Price Prediction Signal for Corn Futures

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We build a price prediction signal for corn future. Given some data, we predict by classifying whether the corn future will increase or decrease.

Sources from multiple financial service firms and forums suggest the following major factors to consider when trading corn futures

- Projected Crop Size

- Seasonality

- Weather

- Export Demand

- US Exchange rate

- Ethanol Demand

Besides the major economic factors, several other factors I will explore, which might affect the price movement, are

- Transportation

- Fertilizer Price

- Geopolitical factors

  - Wars

  - Trade deals

We use a Random Forest classifier to predict whether the corn futures price will increase or decrease, based on the factors above.
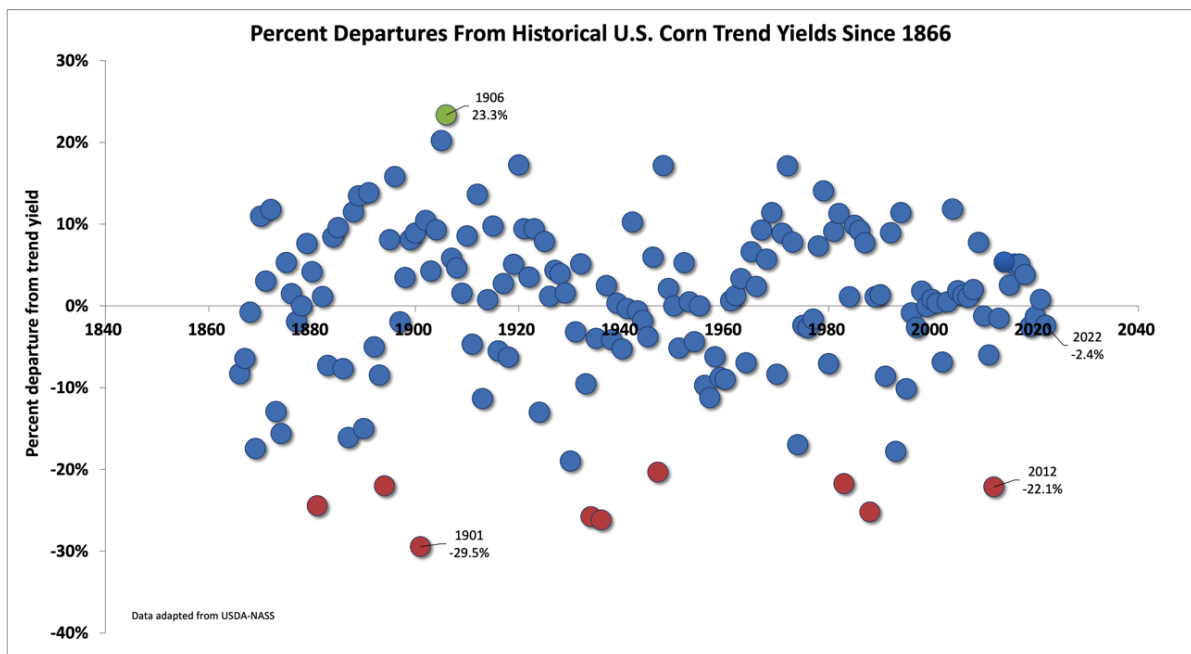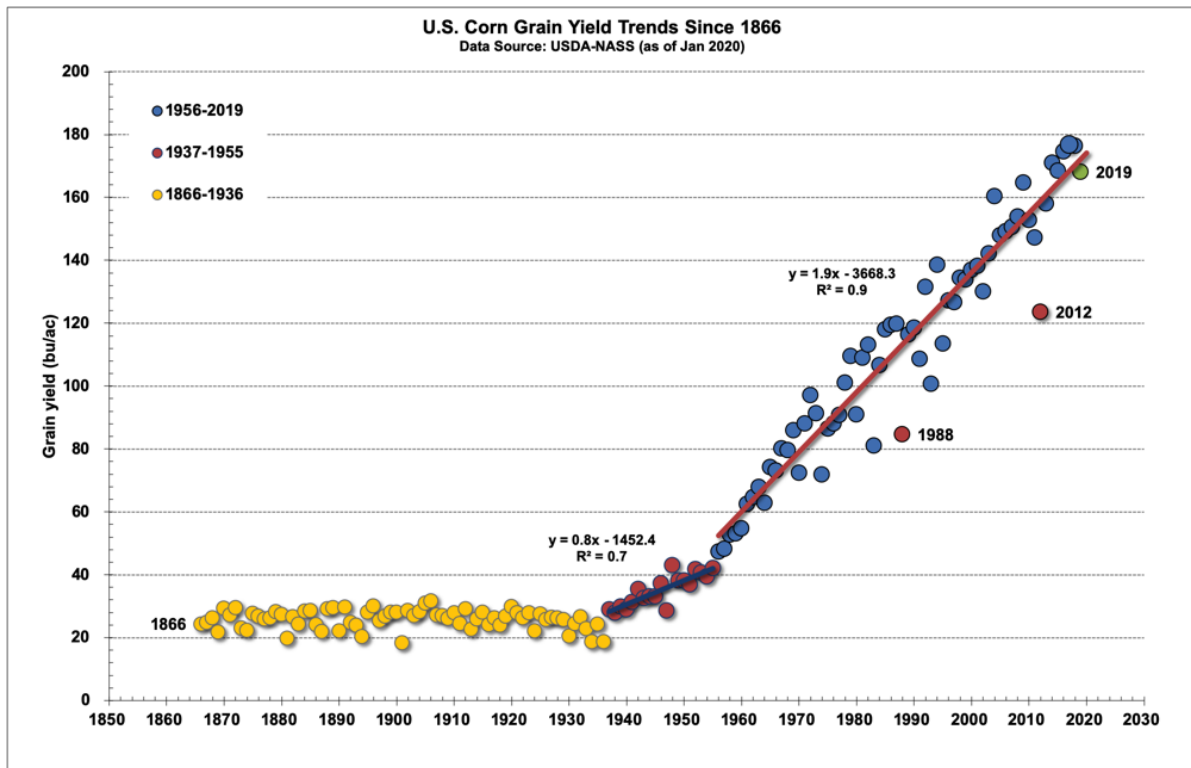
Projected Crop Size

- Direction reflection of corn supply

- Each year, the US Department of Agriculture (USDA) projects how much supply can be expected.

Season

- Seasonality not only determines the planting and harvesting, but also affects trading activity

- "Corn is a seasonal product, the trading of which is less active in winter and more active in summer." from atas.net

- "Corn is planted in the spring and is harvested during autumn. Normally, corn prices go up in the spring and drop back down after the supply goes up in the fall." — Orient Futures

- Corn is typically harvested in late summer or early fall, **between August and October** in the Northern Hemisphere. [src]

Weather

- Flooding and drought directly affects the supply in the harvest season

- Historical droughts: 1988, 2012 (huge drop in grain yield, deviates from trend curve by **22%**)

U.S. Corn Grain Yield Trends Since 1866
Data Source: USDA-NASS (as of Jan 2020)

Legend:
- 1956-2019
- 1937-1955
- 1866-1936

$y = 1.9x - 3668.3$
$R^2 = 0.9$

$y = 0.8x - 1452.4$
$R^2 = 0.7$

Grain yield (bu/ac)

Labeled points: 2019, 2012, 1988, 1866

Percent Departures From Historical U.S. Corn Trend Yields Since 1866

Percent departure from trend yield

Labeled points:
- 1906: 23.3%
- 1901: -29.5%
- 2022: -2.4%
- 2012: -22.1%

Data adapted from USDA-NASS

Not surprisingly, after 1988 drought, a serve drop in production causes corn futures price jump.

Interestingly, market reaction about 2012 drought is not as fierce as expected. In fact this drought is originated from 2010 **Southern United States and Mexico drought.** Although the corn yield in 2010 and 2011 falls in normal range of corn yield trend, the initial reaction about drought from the market is fast, even before the drought started in summer. So the weather forecast is crucial for corn supply and futures price movement

Export Demand

- US is the country with largest corn export

  - As of 2023, US$19.1 billion, 37.2% of total corn exports —The Observatory of Economic Complexity

- "U.S. corn exports are on the rise and account for an average of **15 percent** of the country's total use" — USDA
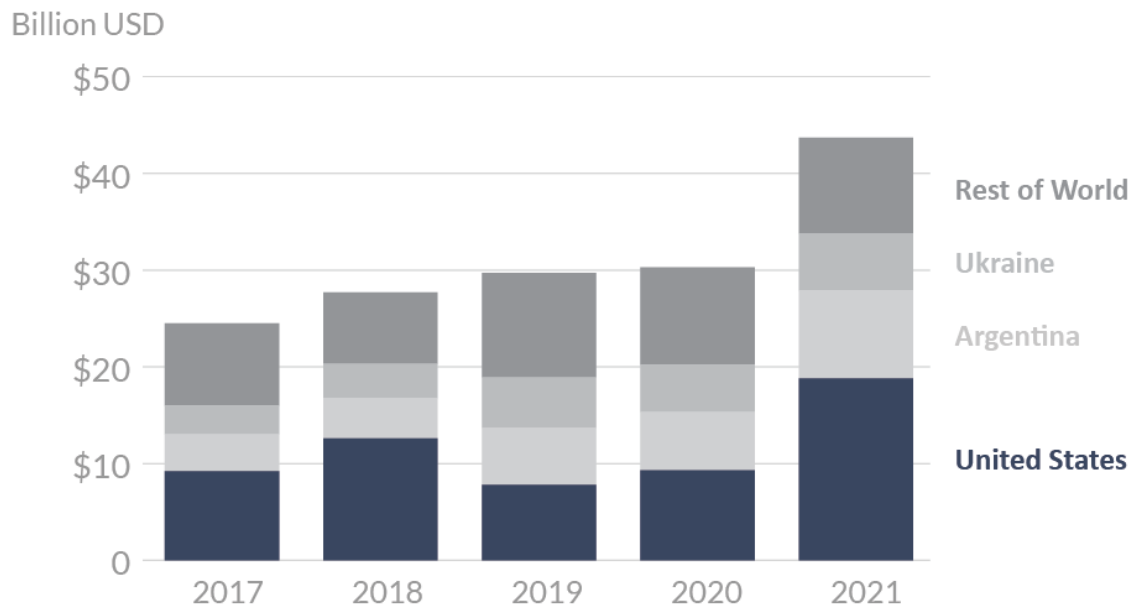
Source: Trade Data Monitor, LLC- BICO HS-6

- Therefore, demands from import countries and trade deals largely affects the future price

  - Large increase in demands from China drove the futures prices increase by more than 150% from July 2020 to July 2021

Top 10 Export Markets for U.S. Corn
(values in million USD)

Country	2017	2018	2019	2020	2021	2020-2021 % Change	2017-2021 Average
China	142	50	55	1,224	5,096	316%	1,313
Mexico	2,645	3,061	2,736	2,680	4,717	76%	3,168
Japan	2,163	2,813	2,011	1,844	3,187	73%	2,404
Colombia	785	927	682	879	1,100	25%	875
Korea, South	705	1,356	359	548	858	57%	765
Canada	131	309	349	272	662	143%	344
Taiwan	395	603	232	178	435	144%	368
Guatemala	145	196	177	218	342	57%	216
Costa Rica	138	143	145	151	208	38%	157
Honduras	85	107	123	130	205	58%	130
All Others	1,796	2,908	801	1,089	1,912	76%	1,701
Total Exported	9,131	12,472	7,671	9,213	18,721	103%	11,441

Source: U.S. Census Bureau Trade Data - BICO HS-10


Geopolitical

- Geopolitical conflicts have large impact on global supply and demand
- Russia - Ukraine war
    - Both are major corn suppliers with large corn production and export
    - Since the outbreak of Russia - Ukraine war on Feb 24th 2022, the market reacted strongly due to the worry of missing corn planting season in May.

- Since these factors are mostly news based, we can use NLP models like BERT to extract keyword embedding about geopolitical relationships of major corn import and export countries, like US, China, Ukraine, Japan, South Korea, Mexico, Russia

US Exchange rate

- "Like all other commodities, corn prices exhibit sensitivity and a strong negative correlation to the USD. Generally speaking, when the USD strengthens, the price of corn falls. In contrast, when the greenback weakens, corn prices tend to rally." — Daniels Trading
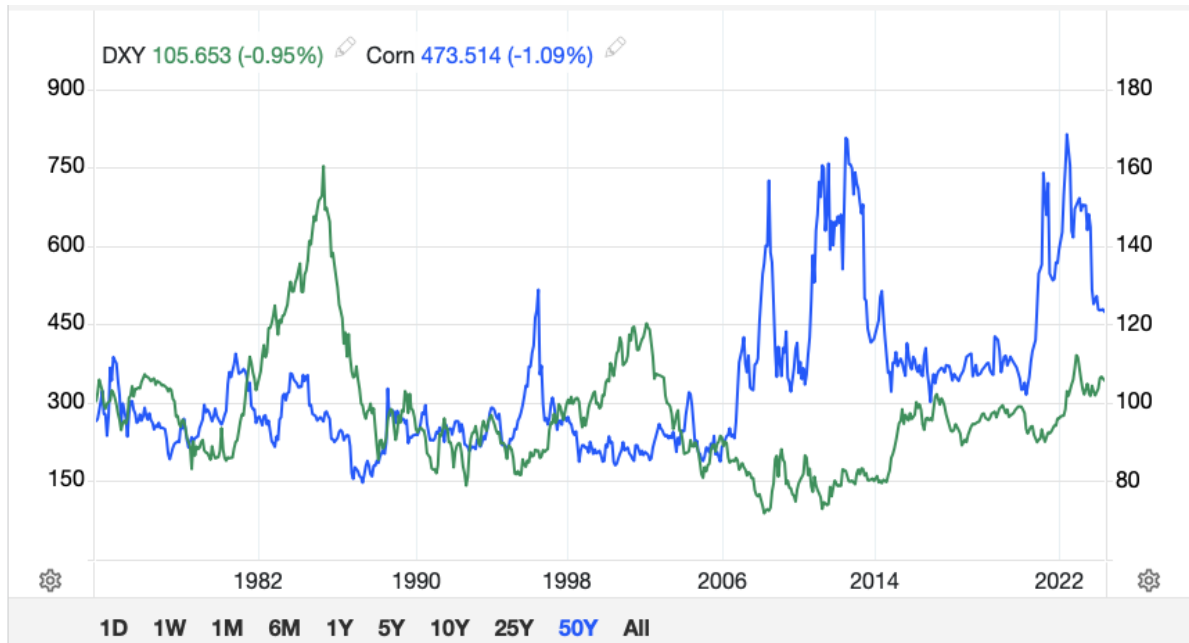
Transportation

Transportation factor is important for deliveries of commodities. A recent news demonstrated this point, as a result of

- Mississippi river water level (proportional to corn price)

  - Between 2015 and 2019, 95% of corn, 94% of soybeans and 45% of wheat moved by barge traveled through the Mississippi River system to Louisiana, **making the river the most significant inland waterway for grain movements.** src: Low Mississippi River Levels Drive up Grain Transportation Costs and USDA grain transportation report

    - Mississippi is the only way out on the water of US for corn export. Land transportation for commodities like corn would be much more expensive. This could have explained

Corn (USd/BU) 480.5000 -1.7500 (-0.36%)

- Freight shipping index appears to be positively correlated with corn futures price

Corn (USd/BU) 474.9494 +11.2672 (+2.43%)
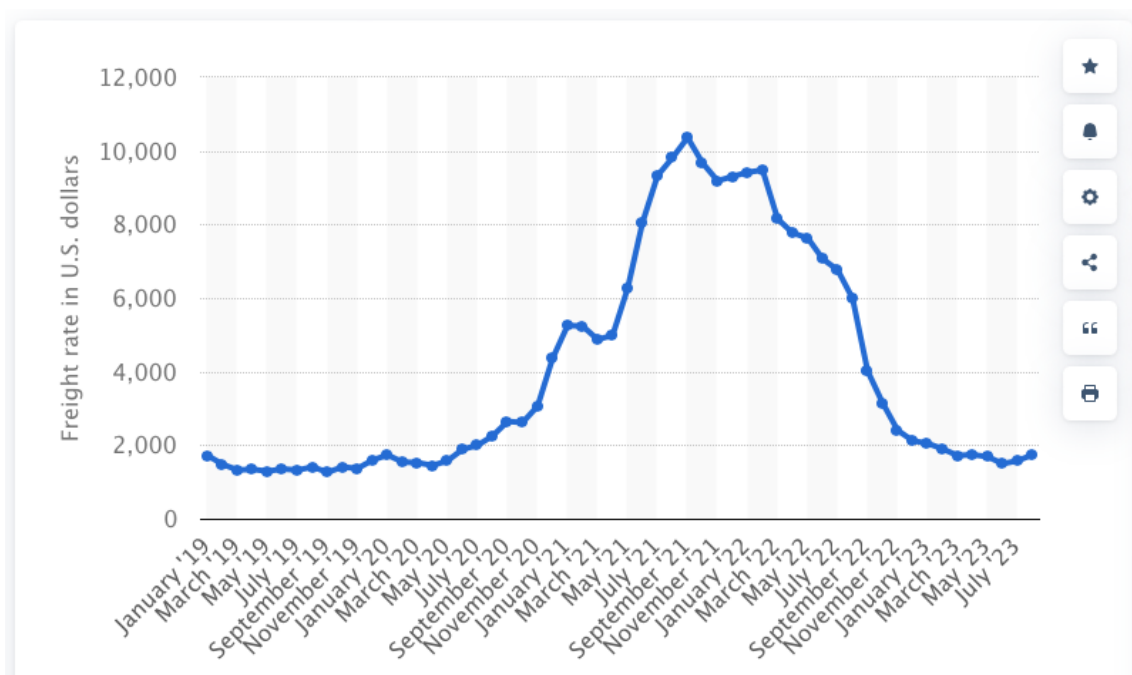
Fertilizer

Fertilizer is crucial for corn production [Mississippi State University] and between **70%** and **80%** of the energy used to produce critical fertilizers comes from natural gas [AGA]

- Natural Gas

    - "While 80% of the gas is used as feedstock for fertilizer, 20% is used for heating the process and producing electricity," according to Yara International

Modeling

Motivation to use Random Forest

- The factors we consider are a combination of continuous quantitative values and categorical values

- Provides feature importance, which is helpful for analysis and decision making

- More robust, aggregated prediction from a ensemble of tree models

    - Overfitting to historical data is a very common issue in application of ML methods in Finance

    - Ensemble learning introduces randomness and brings robustness to prediction