.00%	5.40%	5.70%
Asset Turnover			
Total Asset Turnover	0.6x	0.5x	0.5x
Fixed Asset Turnover	2.0x	2.0x	
Accounts Receivable Turnover	8.2x	7.6x	
Inventory Turnover	13.1x	16.4x	

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Data cleaned for regression analysis

	Return.on.Assets..	Return.on.Capital..	Return.on.Equity..
1	0.064	0.084	0.1150000
2	0.069	0.092	0.1330000
3	0.076	0.102	0.1520000
4	0.076	0.099	0.1470000
5	0.087	0.115	0.1660000
6	0.096	0.128	0.1830000
7	0.100	0.136	0.2040000
8	0.092	0.125	0.2000000
9	0.095	0.127	0.2610000
10	0.051	0.067	0.1390000
11	-0.020	-0.027	-0.4120000
12	-0.001	-0.001	-0.1030000
13	0.022	0.030	0.1000000
14	0.047	0.062	0.7660000
15	0.052	0.065	0.1000000
16	0.057	0.072	0.1030000
17	0.063	0.079	0.1280000
18	0.071	0.088	0.1010000
19	0.000	0.112	0.2280000

Showing 1 to 19 of 550 entries, 108 total columns

Stock.Return..1.Year.	SP500.1.Year	SP500.2.Year	SP500.3.Year	Sector	Year	Company
0.9018019	1.1231555	1.377175	0.884667	CD	2010.0	DIS
1.7419247	1.0040424	1.127696	1.382742	CD	2011.0	DIS
1.2305487	1.1454453	1.150076	1.291714	CD	2012.0	DIS
1.3838744	1.2565905	1.439356	1.445174	CD	2013.0	DIS
1.1559272	1.1241259	1.412566	1.618017	CD	2014.0	DIS
0.8980286	0.9667184	1.086713	1.365554	CD	2015.0	DIS
1.0739699	1.1167953	1.079627	1.213636	CD	2016.0	DIS
1.1809486	1.1964852	1.336229	1.291757	CD	2017.0	DIS
1.1152797	0.9236697	1.105157	1.234234	CD	2018.0	DIS
0.9551988	1.2984880	1.199374	1.435033	CD	2019.0	DIS
0.8490814	1.1231555	1.377175	0.884667	CD	2010.0	PHM
2.9180833	1.0040424	1.127696	1.382742	CD	2011.0	PHM
1.0725636	1.1454453	1.150076	1.291714	CD	2012.0	PHM
1.0661728	1.2565905	1.439356	1.445174	CD	2013.0	PHM
0.8138027	1.1241259	1.412566	1.618017	CD	2014.0	PHM
1.0557768	0.9667184	1.086713	1.365554	CD	2015.0	PHM
1.8032347	1.1167953	1.079627	1.213636	CD	2016.0	PHM
0.7653214	1.1964852	1.336229	1.291757	CD	2017.0	PHM

We used six different models

- Multiple linear regression
 - Baseline model
- LASSO, Ridge, Backward Elimination
 - Regularization and feature selection
- Random Forest and XGBoost
 - Break free of assumption of linearity

Results of models

Model	1 Year Stock Return MAE	2 Year Stock Return MAE	3 Year Stock Return MAE
Multiple Linear Regression	41.0%	38.4%	39.1%
LASSO	18.8%	30.5%	35.5%
Ridge	43.6%	31.8%	54.6%
Backward Elimination	28.2%	30.6%	39.3%
Random Forest	17.6%	25.5%	32.4%
XGBoost	19.1%	26.4%	34.4%

MAE increases as year increases



Result of Random Forest

1 Year Return	IncNodePurity
Total Revenue 5	1.60
EBITA 5	0.93
<u>Cash from Operations 2</u>	0.82
Capital Expenditure 5	0.53
<u>Cash from Operations</u>	0.52

Increase In Node Purity: decrease in purity if a particular variable has no information

2 Year Return	IncNodePurity
Total Revenue 5	2.09
Capital Expenditure 5	1.82
<u>Cash from Operations 2</u>	1.67
Total Revenue 3	1.60
Return on Capital	1.43

3 Year Return	IncNodePurity
EBITDA Margin	4.67
Return on Capital	3.98
Inventory 5	3.31
Inventory 3	3.24
Avg Days Sales Out	3.14

Revenue (Earning)

- Total Revenue 5 & 3
- EBITA 5
- EBITDA Margin
- Avg Days Sales Out
- Inventory 5 & 3

Operations

- Cash from Operations 5 & 2

Expenditures

- Capital Expenditure 5

Return (Ability of generate profit)

- Return on Capital

Statistical Significance Founded in Backward Elimination

1 Year Return	2 Year Return	3 Year Return
<u>Total Revenue</u>	Total Revenue	SG&A Margin
Net Income Margin	Total Liability Total Assets	<u>EBITDA</u>
<u>EBITA</u>	Avg Cash Conversion Cycle	Gross Margin
Diluted Earnings per Share	Total Debt Equity	<u>Capital Expenditure</u>
Avg Cash Conversion Cycle	Gross Margin	<u>EBITA</u>
<u>Inventory 5</u>	SG&A Margin	Total Assets 5
Levered Free Cash Flow	<u>EBITDA</u>	

Adjusted R-squared: 0.4437
p-value: < 2.2e-16

Adjusted R-squared: 0.3225
p-value: < 2.2e-16

Adjusted R-squared: 0.3585
p-value: < 2.2e-16

Limitation of Research

1. Don't track the stock performance pattern in each specific sector
 - market sensitivity
2. Only examined data from 2010 - 2019
 - miss stock performance pattern in Great Recession and Covid-19
3. Only collected data from three different sectors
4. Not all financial ratios were included

Conclusion

- The MAE's of our models not low enough for good confidence
- We were still able to determine significant ratios
- Future research can improve on what we've done

Slides For Potential Questions

1. How you determine whether to trust the results in Random Forest or not given it doesn't provide statistics like p-value?
2. Regression model specific (Details attached after this page)
 - How the algorithm works
 - Residual Plots

LASSO Regression

$$\frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2 + \lambda \sum_{j=1}^p |\hat{\beta}_j|$$

Ridge Regression

$$\frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2 + \lambda \sum_{j=1}^p (\hat{\beta}_j)^2$$

Backward Elimination

Step: AIC=-1355.41

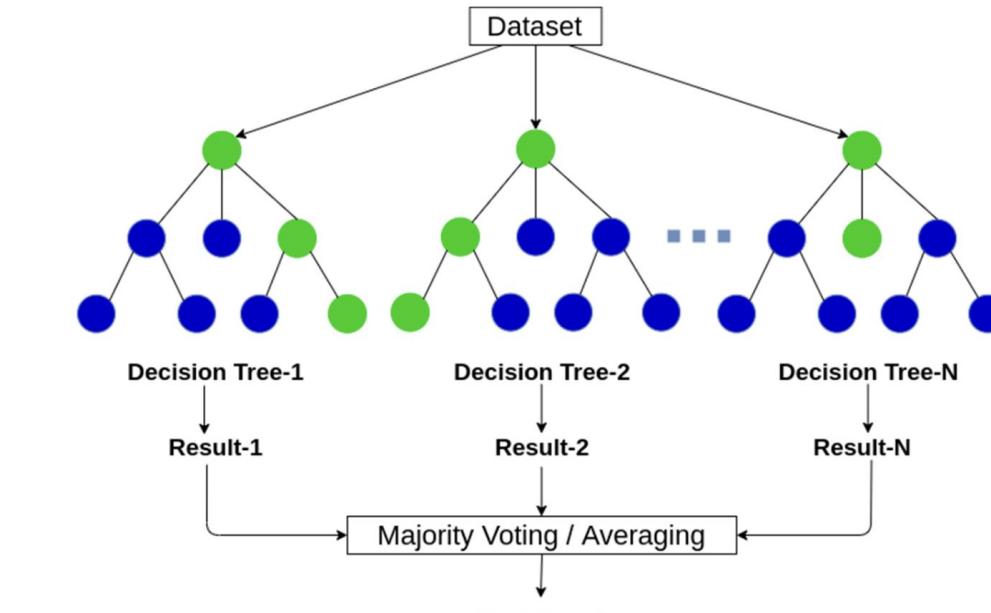
(Stock.Return..2.Year.) ~ Return.on.Equity.. + Return.on.Common.Equity.. +
Gross.Margin.. + EBITDA.Margin.. + EBITA.Margin.. + Normalized.Net.Income.Margin.. +
Levered.Free.Cash.Flow.Margin.. + Avg..Days.Sales.Out. +
Avg..Days.Payable.Out. + Total.Debt.Equity + LT.Debt.Equity +
LT.Debt.Capital + Total.Liabilities.Total.Assets + Total.Revenue +
Gross.Profit + EBIT + Net.Income + Normalized.Net.Income +
Total.Assets + Tangible.Book.Value + Cash.from.Ops. + Capital.Expenditures +
Total.Revenue2 + EBITDA2 + EBIT2 + Earnings.from.Cont..Ops.2 +
Diluted.EPS.before.Extra2 + Net.PP.E2 + Capital.Expenditures2 +
Levered.Free.Cash.Flow2 + Unlevered.Free.Cash.Flow2 + Dividend.per.Share2 +
Total.Revenue3 + EBITDA3 + Accounts.Receivable3 + Inventory3 +
Levered.Free.Cash.Flow3 + Unlevered.Free.Cash.Flow3 + EBITDA5 +
EBITA5 + Net.Income5 + Diluted.EPS.before.Extra5 + Accounts.Receivable5 +
Inventory5 + Net.PP.E5 + Common.Equity5 + Levered.Free.Cash.Flow5 +
Dividend.per.Share5 + SP500.2.Year



Step: AIC=-1365.52

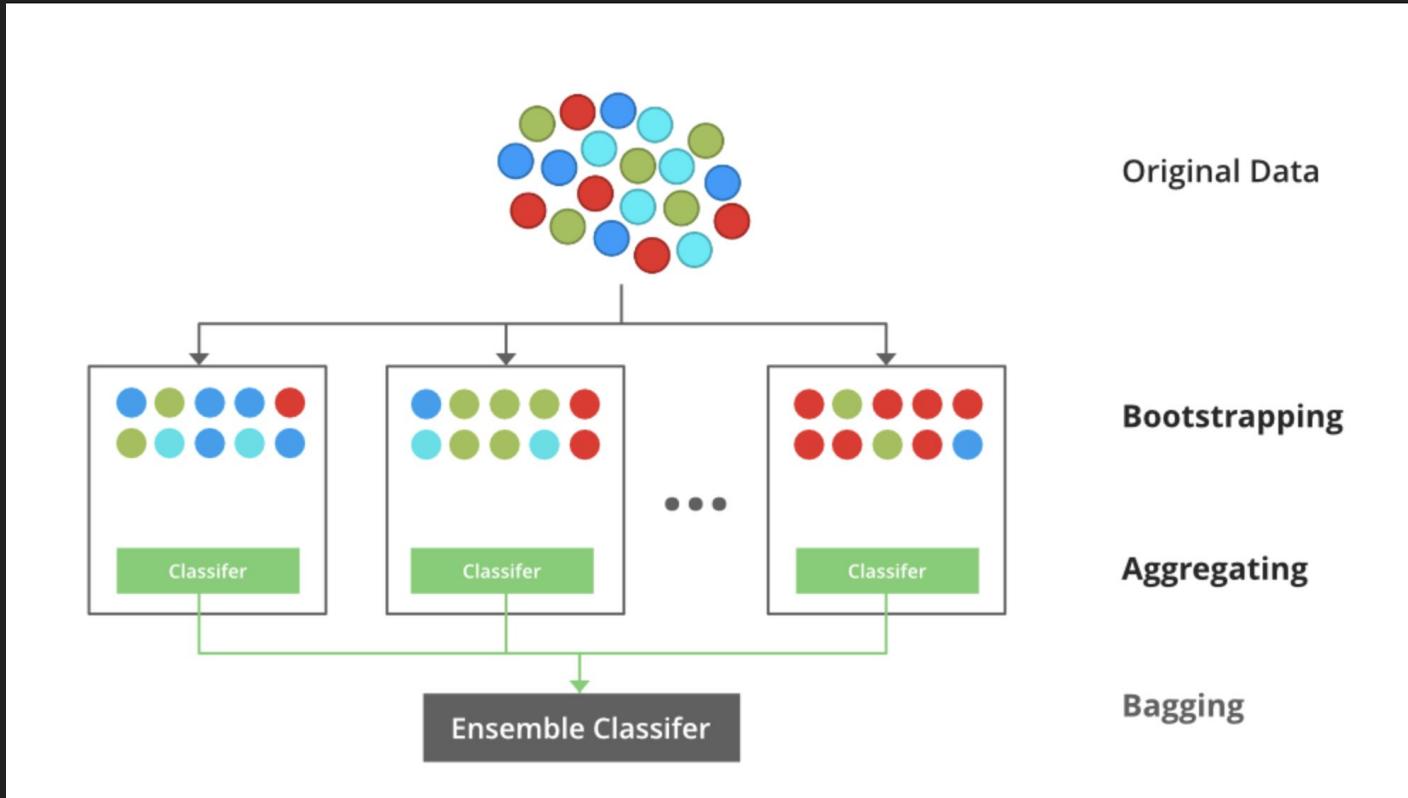
(Stock.Return..2.Year.) ~ Return.on.Equity.. + Normalized.Net.Income.Margin.. +
Avg..Days.Sales.Out. + Total.Debt.Equity + LT.Debt.Equity +
LT.Debt.Capital + Total.Revenue + Gross.Profit + EBIT + Normalized.Net.Income +
Total.Assets + Cash.from.Ops. + Total.Revenue2 + EBITDA2 +
Earnings.from.Cont..Ops.2 + Diluted.EPS.before.Extra2 + Capital.Expenditures2 +
Levered.Free.Cash.Flow2 + Dividend.per.Share2 + Total.Revenue3 +
EBITDA3 + Accounts.Receivable3 + Inventory3 + Levered.Free.Cash.Flow3 +
Unlevered.Free.Cash.Flow3 + EBITDA5 + EBITA5 + Net.Income5 +
Diluted.EPS.before.Extra5 + Accounts.Receivable5 + Inventory5 +
Net.PP.E5 + Common.Equity5 + Dividend.per.Share5 + SP500.2.Year

Random Forest



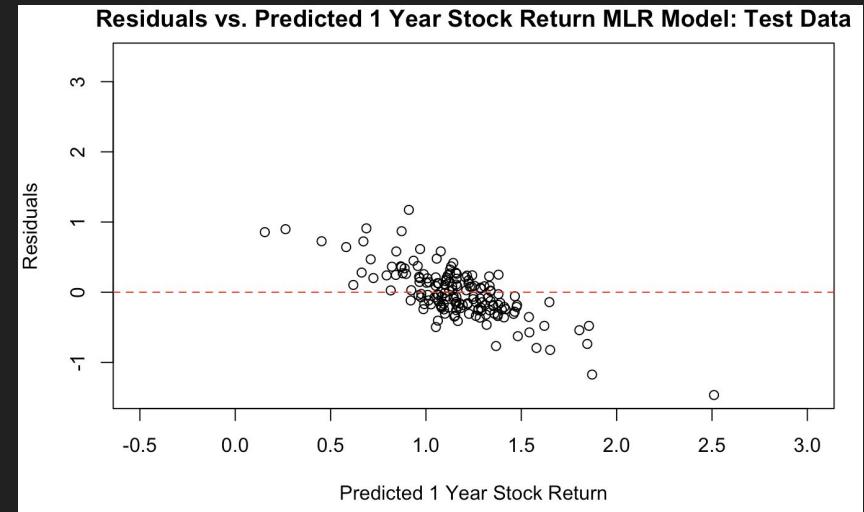
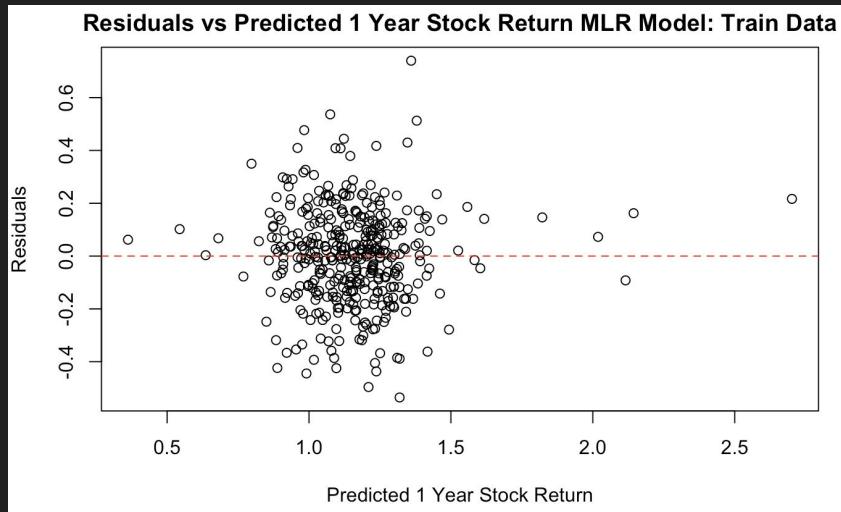
Source: <https://anasbrital98.github.io/blog/2021/Random-Forest/>

XGBoost

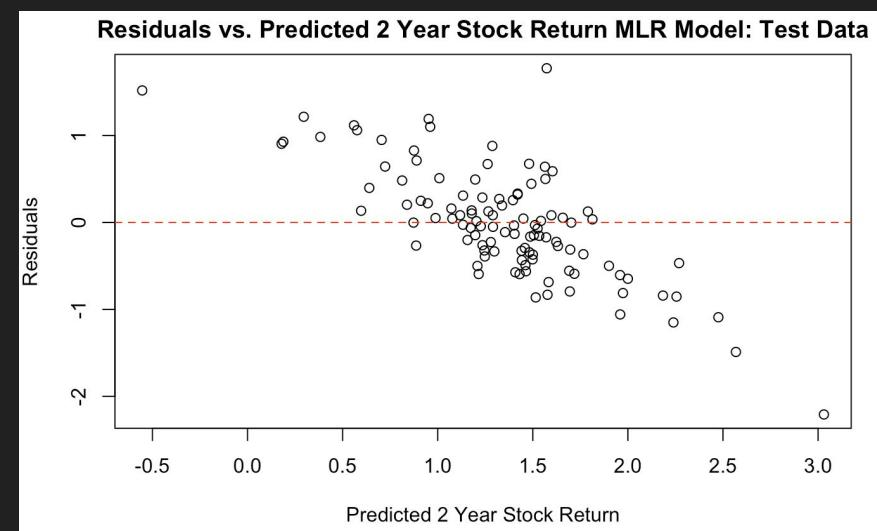
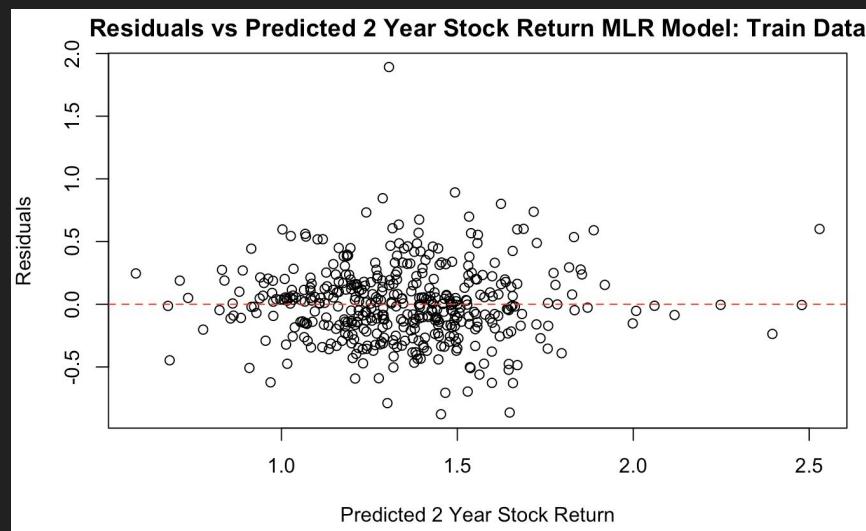


Source: <https://www.geeksforgeeks.org/xgboost/>

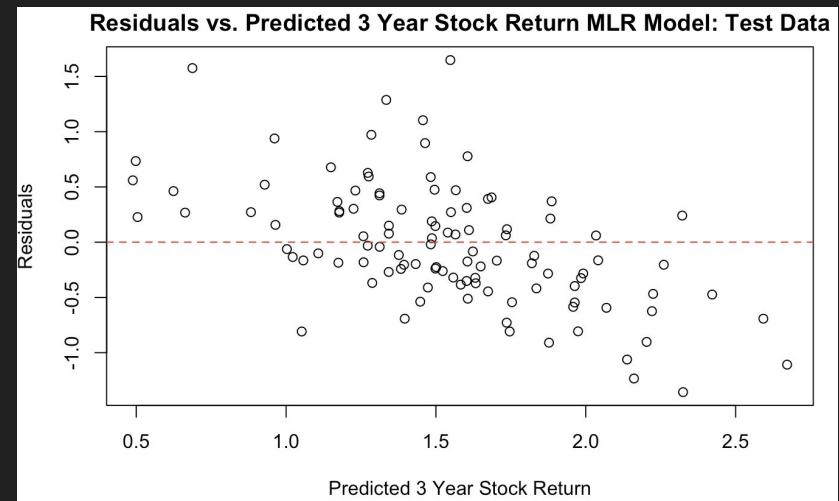
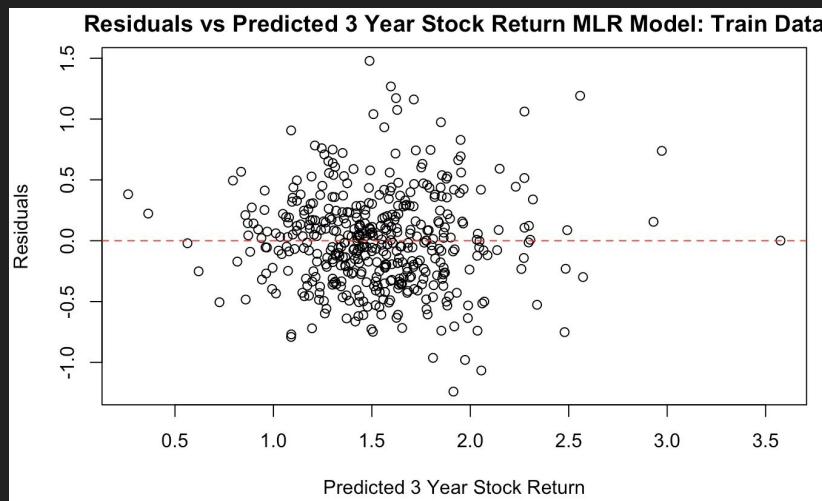
MLR Residuals 1 Year Stock Return



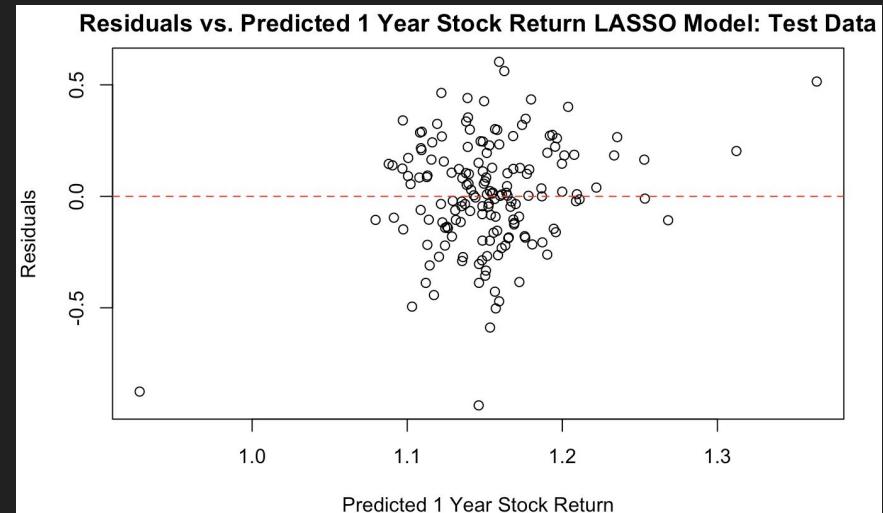
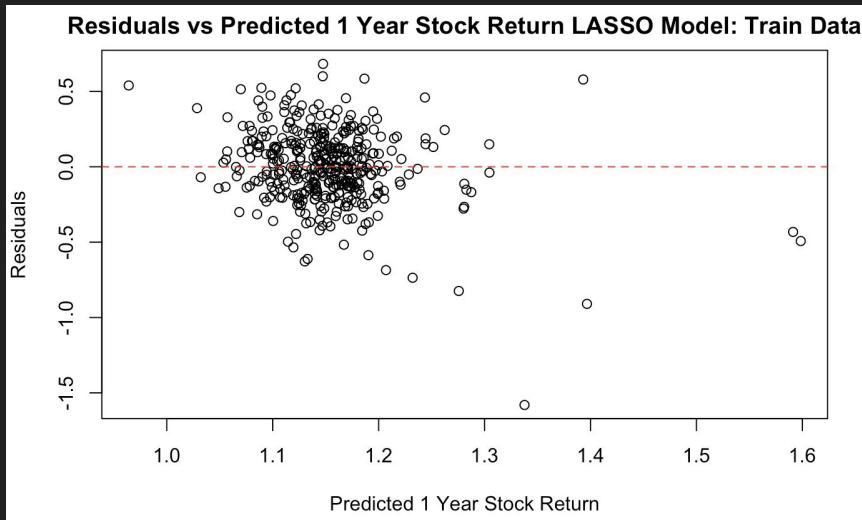
MLR Residuals 2 Year Stock Return



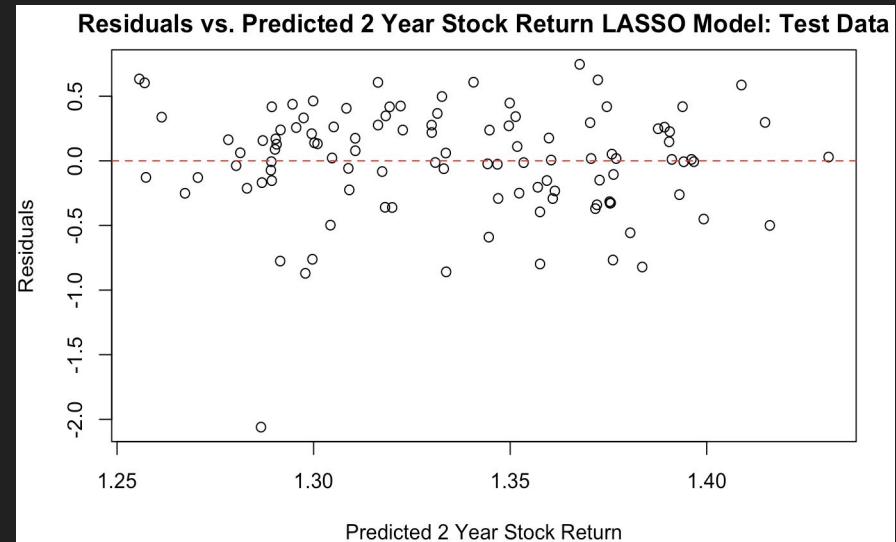
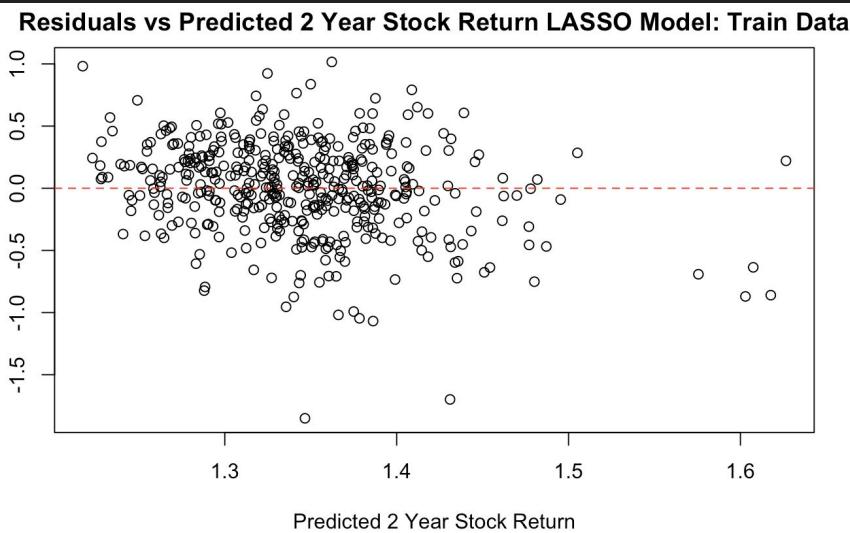
MLR Residuals 3 Year Stock Return



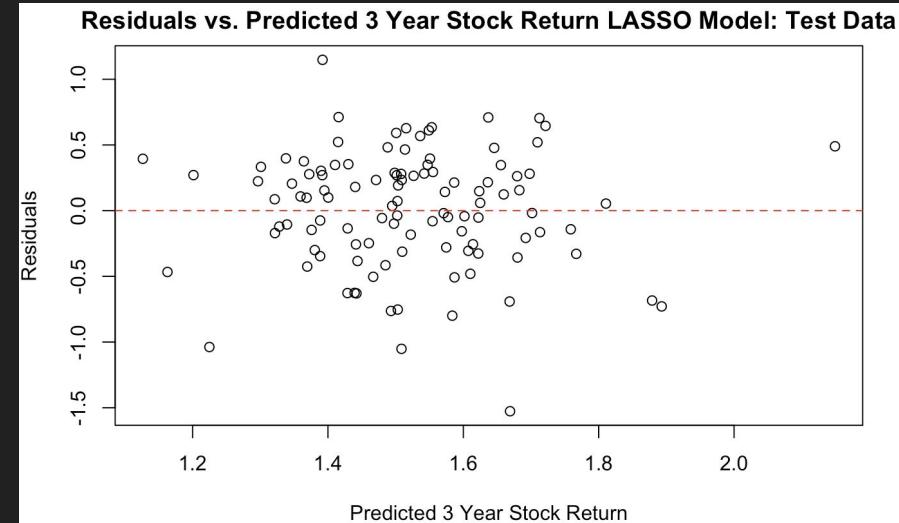
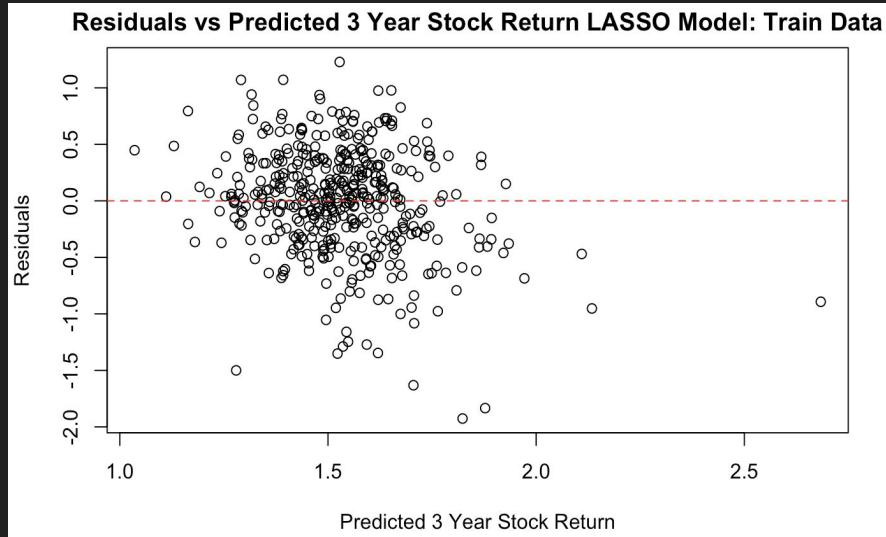
LASSO Residuals 1 Year Stock Return



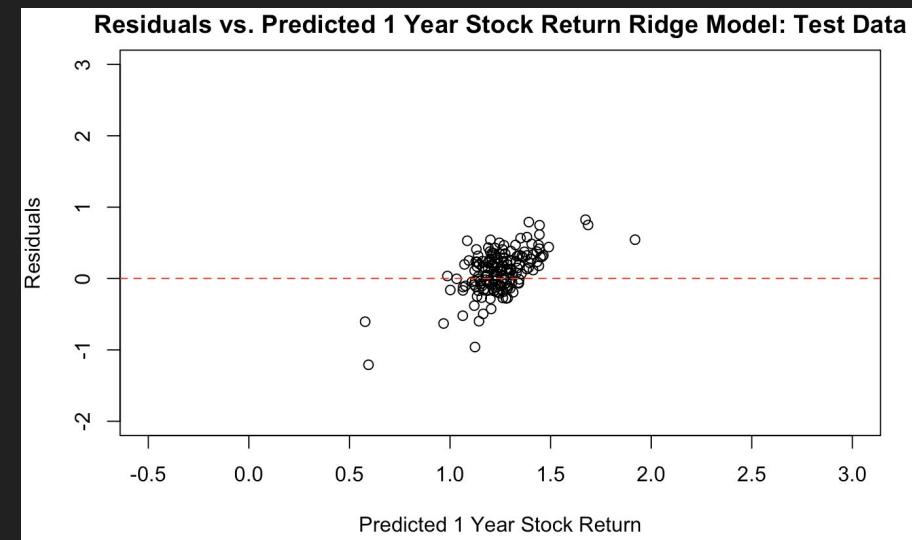
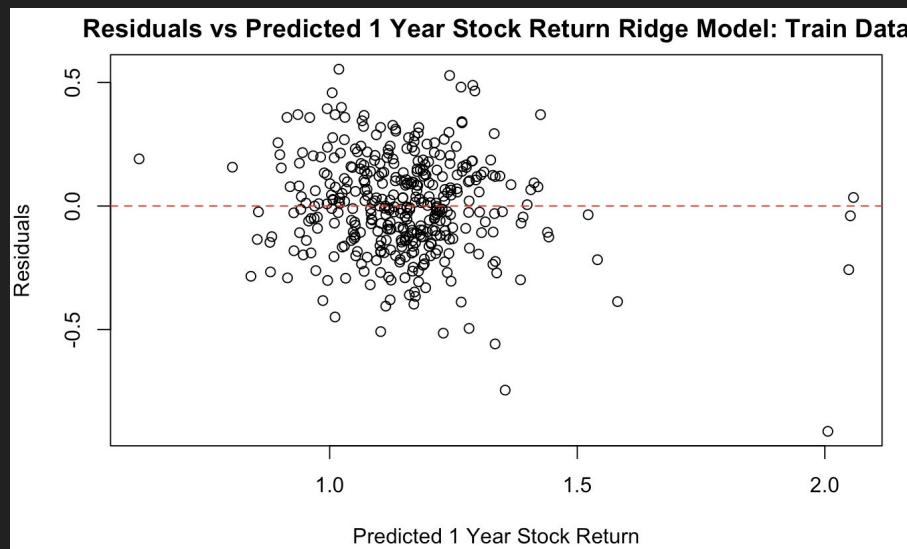
LASSO Residuals 2 Year Stock Return



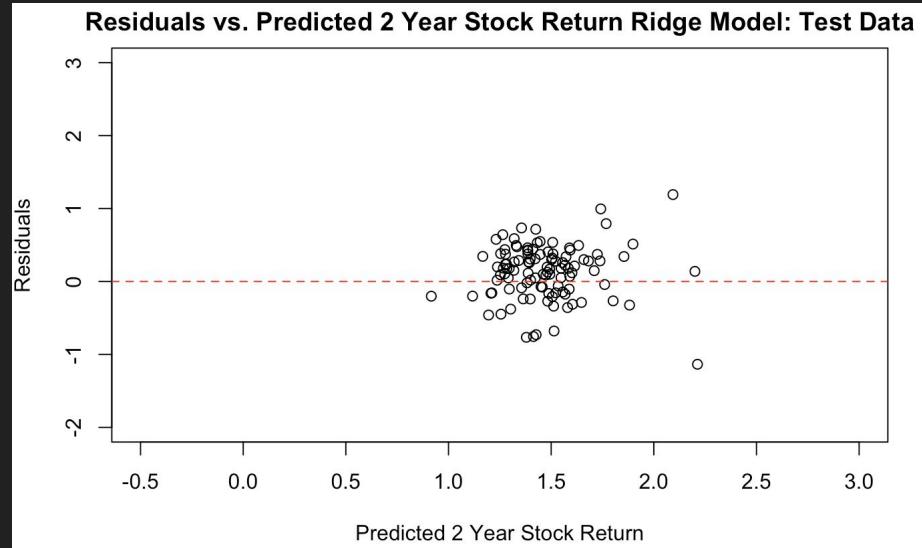
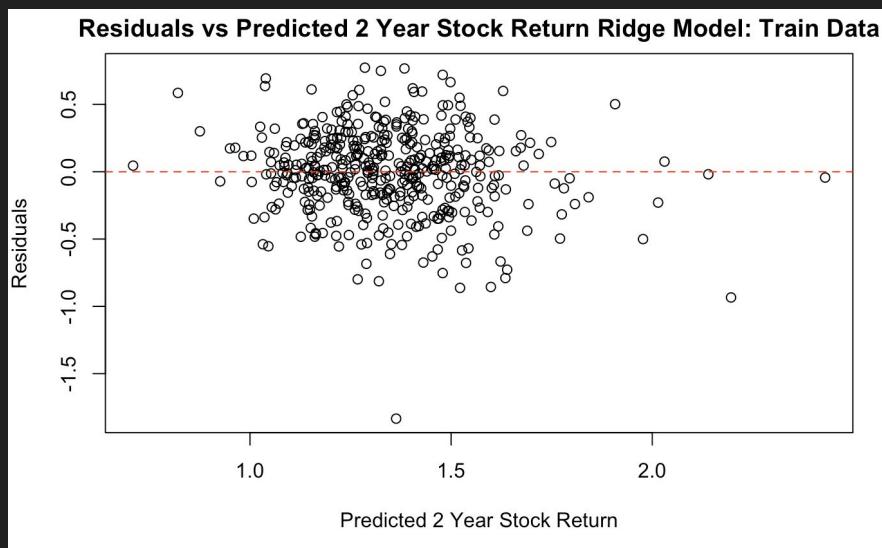
LASSO Residuals 3 Year Stock Return



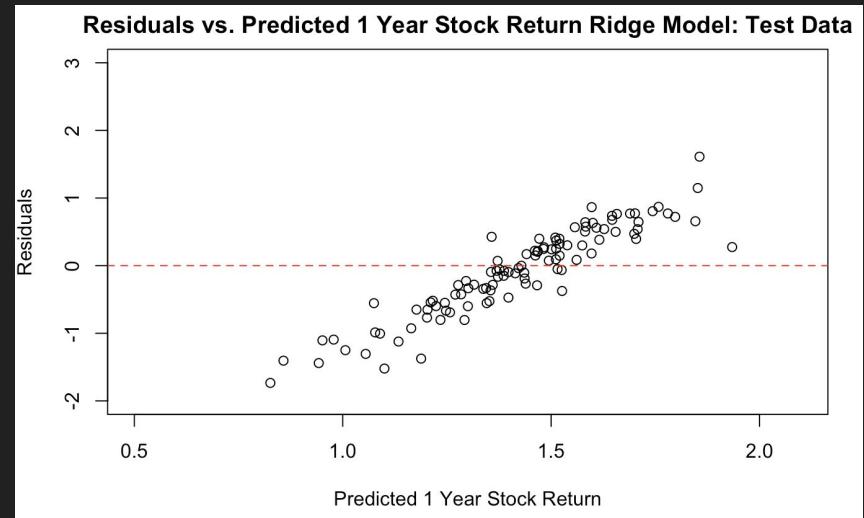
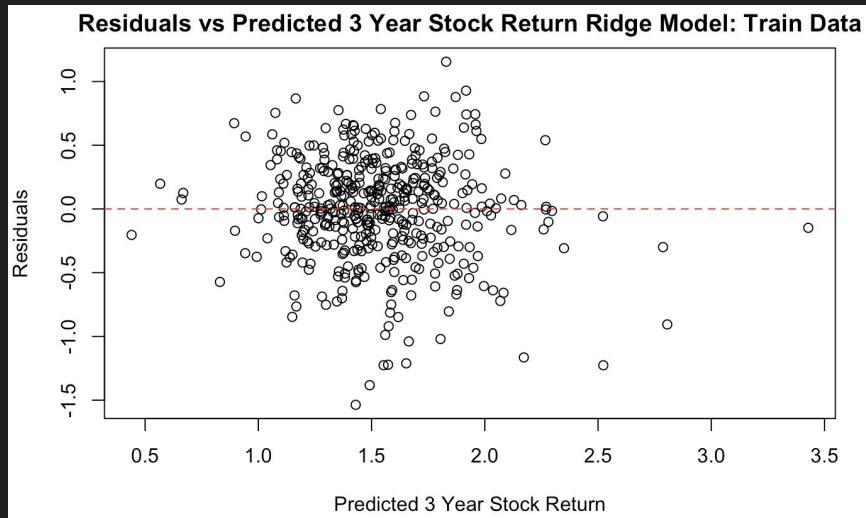
Ridge Residuals 1 Year Stock Return



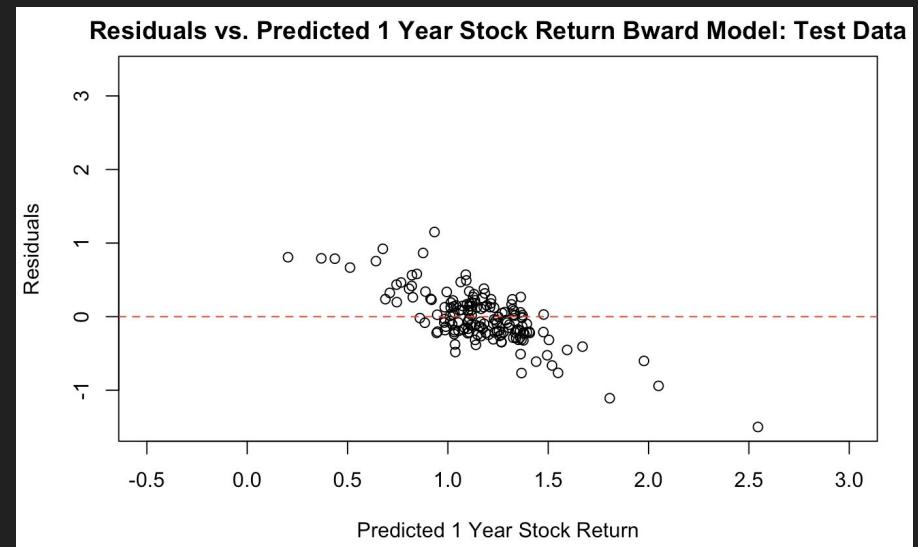
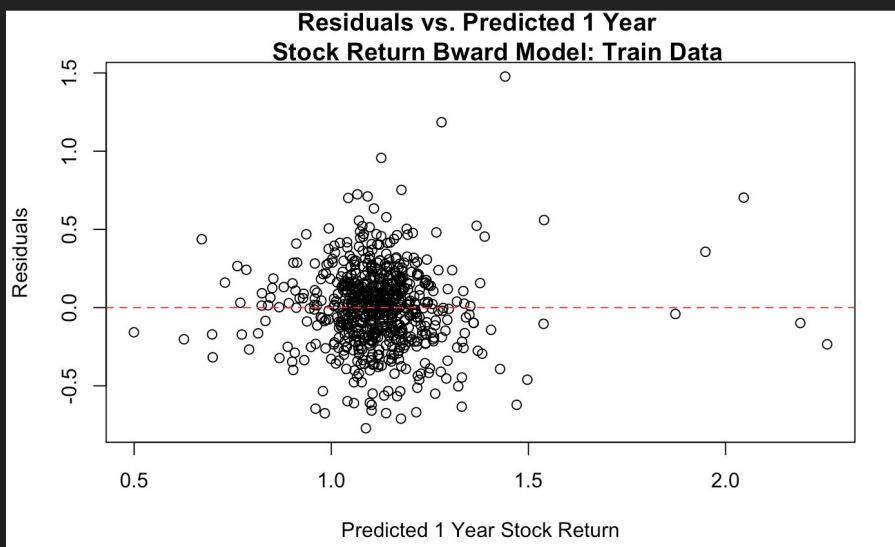
Ridge Residuals 2 Year Stock Return



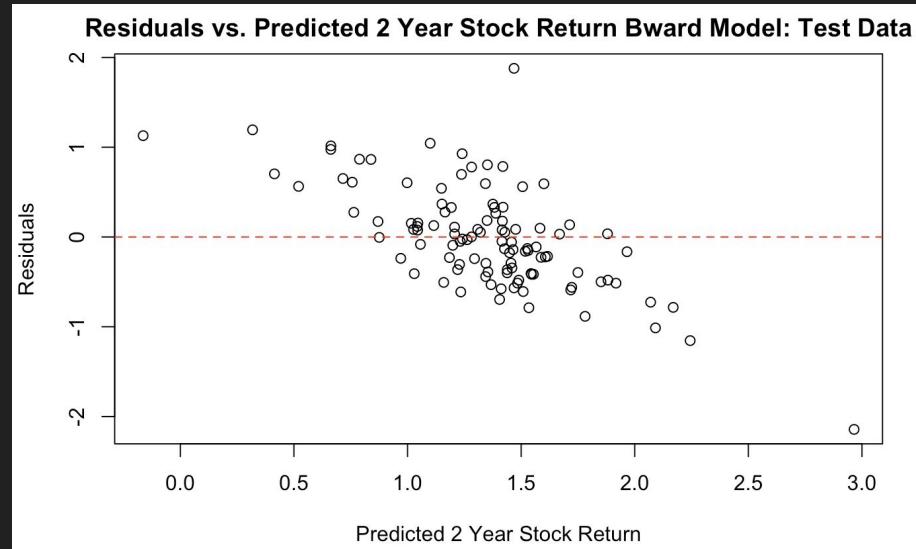
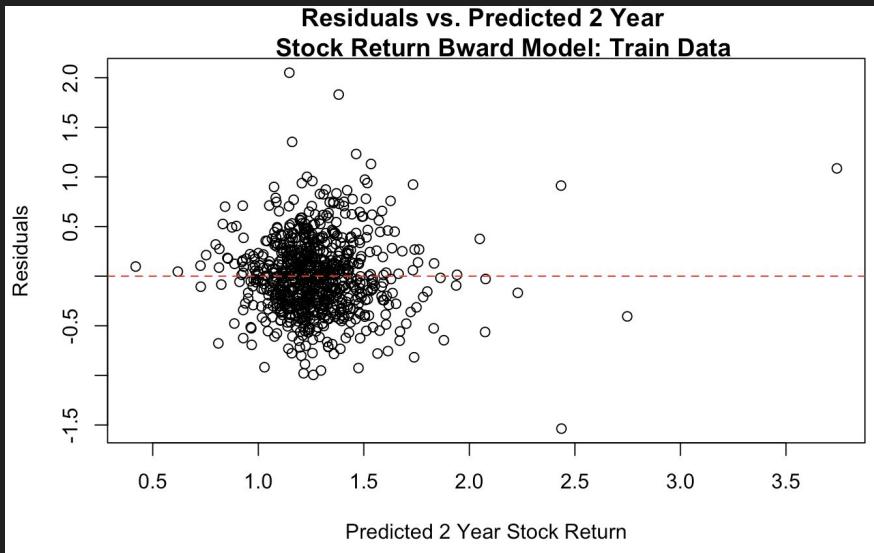
Ridge Residuals 3 Year Stock Return



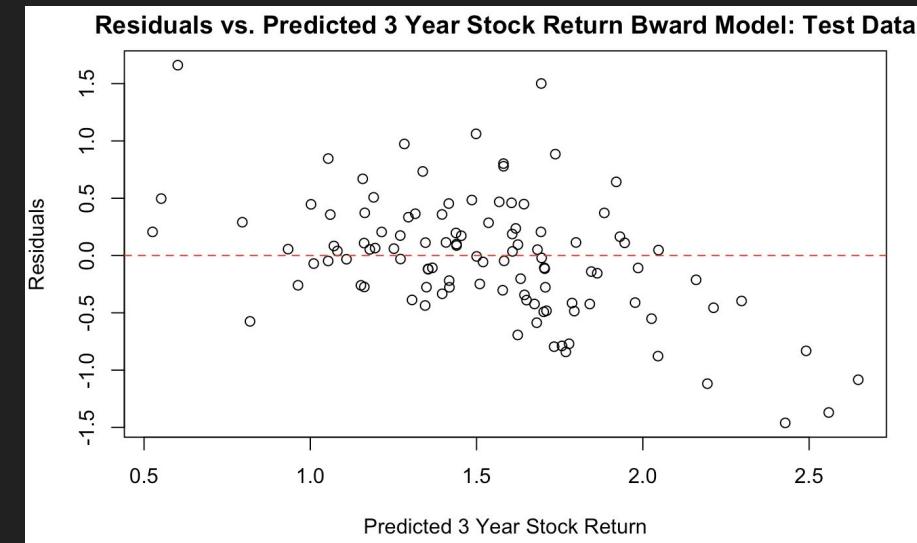
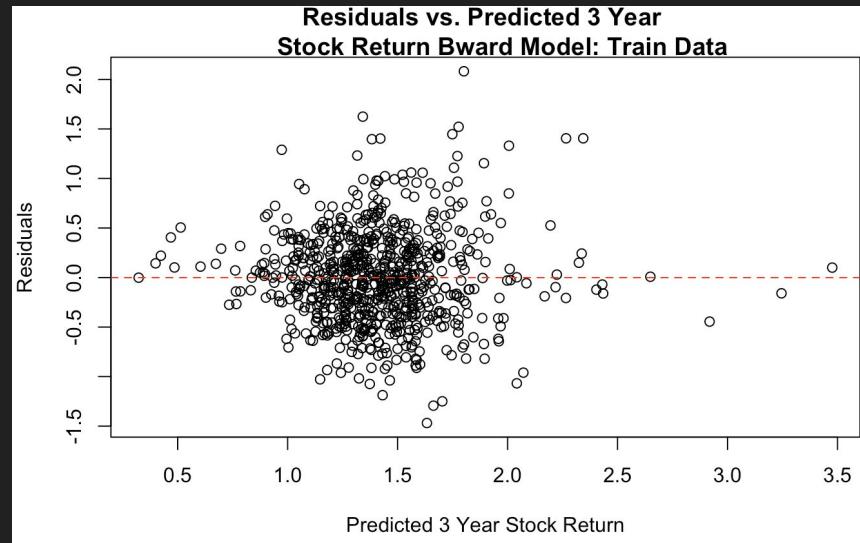
Backward Residuals 1 Year Stock Return



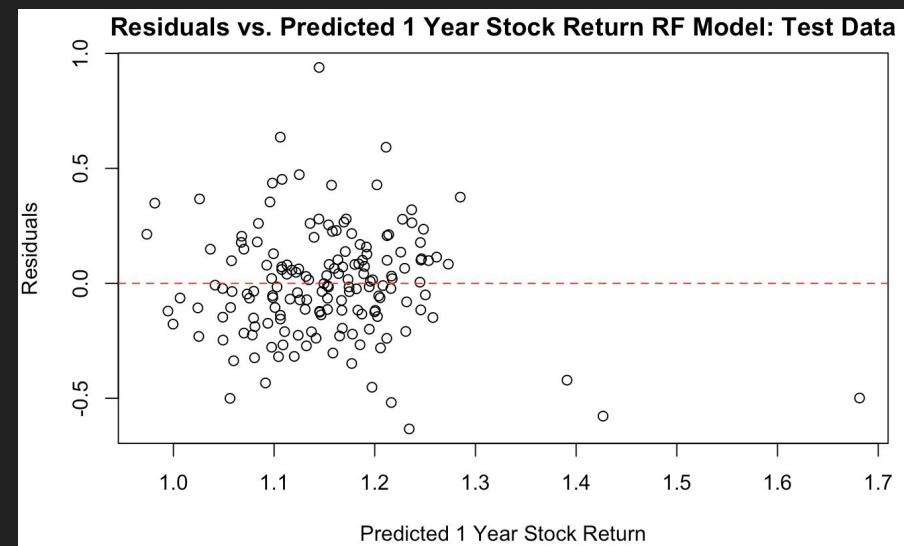
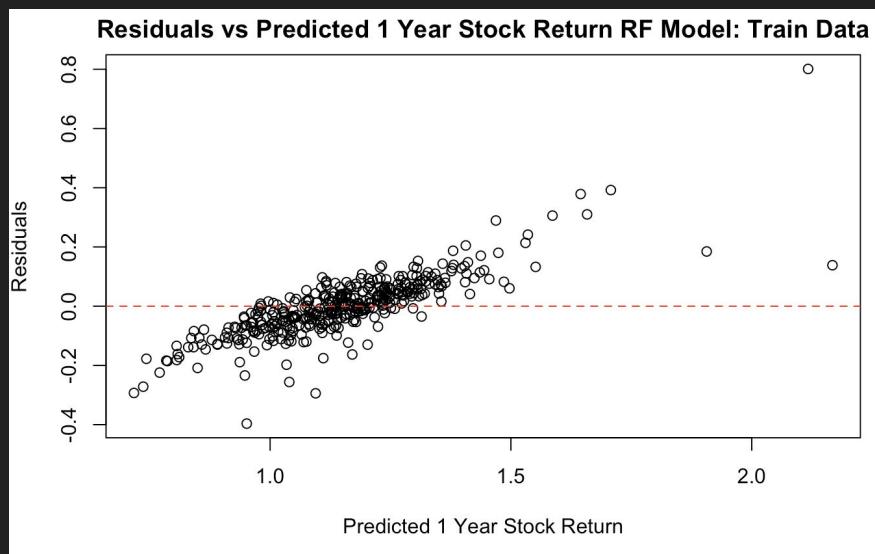
Backward Residuals 2 Year Stock Return



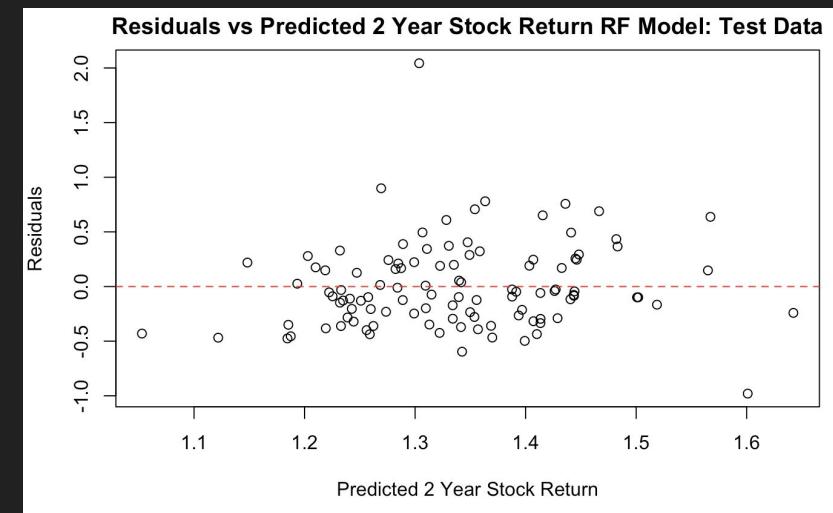
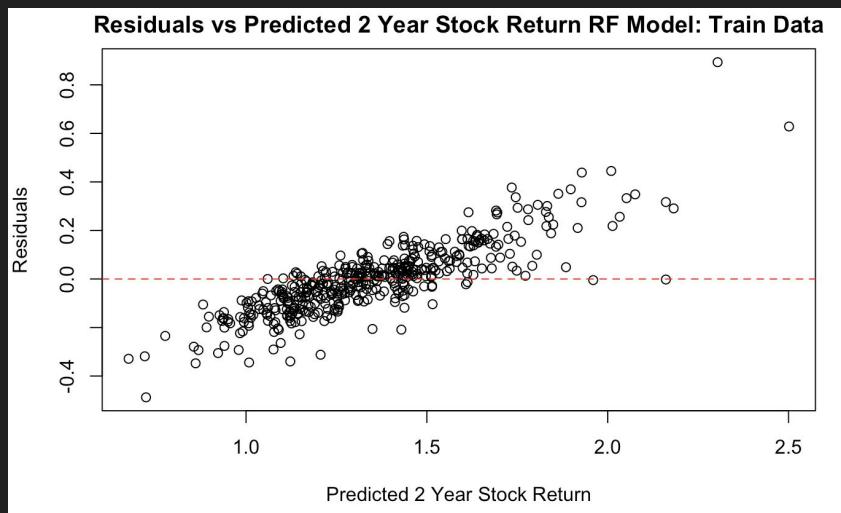
Backward Residuals 3 Year Stock Return



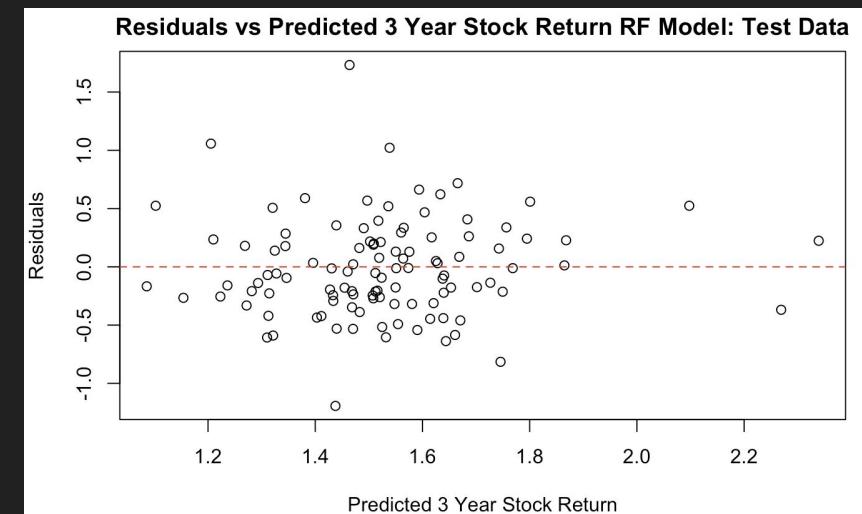
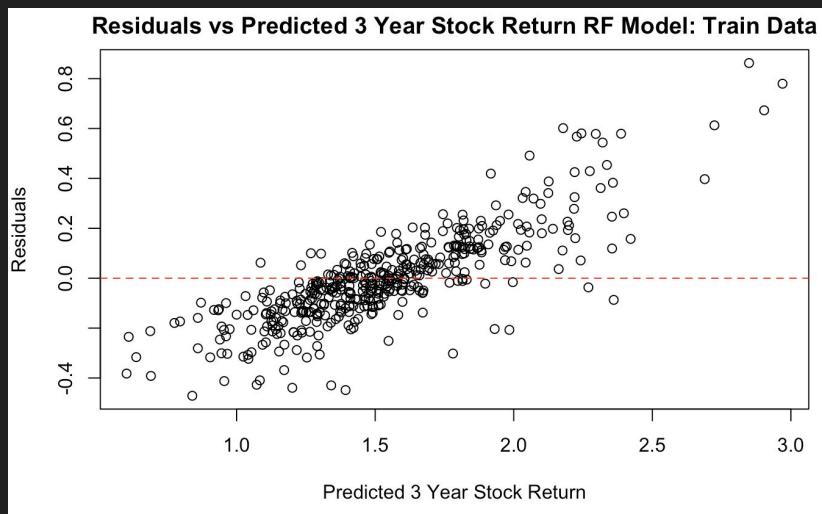
Random Forest Residuals 1 Year Stock Return



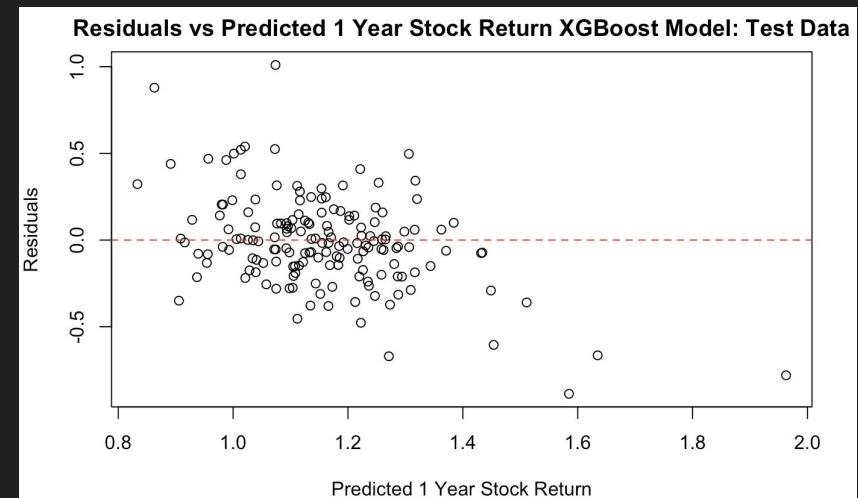
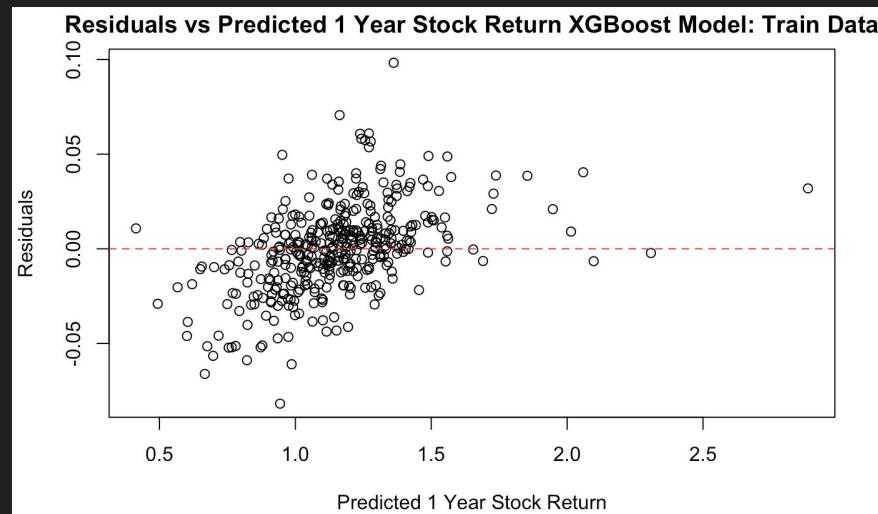
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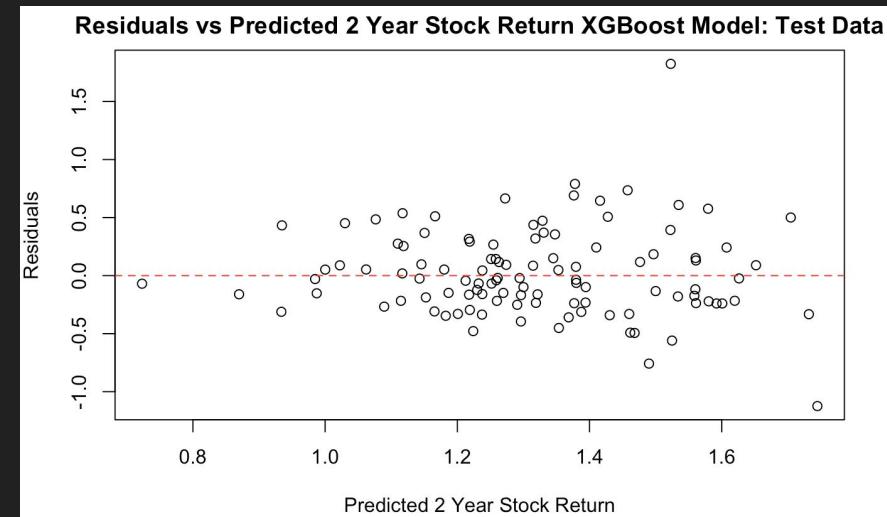
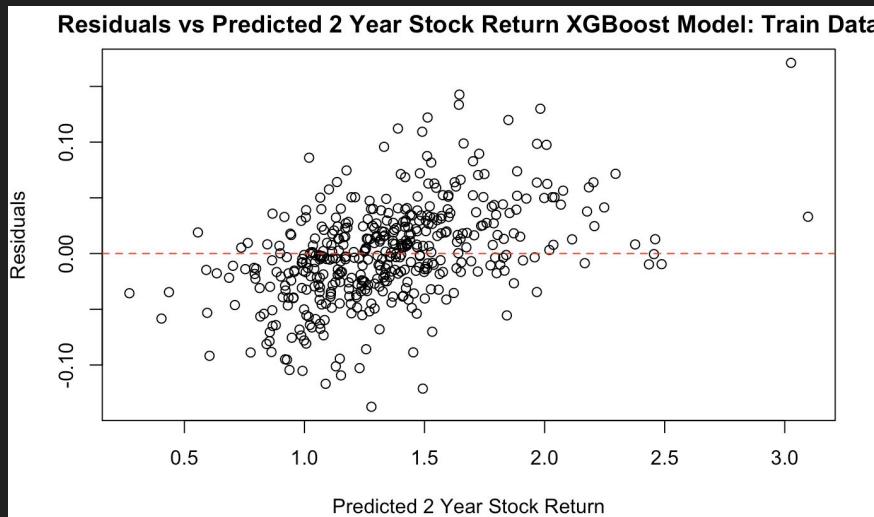
Random Forest Residuals 3 Year Stock Return



XGBoost Residuals 1 Year Stock Return



XGBoost Residuals 2 Year Stock Return



XGBoost Residuals 3 Year Stock Return

