Would AI Stocks Estimate Be As Surprised to USDA Stocks Reports as Private Market Analysts?

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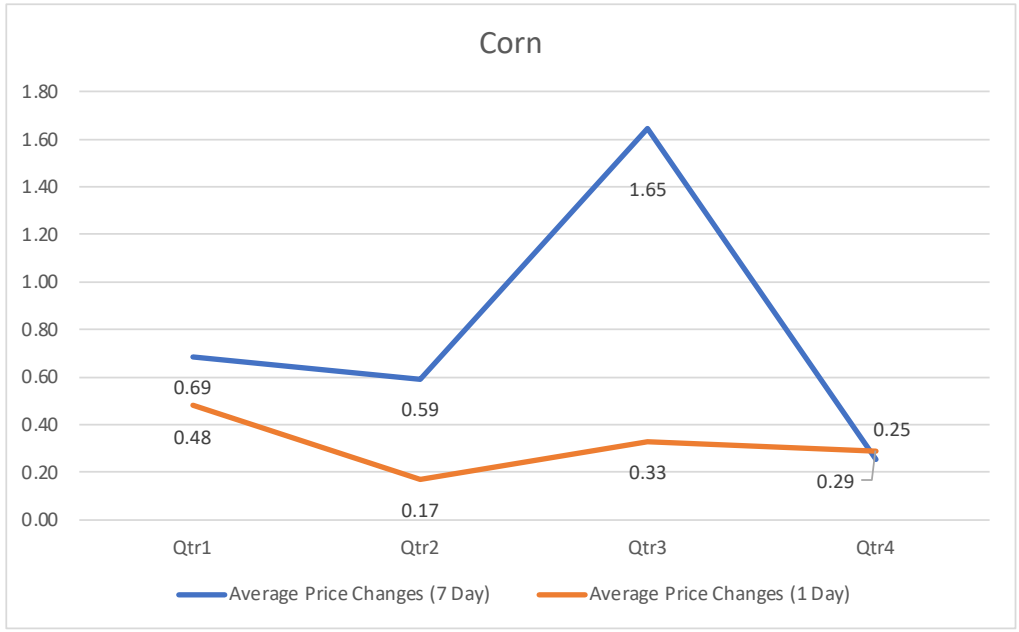
Background

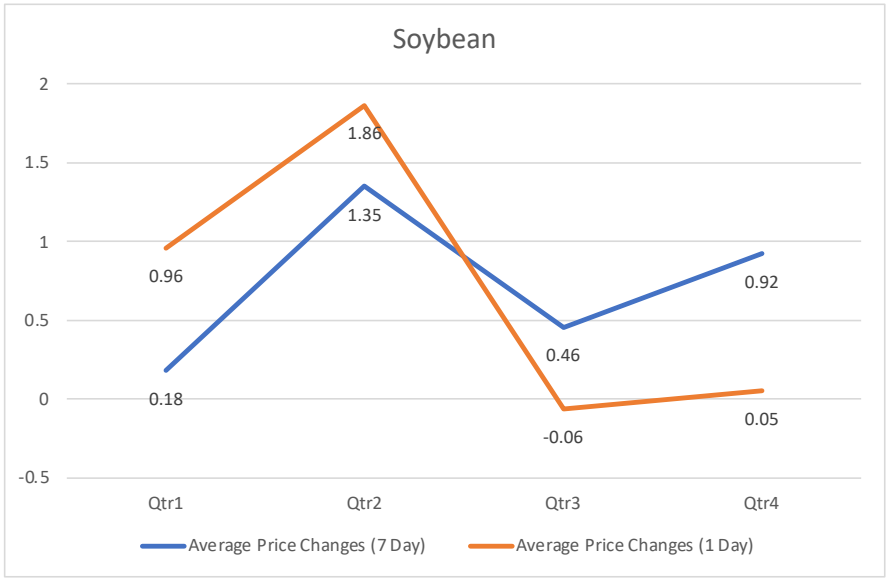
- USDA Releases a quarterly grain stocks report to assess the current supply.
- Grain stocks reports are based on survey responses from a random sample of producers and an extensive sample of grain purchasers.
- Unknown sources of surprise in USDA estimates (e.g., grain in transit?, errors in estimating production, survey error?)

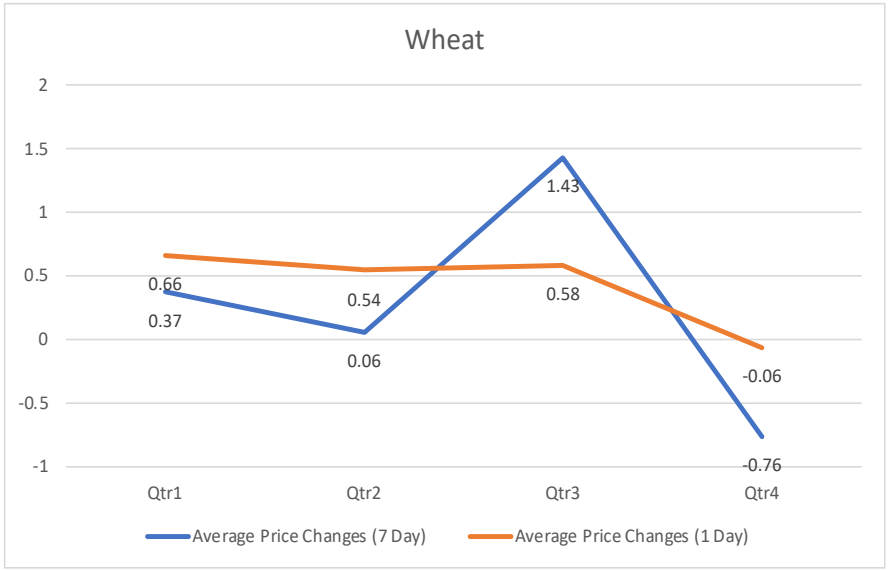
Motivation

- Surprises to USDA reports with price impacts
- Reuters is now providing an AI Smart Estimate of USDA reports and their market analysts survey.
- Understanding the Market Efficiency of Agricultural Commodities Market - USA
- Unknown sources of surprise in USDA estimates—Can AI & 'Big Data' reduce surprise?

Quarterly Reports Surprise on Prices







Variations are in Dollar amount

Theory of Information and Markets

- Eugene Fama's(1970) EMH is that the price in any market represents all the information available.
- A weak EMH suggests that buyers can find undervalued and overvalued assets using fundamental analysis because the market lacks information or computation abilities.
- A strong EMH suggests all publicly available information is incorporated in the crop's current price, and there is no technical or fundamental analysis that could reliably capture gain in a market.

Theory of Information and Markets

A market is inefficient if the prices do not adequately reflect their actual value. Market inefficiency can occur for various reasons, including

- Asymmetries in information,
- A lack of buyers and sellers (i.E., Poor liquidity),
- High transaction costs or delays,
- Market psychology,
- Human emotion.

Market inefficiency results in deadweight losses. Most markets exhibit some degree of inefficiency; in extreme cases, an inefficient market can illustrate market failure.

Theory of Information and Markets

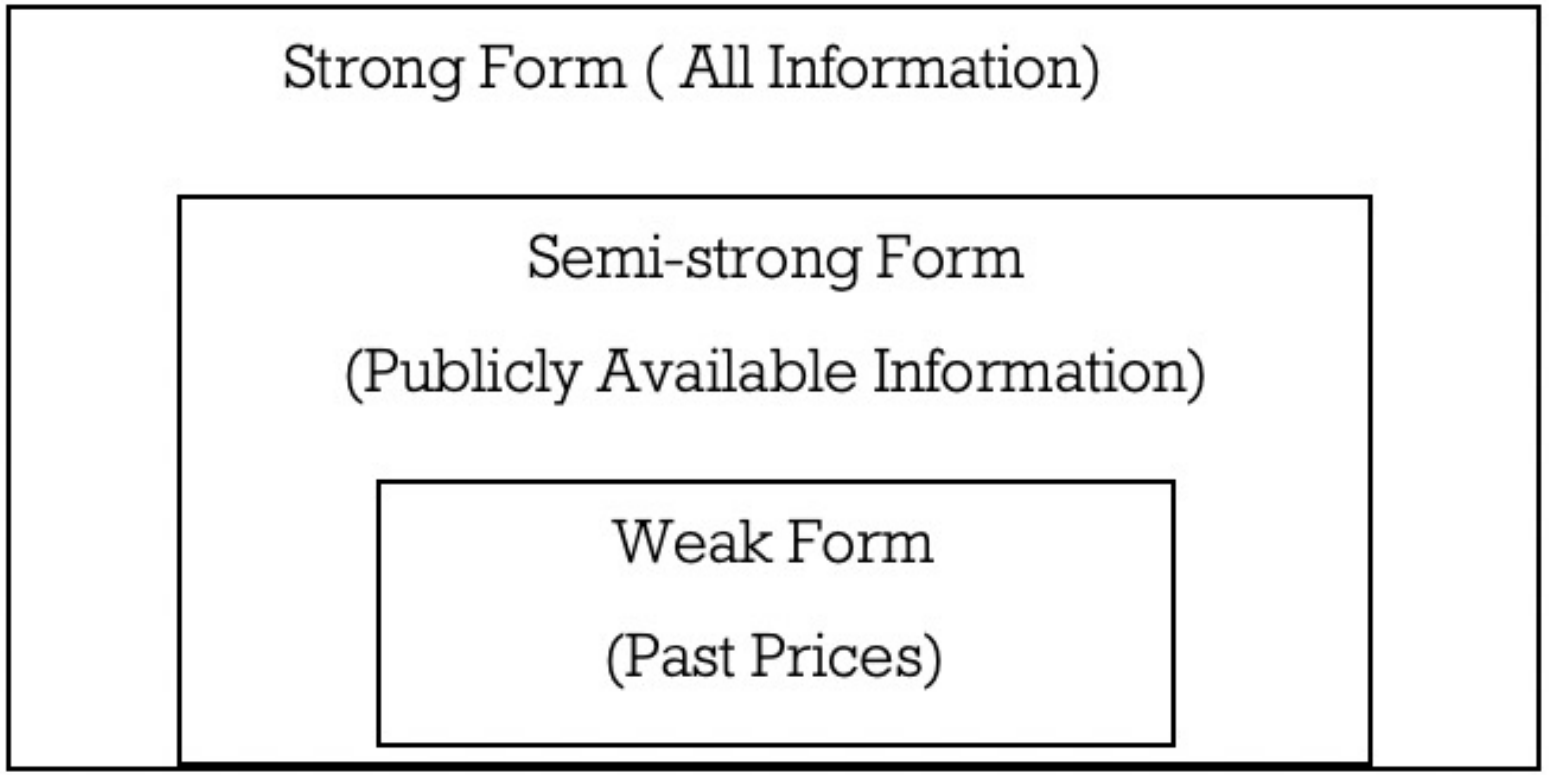


Figure: Cumulative levels of market efficiency and the information associated with each level (Jones, 1993:628)

Previous literature on USDA Reports, Market Surprises, and Price Effects

- Isengildina-Massa et al. (2020) suggested that it is important to determine whether USDA forecasts have become less competitive relative to private forecasts over time with the emergence of "big data," better predictive methods, and better access to information.
- Several studies have indicated a decrease in the informational usefulness of USDA agricultural output estimates (Garcia et al. (1997)), consistent with the rise in the availability of private forecasts.
- Karali, B. et al. (2018) suggested that market surprises based on survey-based forecasts suffer from the errors-in-the-variables problem and therefore attenuate the price responses when ignored.
- Xiao et al. (2017) found the inefficiency in these projections— soybeans worst of all. They detect bias in soybeans forecast revisions but not in corn and wheat revisions.
- Garcia et al. (1997) found that for soybeans, private forecasts appeared more accurate than USDAs at the beginning of the forecasting cycle (August and September), but USDA forecasts were dominant for October and November.

Description of New Research

Research Objectives

1. Evaluate whether AI and 'Big Data' can predict more accurately what the USDA will report for Grain Stocks compared to market analysts.

2. Identify the sources of surprises to USDA Grain Stock reports.

Data

Data Source	Data	Variable Name	Timeline
USDA-NASS	Grain Stocks and Production by State	commodity, state_name, bushels_stocks, bushes_production,	Aggregated Quarterly
US Surface Transportation Board	Weekly Grain Loaded on Trains by State	rail_bushels	Aggregated Quarterly
US Army Corp of Engineers	Weekly Grain Barges that moved through locks on the Mississippi, Arkansas & Ohio River	barge_bushels	Aggregated Quarterly
Energy Information Adminstration	Weekly Ethanol Production in PADD2 (Midwest)	ethanol_crush	Aggregated Quarterly
National Oilseed Processors Assoc	Monthly Oilseed Crush	oilseed_crush	Aggregated Quarterly
USDA's Foreign Agriculutaral Service	Weekly Grain Exports	weekly exports	Aggregated Quarterly
Reuters	Market Analysts Survey	Average, Actual, Market_analyst_Reuters, surprise	Aggregated Quarterly
Bloomberg	Market Analysts Survey	Average, Actual, Market_analyst_Bloomberg, surprise	Aggregated Quarterly

Data

	Bushels_Stocks	Carry_Over	Bushels_Production	Rail_Bushels	Barge_Bushels	Oilseed_Crush	Ethanol_Crush	Accumulated_Exports
2014	**14068.6**	**1747.781**	**17835.839**	**2570.239**	**4728.689433**	**7.26616**	**70469.7**	**6935.036864**
CORN	10539.923	1149.362	12966.4	863.429	2226.004	2.52736	24511.2	1701.237088
SOYBEANS	2171.983	77.834	3094.8	825.321	2400.929666	1.73756	16851.45	2355.101397
WHEAT	1356.694	520.585	1774.639	881.489	101.755767	3.00124	29107.05	2878.698379
2015	**32530.793**	**7900.511**	**69119.995**	**8687.483**	**14501.15804**	**26.140707**	**324004.17**	**48387.31056**
CORN	23721.847	5558.476	50960.06	3231.1055	8675.048571	9.87456	137200.56	18082.3899
SOYBEANS	4317.375	499.306	12661.18	3090.6015	4985.409933	7.092882	96262.53	22331.64454
WHEAT	4491.571	1842.729	5498.755	2365.776	840.699533	9.173265	90541.08	7973.276119
2016	**35500.555**	**9643.9**	**72561.53**	**9452.4185**	**17073.44189**	**26.156024**	**353514.84**	**48795.1299**
CORN	25079.657	6531.956	52705.12	3470.908	10650.75829	9.702768	144557.28	17522.2435
SOYBEANS	4923.247	674.474	13731.99	3387.3315	5479.0276	7.277076	108417.96	22638.64198
WHEAT	5497.651	2437.47	6124.42	2594.179	943.656	9.17618	100539.6	8634.24442
2017	**37995.699**	**11562.255**	**74242.461**	**9334.115**	**16339.10166**	**26.12668**	**375162.48**	**57033.96172**
CORN	27132.236	7642.464	54416.02	3461.801	10125.96686	9.73944	154499.52	22709.47042
SOYBEANS	5548.381	863.4	14516.9	3368.4175	5179.004	7.30458	115874.64	25042.91491
WHEAT	5315.082	3056.391	5309.541	2503.8965	1034.1308	9.08266	104788.32	9281.576389
2018	**38861.324**	**12835.766**	**72993.952**	**9308.236**	**16002.52136**	**28.158378**	**369195.96**	**53360.12892**
CORN	26715.898	8412.804	53245.38	3481.506	11006.07086	10.627296	154260.96	22766.97347
SOYBEANS	6745.728	1331.854	14664.22	3399.7845	4214.3288	7.970472	115695.72	22900.47618
WHEAT	5399.698	3091.108	5084.352	2426.9455	782.1217	9.56061	99239.28	7692.679264
2019	**38889.686**	**13685.474**	**69822.294**	**8890.385**	**11092.20976**	**28.69036**	**358939.35**	**48720.77522**
CORN	25696.573	8233.416	51082.22	3330.4005	5753.823429	10.80176	150153.36	21405.70605
SOYBEANS	7845.608	2468.61	13367.4	3236.0755	4514.6008	8.10132	112615.02	19182.41291
WHEAT	5347.505	2983.448	5372.674	2323.909	823.785533	9.78728	96170.97	8132.65626
2020	**35835.541**	**13316.623**	**68575.518**	**9812.2045**	**15731.3524**	**30.311164**	**345264.99**	**46658.46913**
CORN	24507.805	7789.66	50352.04	3583.9545	8709.580002	11.307728	142201.92	16669.29414
SOYBEANS	6425.768	2629.312	12995.09	3506.1215	6171.7716	8.480796	106651.44	20620.50467
WHEAT	4901.968	2897.651	5228.388	2722.1285	850.0008	10.52264	96411.63	9368.670315
2021	**32420.666**	**9733.104**	**72287.33**	**10547.397**	**16475.97913**	**29.628776**	**355052.04**	**62595.26705**
CORN	23209.053	5801.334	53118.59	3893.6345	11684.04286	10.944992	145657.68	26538.3175
SOYBEANS	5126.791	1419.672	14490.96	3826.249	4020.4096	8.208744	109243.26	27981.3458
WHEAT	4084.822	2512.098	4677.78	2827.5135	771.526667	10.47504	100151.1	8075.60374
2022	**32170.339**	**7689.205**	**71720.859**	**10096.821**	**13727.7524**	**30.525264**	**375420.78**	**55391.46782**
CORN	22879.902	4698.466	52710.97	3763.6865	8004.812	11.307008	154260.96	23995.29237
SOYBEANS	5561.775	932.238	14554.51	3701.866	4971.8504	8.480256	115695.72	24158.30081
WHEAT	3728.662	2058.501	4455.379	2631.2685	751.09	10.738	105464.1	7237.87464

Table: Independent Variables (USA)

In Millions

Data

	Bushels_Stocks	Carry_Over	Bushels_Production	Rail_Bushels	Barge_Bushels	Oilseed_Crush	Ethanol_Crush	Accumulated_Exports
2014	**817.92**	**101.219**	**1148.57**	**199.9515**	**362.74715**	**0.47388**	**4595.85**	**471.937886**
CORN	607.504	75.896	787.36	66.6505	139.12525	0.15796	1531.95	106.327318
SOYBEANS	132.798	3.443	229.95	66.6505	218.2663333	0.15796	1531.95	214.100127
WHEAT	77.618	21.88	131.26	66.6505	5.355566667	0.15796	1531.95	151.510441
2015	**1873.978**	**444.288**	**4443.272**	**722.05**	**1015.421569**	**1.701117**	**21813.435**	**3499.595026**
CORN	1389.953	336.53	3174.26	262.752	542.1905357	0.61716	8575.035	1130.149369
SOYBEANS	249.791	22.606	930.94	262.752	430.7282333	0.61716	8575.035	1960.069145
WHEAT	234.234	85.152	338.072	196.546	42.5028	0.466797	4663.365	409.376512
2016	**2095.631**	**553.394**	**4560.238**	**686.931**	**1169.440826**	**1.671655**	**23096.64**	**3413.405938**
CORN	1523.602	392.562	3251.4	251.272	665.6723928	0.606423	9034.83	1095.140219
SOYBEANS	275.491	34.63	982.87	251.272	456.5856333	0.606423	9034.83	1886.553498
WHEAT	296.538	126.202	325.968	184.387	47.18279999	0.458809	5026.98	431.712221
2017	**2106.738**	**685.395**	**4313.987**	**658.2555**	**1118.058129**	**1.687011**	**24667.23**	**3982.29476**
CORN	1562.166	481.928	3125.06	250.9325	632.8729286	0.608715	9656.22	1419.341901
SOYBEANS	324.771	54.346	994.29	250.9325	431.5836667	0.608715	9656.22	2086.909576
WHEAT	219.801	149.121	194.637	156.3905	53.60153333	0.469581	5354.79	476.043283
2018	**2125.057**	**689.255**	**4199.326**	**733.964**	**1080.237795**	**1.831602**	**24505.74**	**3736.186713**
CORN	1527.059	508.558	3028.4	275.086	687.8794285	0.664206	9641.31	1422.935842
SOYBEANS	392.325	77.644	984.66	275.086	351.1940667	0.664206	9641.31	1908.373015
WHEAT	205.673	103.053	186.266	183.792	41.1643	0.50319	5223.12	404.877856
2019	**2040.697**	**755.955**	**3667.474**	**529.9035**	**779.187831**	**1.86534**	**23830.8**	**3364.425577**
CORN	1374.278	492.908	2669.76	196.2975	359.6139643	0.67511	9384.585	1337.856628
SOYBEANS	464.914	158.84	794.6	196.2975	376.2167333	0.67511	9384.585	1598.534409
WHEAT	201.505	104.207	203.114	137.3085	43.35713334	0.51512	5061.63	428.03454
2020	**1962.708**	**816.354**	**3507.38**	**619.094**	**1101.82305**	**1.948445**	**22745.73**	**3240.288124**
CORN	1365.721	484.128	2556.36	223.1215	544.3487501	0.706733	8887.62	1041.830884
SOYBEANS	386.421	201.604	745.04	223.1215	514.3143	0.706733	8887.62	1718.375389
WHEAT	210.566	130.622	205.98	172.851	43.16	0.534979	4970.49	480.081851
2021	**1744.793**	**590.984**	**3952.165**	**711.0565**	**1103.863145**	**1.891876**	**23214.765**	**4394.203848**
CORN	1297.382	353.022	2910.44	260.022	730.2526787	0.684062	9103.605	1658.644844
SOYBEANS	293.754	119.374	883.84	260.022	335.0341334	0.684062	9103.605	2331.778817
WHEAT	153.657	118.588	157.885	191.0125	38.57633333	0.523752	5007.555	403.780187
2022	**1692.767**	**426.01**	**3794.72**	**582.5785**	**952.1761167**	**1.950276**	**24555.825**	**3874.791239**
CORN	1260.794	269.534	2791.28	216.1355	500.30075	0.706688	9641.31	1499.705773
SOYBEANS	282.244	71.388	816.52	216.1355	414.3208667	0.706688	9641.31	2013.191734
WHEAT	149.729	85.088	186.92	150.3075	37.5545	0.5369	5273.205	361.893732

Table: Independent Variables (South Dakota)

In Millions

Data

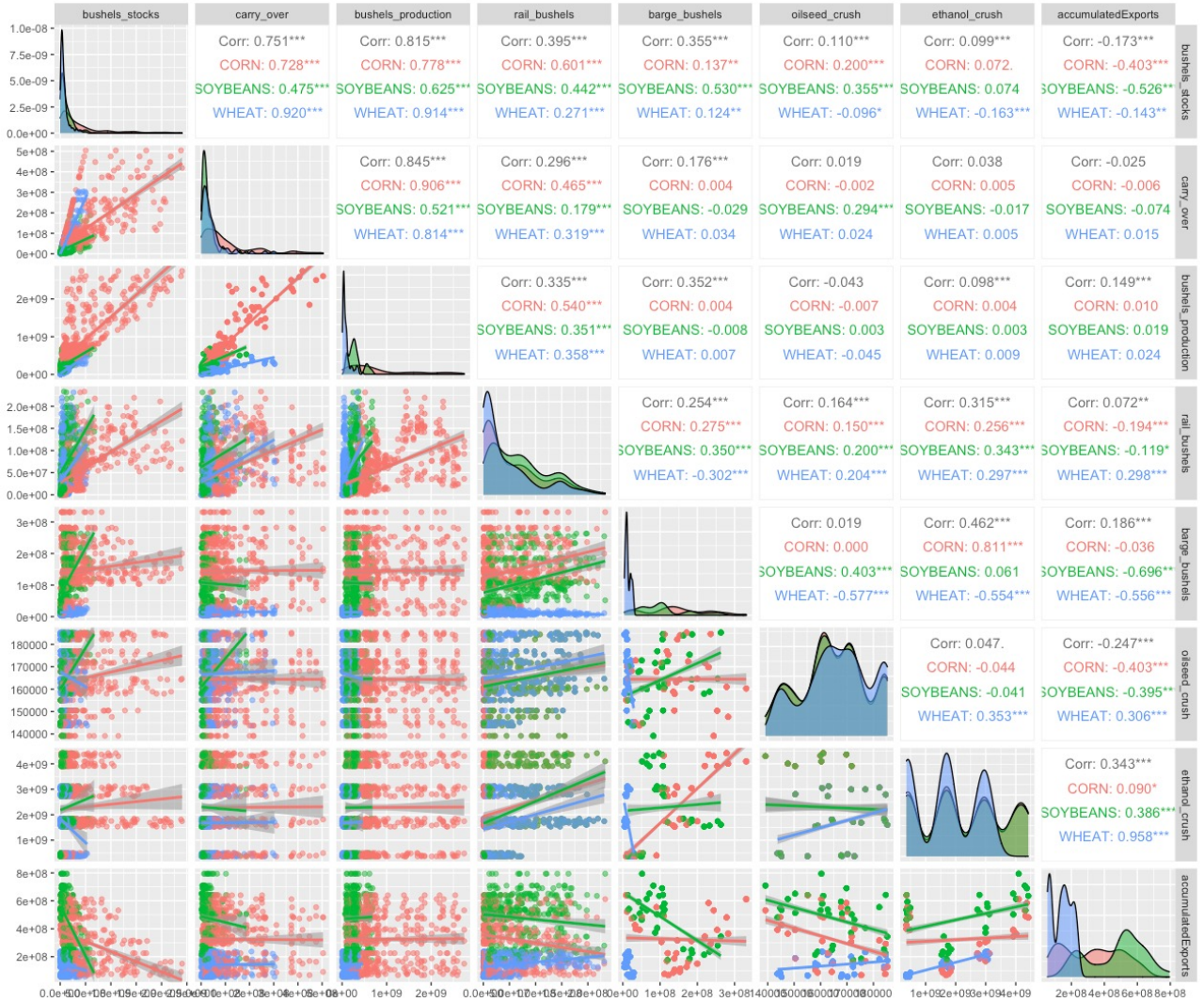


Figure: Correlation Matrix

Model

- Linear Regression

$$\widehat{bushelsstocks} = \beta_0 + \beta_1 bushelsproduction + \beta_2 oilseedcrush + \beta_3 accumulatedExports + \beta_4 ethanolcrush + \beta_5 bargebushels + \beta_6 railbushels + \beta_7 comoditySOYBEANS + \beta_8 commodityWHEAT + \beta_9 quarteQ2 + \beta_{10} quarterQ3 + \beta_{11} quarterQ4 + \epsilon$$

- Random Forest

$$\hat{f}_B^{rf}(x) = \frac{1}{B} w \sum_{b=1}^{B} T_b(x)$$

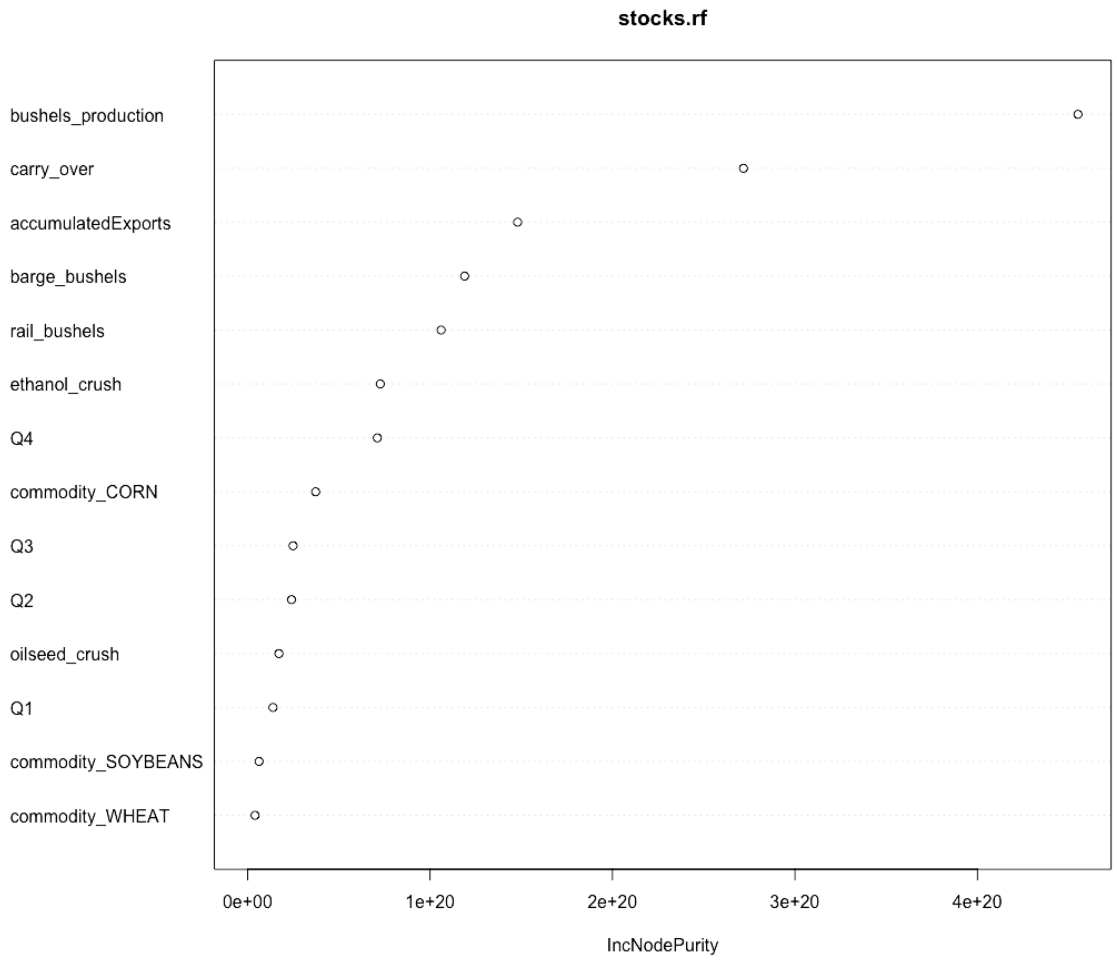
*x represents all the features (independent variables used)

Results

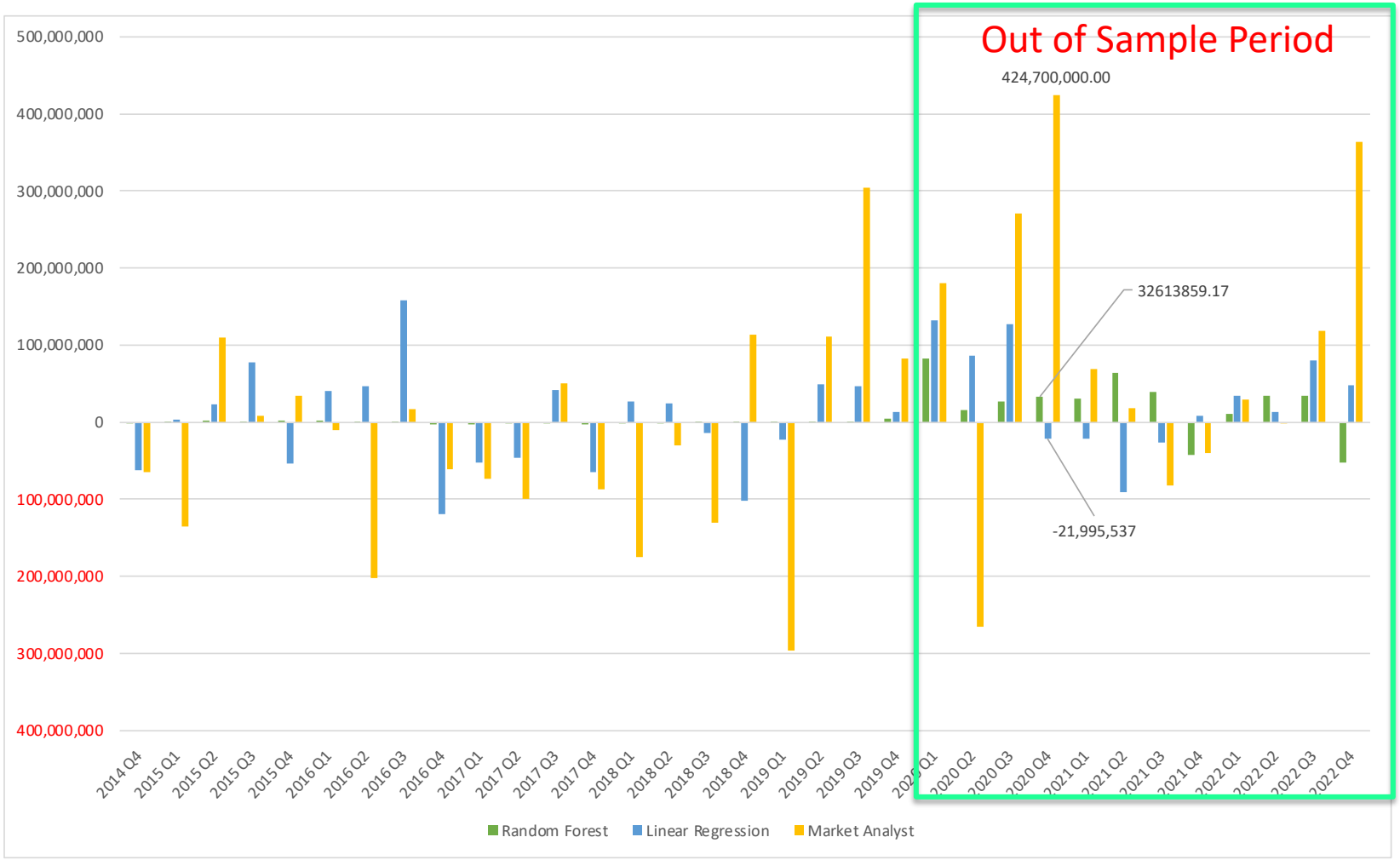
Tables & Figures

	Dependent variable:
	bushels_stocks
bushels_production	0.326***
	(0.010)
carry_over	0.235***
	(0.057)
oilseed_crush	1,063.442***
	(342.628)
accumulatedExports	-0.848***
	(0.044)
ethanol_crush	0.165***
	(0.026)
barge_bushels	-0.295***
	(0.067)
rail_bushels	0.231***
	(0.075)
commodity_SOYBEANS	234,765,132.000***
	(19,431,113.000)
commodity_CORN	117,577,384.000***
	(16,747,922.000)
Q2	-220,668,016.000***
	(33,730,629.000)
Q3	196,212,702.000***
	(68,406,411.000)
Q4	263,095,396.000***
	(33,766,130.000)
Constant	-458,084,349.000***
	(89,794,219.000)
Observations	8,049
R^2	0.658
Adjusted R^2	0.657
Residual Std. Error	5,622,849,946,479.000 (df = 8036)
F Statistic	1,285.958*** (df = 12; 8036)
Note:	*p<0.1; **p<0.05; ***p<0.01

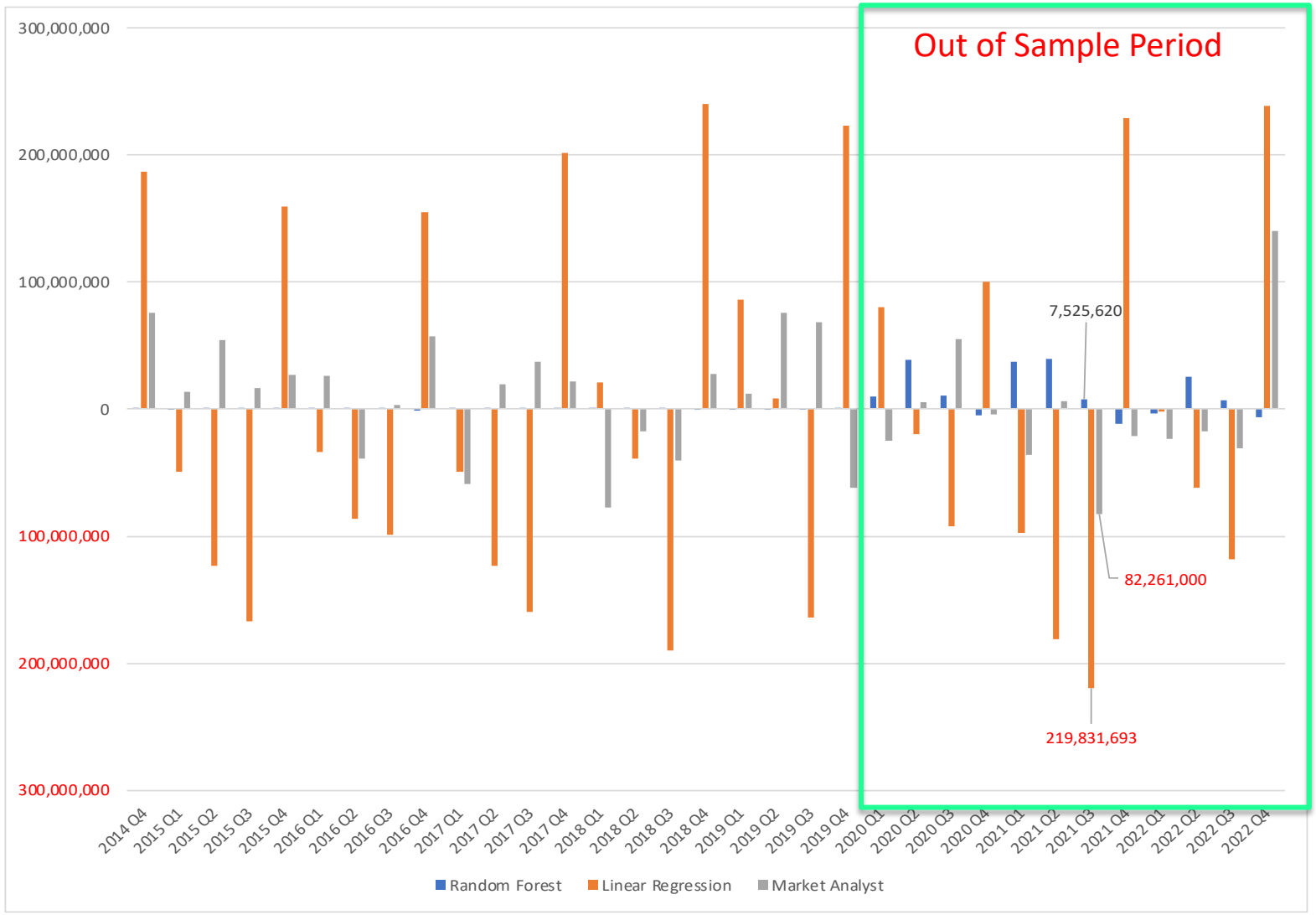
Tables & Figures



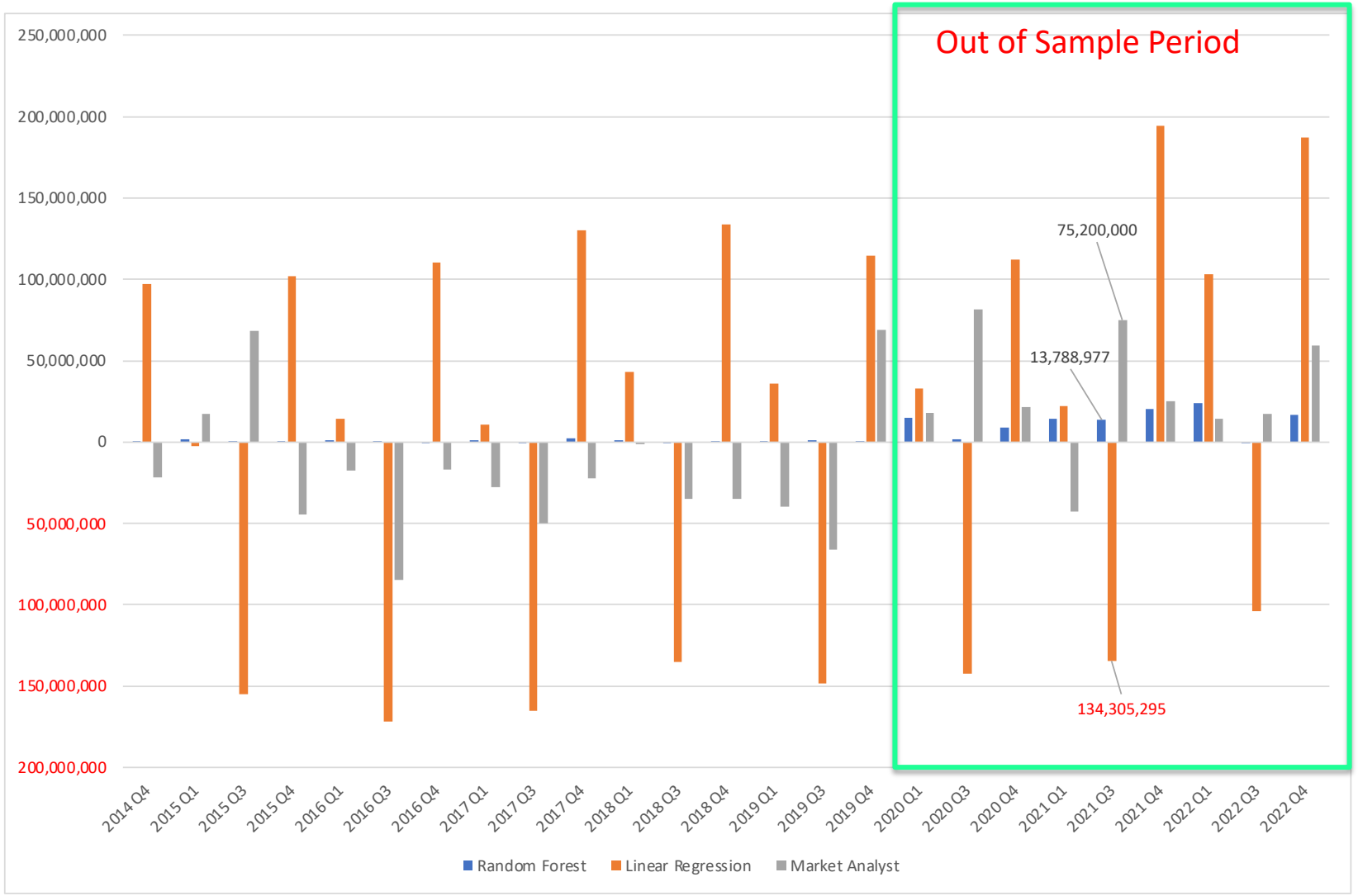
Comparison of Surprise for Corn



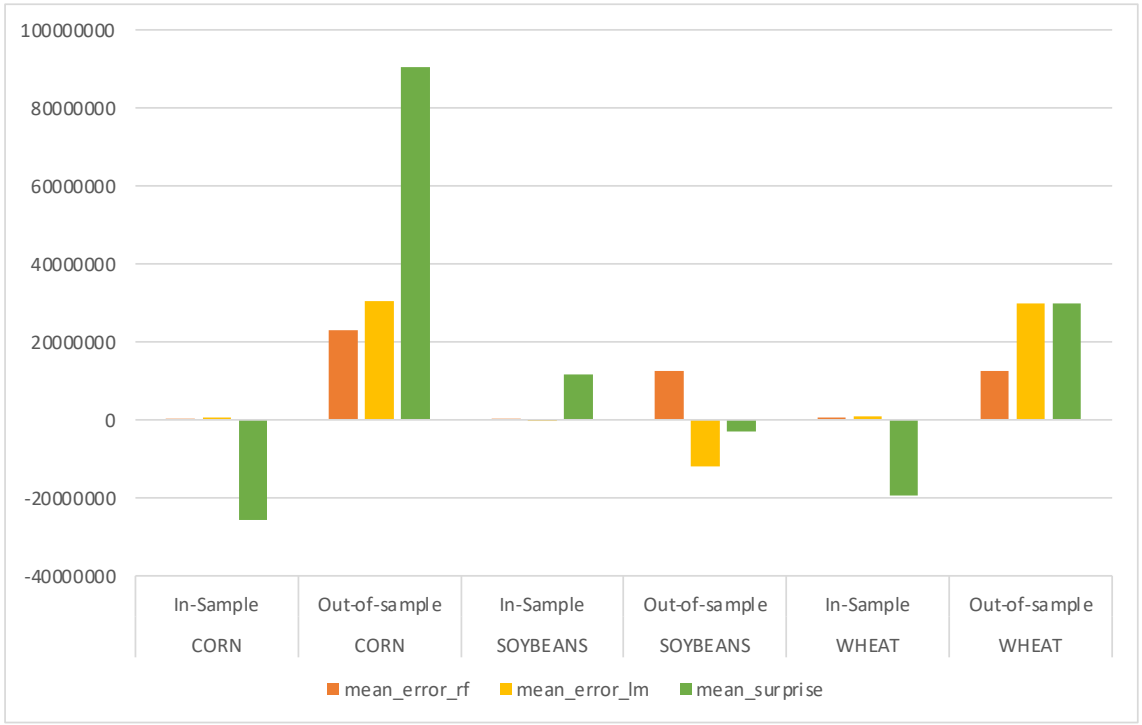
Comparison of Surprise for Soybean

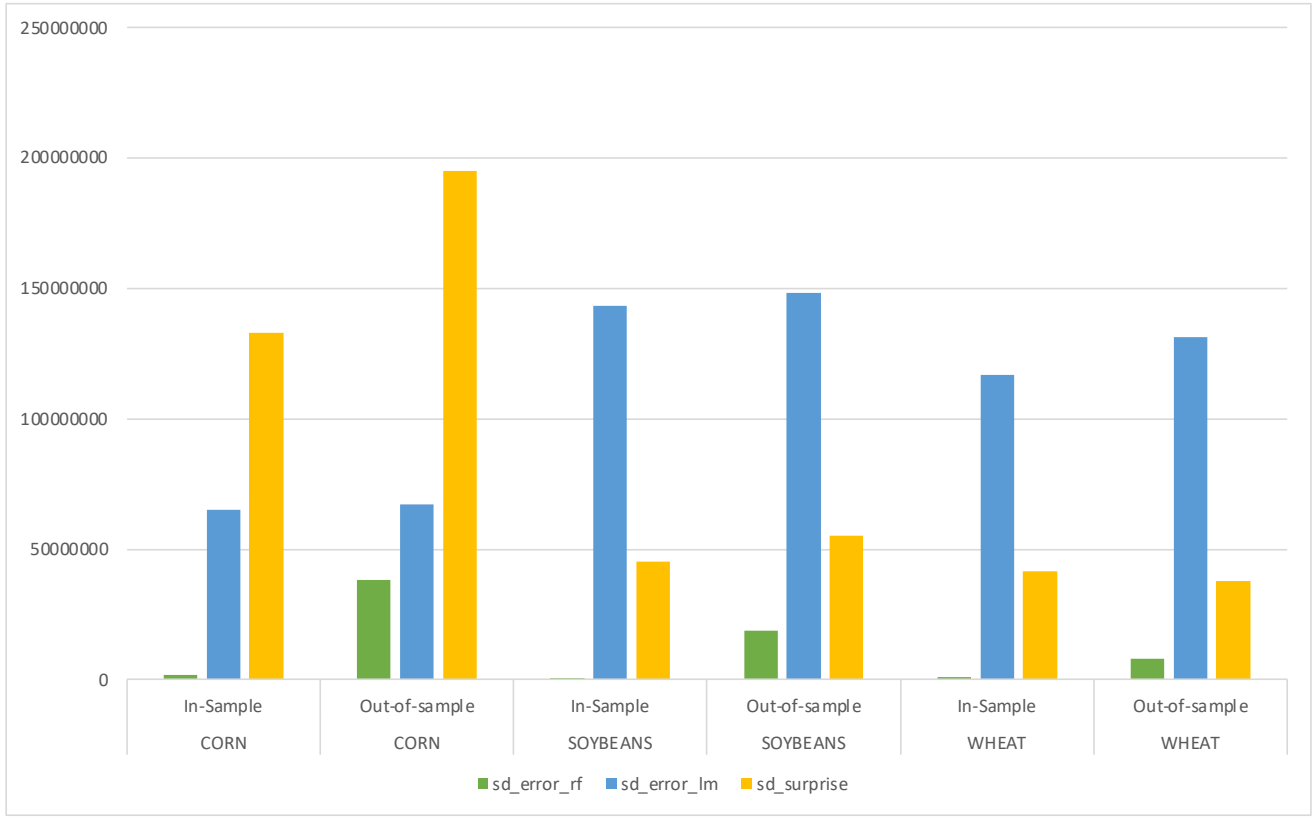


Comparison of Surprise for Wheat

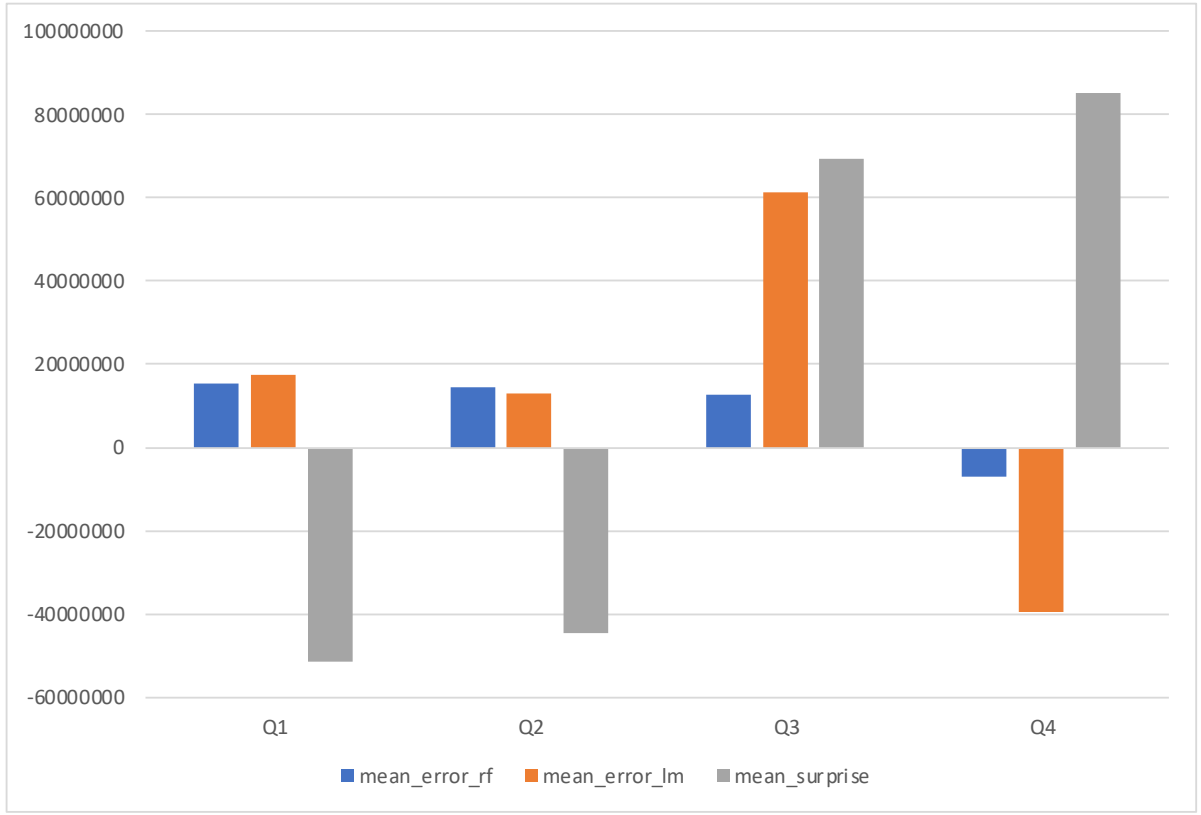


Comparison Between the means & SD of ML, LM, & Analysts among three major Crops in diff. Sample

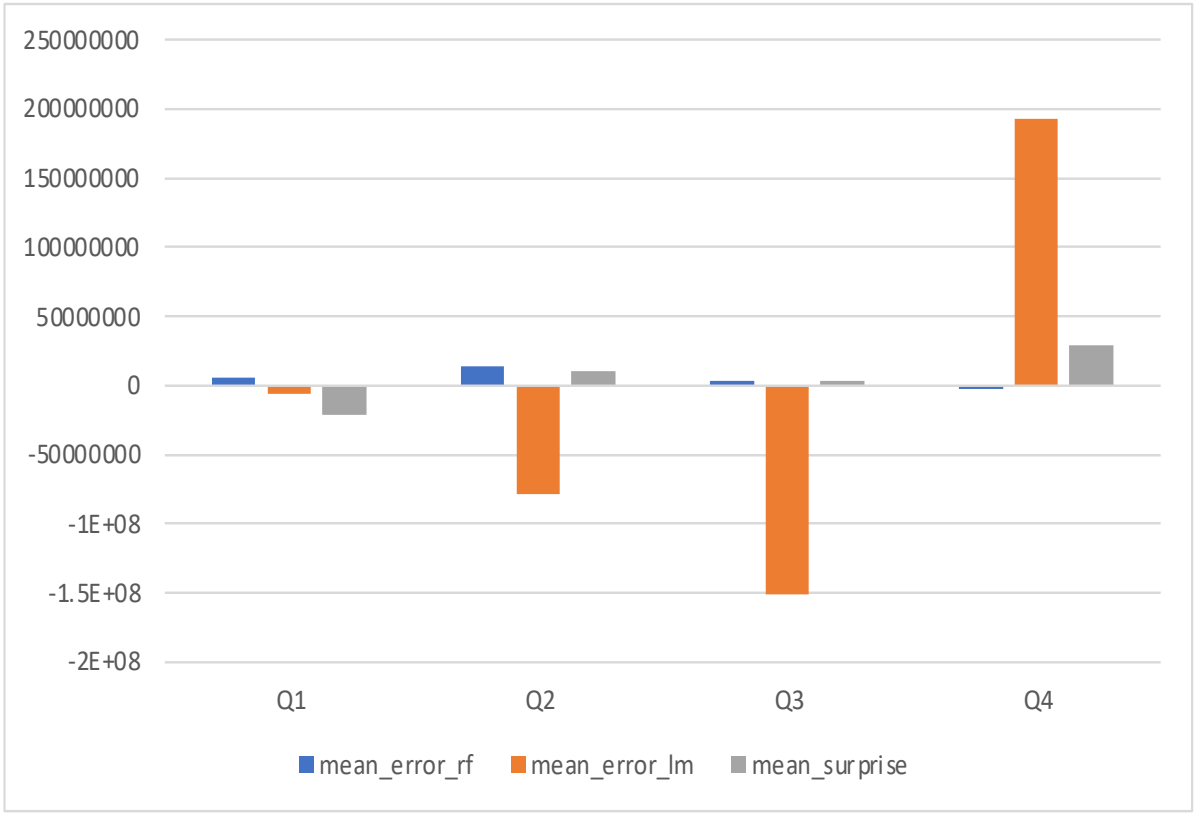




Comparison Between the means of ML, LM, & Analysts among three major Crops in diff. Quarters



Corn

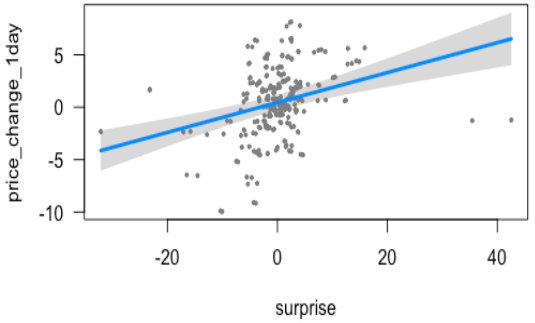


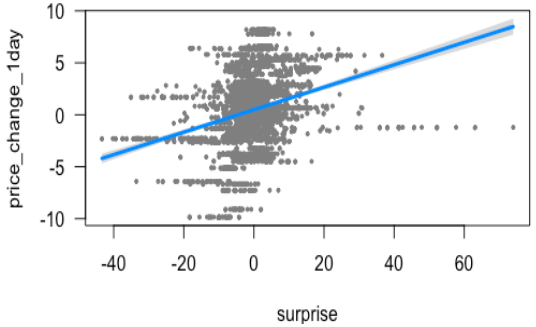
Soybean

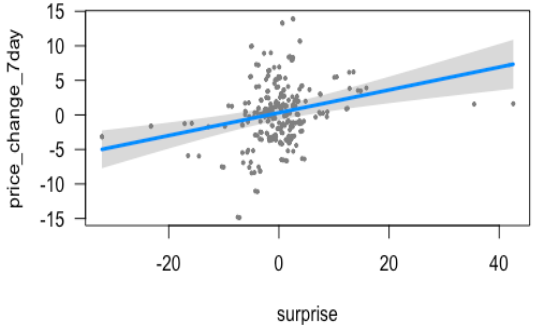
Impacts of Surprises on Price

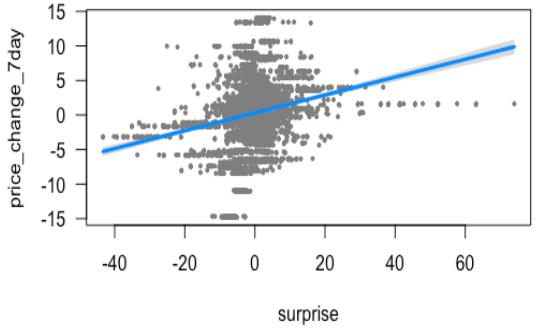
Table II

	Impacts of Stocks Surprises by Private Analyst on Price			
	price_change_1day (1)	price_change_7day (2)	price_change_1day (3)	price_change_7day (4)
Stock Surprise	0.108***	0.129***	0.143***	0.165***
	(0.005)	(0.007)	(0.028)	(0.040)
Corn	-0.171*	0.371***	-0.123	0.498
	(0.098)	(0.138)	(0.468)	(0.662)
Soybean	0.262***	0.400***	0.268	0.418
	(0.098)	(0.139)	(0.469)	(0.664)
Bloomberg	-0.050	-0.122	-0.061	-0.060
	(0.080)	(0.113)	(0.383)	(0.542)
Constant	0.537***	0.440***	0.511	0.372
	(0.084)	(0.118)	(0.387)	(0.547)
Observations	5,932	5,932	262	262
R^2	0.072	0.052	0.093	0.064
Adjusted R^2	0.072	0.052	0.079	0.050
Residual Std. Error	3.068 (df = 5927)	4.326 (df = 5927)	3.096 (df = 257)	4.381 (df = 257)
F Statistic	115.286***	81.995***	6.590***	4.424***
Significance Levels				*p<0.1; **p<0.05; ***p<0.01









Concluding Thoughts

Preliminary Thoughts

- RF & LM is more accurate at predicting USDA grain stocks than market analysts
- Most of the "market surprise" appears to come from error in estimating production and accounting for survey noise compared to grain in transit.
- Some production and survey error can be accounted for by estimating stocks at a finer level (e.g., state-level)

Thank You

Questions?