Have Fertilizer Prices Bottomed Out?

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Introduction[1]

Anhydrous ammonia prices peaked in early summer of 2022 at a price above $1,500/ton. Since then, anhydrous prices have steadily declined to around $600 in July of this year. However, since July, anhydrous prices have risen to $800. Farmers may be wondering if the rise in nitrogen prices over the last several months is temporary or will nitrogen prices continue lower.

Fertilizer is a major expense item for most grain farms so any price increase in fertilizer can have a significant effect on farm profitability. As shown by Ibendahl, Fertilizer accounts for 20% of farm expenses. This makes fertilizer the second most expensive production input on a farm (machinery is the most expensive). Thus, even small changes in fertilizer prices can have large effects on farm profitability.

Ibendahl has been predicting fertilizer prices for many years. His initial models used corn and oil prices to predict anhydrous ammonia prices. However, something occurred during the fall of 2021 that broke these earlier models because the run-up in fertilizer prices was not anticipated. Ibendahl added inflation expectations to the model in his February 2022 estimate and the model has been performing with better predictive power ever since.

The purpose of this article is to forecast anhydrous ammonia prices for the next 12 months so that farmers can plan their fertilizer purchases. Many farmers purchase their spring fertilizer in the fall so farmers do have some flexibility for the purchase of this production input. Correctly timing fertilizer purchases could improve profitability. All the major fertilizer products are highly correlated so the direction of price changes in anhydrous ammonia is usually reflected in the prices of the other fertilizer products.

Data and model

All the fertilizer prices in the analysis come from DTN (accessed from ProphetX). Ibendahl's analyses prior to 2022 showed that predicting the anhydrous price was possible since the price of anhydrous ammonia is positively correlated with both the price of oil and corn. Even though anhydrous ammonia is produced from natural gas, models using natural gas as a price predictor for anhydrous never worked very well. The price variations in natural gas never seemed to match

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the variability of anhydrous. Because natural gas and oil have similar uses, the correlation is high. Thus, substituting oil into a price predictor model for anhydrous accomplished the goal of using natural gas but the correlation better aligned with how anhydrous prices varied.

Anhydrous ammonia is positively correlated with the corn price and the oil price because these two products represent something about the demand and supply of anhydrous ammonia fertilizer. Economic theory tells us that higher prices for an output will cause producers to produce more by using more of the production inputs. Thus higher corn prices lead to more nitrogen fertilizer per corn acre (i.e., increased demand of nitrogen fertilizer). Also, a higher corn price (relative to other crops) will shift more acres to corn (which uses nitrogen) and fewer acres to soybeans (which doesn't need nitrogen fertilizer).

A visual inspection of oil and anhydrous ammonia historical prices indicates that anhydrous ammonia prices tend to lag oil prices. This is not surprising as ammonia producers need some time to adjust production to account for changes in their input prices. The most recent models by Ibendahl have used a 6-month lag for oil prices.

All the fertilizer models by Ibendahl since the beginning of 2022 have used inflation expectations as a third explanatory variable. Inflation was relatively low before 2022 but has become a bigger factor in the last two years. To incorporate this into the model, the University of Michigan monthly survey of inflation expectations was used as a variable. Inflation seems to be more of a leading explanatory variable. That is, future inflation is a guide to prediction anhydrous prices. In this model, inflation is for expectations two months in the future.

The historical prices since 2009 for the dependent variable (anhydrous) and the three independent variables (corn, inflation, and oil) are shown in Figure 1. The correlation for these factors is shown in Figure 2. Figure 2 packs a lot of information. The diagonal of the figure has the histogram and the density plot of the factor under consideration. For example, anhydrous, in the upper left hand corner has a bar graph for the histogram and the line is the density plot. A density plot can be thought of as a smoothed histogram. The other three factors can be interpreted similarly. The number along the sides are the scale for each individual figure. The prices for anhydrous can be found at the very bottom in the first column. The other boxes in Figure 2 represent the relationship between the factors. In the upper quadrant is the correlation. To find the correlation, draw a horizontal line or vertical line from the two factors you are interested in. Where those line cross in the upper quadrant is the correlation. For example, the correlation for anhydrous and corn is in the first row and the third column. This particular correlation is 0.74.

The lower quadrant is the scatter plot and regression line between the two factors being considered. Using anhydrous and corn again for an example, the scatter plot is in the third row and the first column. The axis labels for these scatter plots can again be found along the sides. Anhydrous has the prices along the bottom in the first column while corn prices are along the right side in the third row.

Because other nitrogen fertilizers start from ammonia, the correlation between nitrogen products is high (Figure 3). Thus, forecasting anhydrous will provide guidance for the prices of other nitrogen fertilizers. However, the correlation between the nitrogen fertilizers and the dual nutrient fertilizers (DAP and MAP with both N and P) is also strong. Even Potash (K) is strongly correlated with the other fertilizers. Thus predicting anhydrous ammonia prices gives good price guidance about prices for all the other major fertilizers.

Model to Predict Anhydrous Ammonia Prices

With the corn price representing the demand for anhydrous ammonia, the oil price representing the supply for anhydrous, and inflation expectations representing some of the recent volatility, a formal regression model was developed using ordinary least squares. This model resulted in the equation shown in Figure 7. This regression result has an adjusted R-squared of 0.70. Given that correlations can range from -1.0 to +1.0, a correlation of 0.70 is considered strong.

Figure 4 shows the actual anhydrous ammonia price vs the predicted anhydrous ammonia price since 2009. Figure 5 shows a scatter plot of the actual vs predicted values. A visual inspection of Figure 4 indicates the model may still be missing the actual price peaks and valleys but is still getting the overall trend correct.

Figure 6 is a time shortened version of Figure 4. It also include the price forecast for the next 12 months. The price forecast uses the futures market price of both oil and corn. Inflation expectations are based on Ibendahl's estimate of an inflation rate of 5% for the next year. Given these model inputs, anhydrous prices of $1,000 are not unexpected going forward.

Discussion

There are many events happening right now in the world that could easily affect fertilizer prices. With Russia being a major fertilizer exporter, any surprises with the Russian/Ukraine war could easily drive up prices. Also, the Middle East is once again at the top of the news. Any conflict in that region has the potential to drive up oil prices which would like lead to an increase in fertilizer prices.

With the model currently estimating higher anhydrous prices than actual prices, the fertilizer price floor may have been reached. Certainly the last two months indicate prices are on the upswing. While the factors used in this model could certainly go lower, there is a much greater risk that oil and inflation could go much higher. Last year, farmers who delayed purchasing their fertilizer benefited from declining fertilizer prices. This fall is shaping up to be the exact opposite with prices possibly increasing throughout the winter.

References

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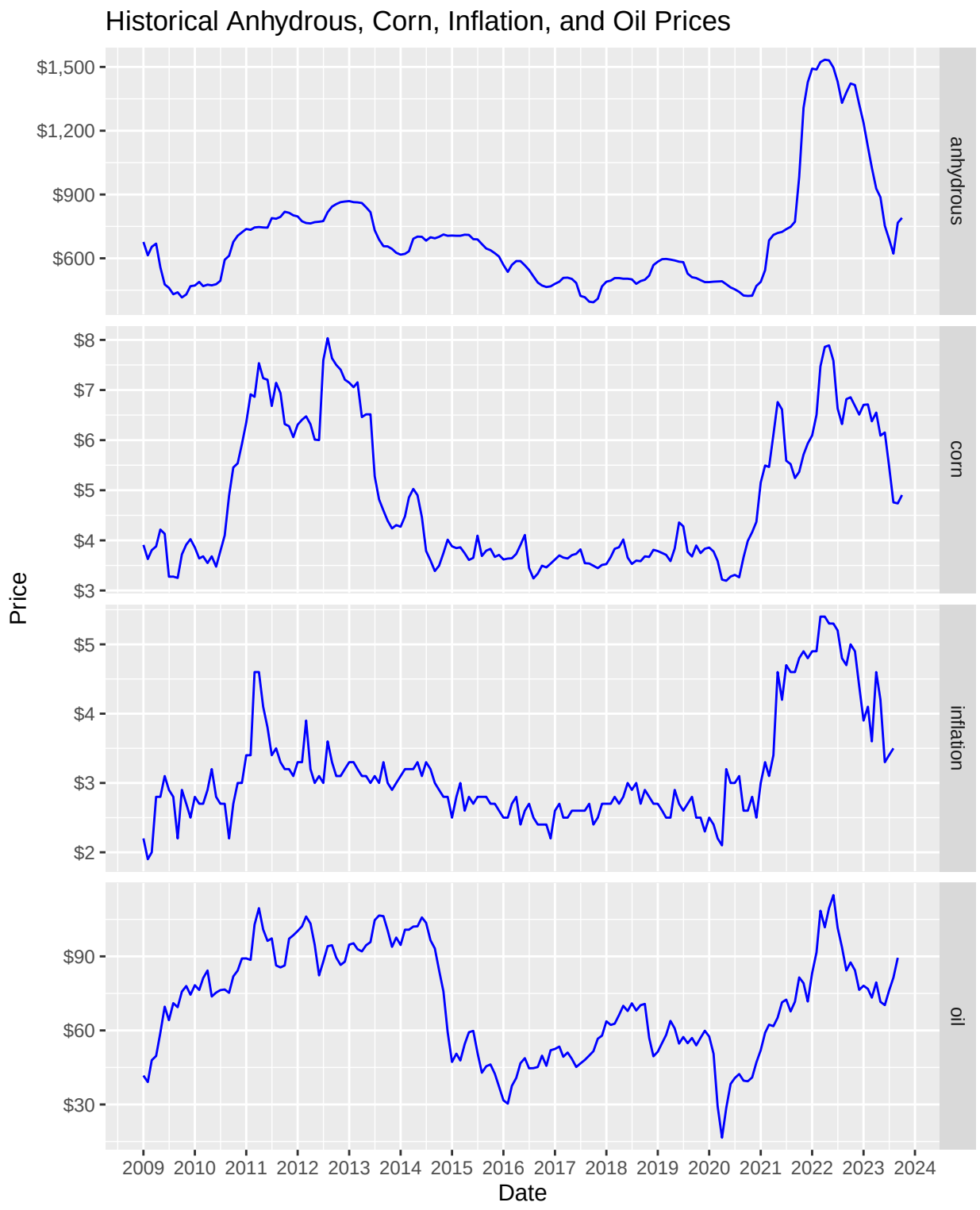

Figure 1: Historical Prices of Model Factors

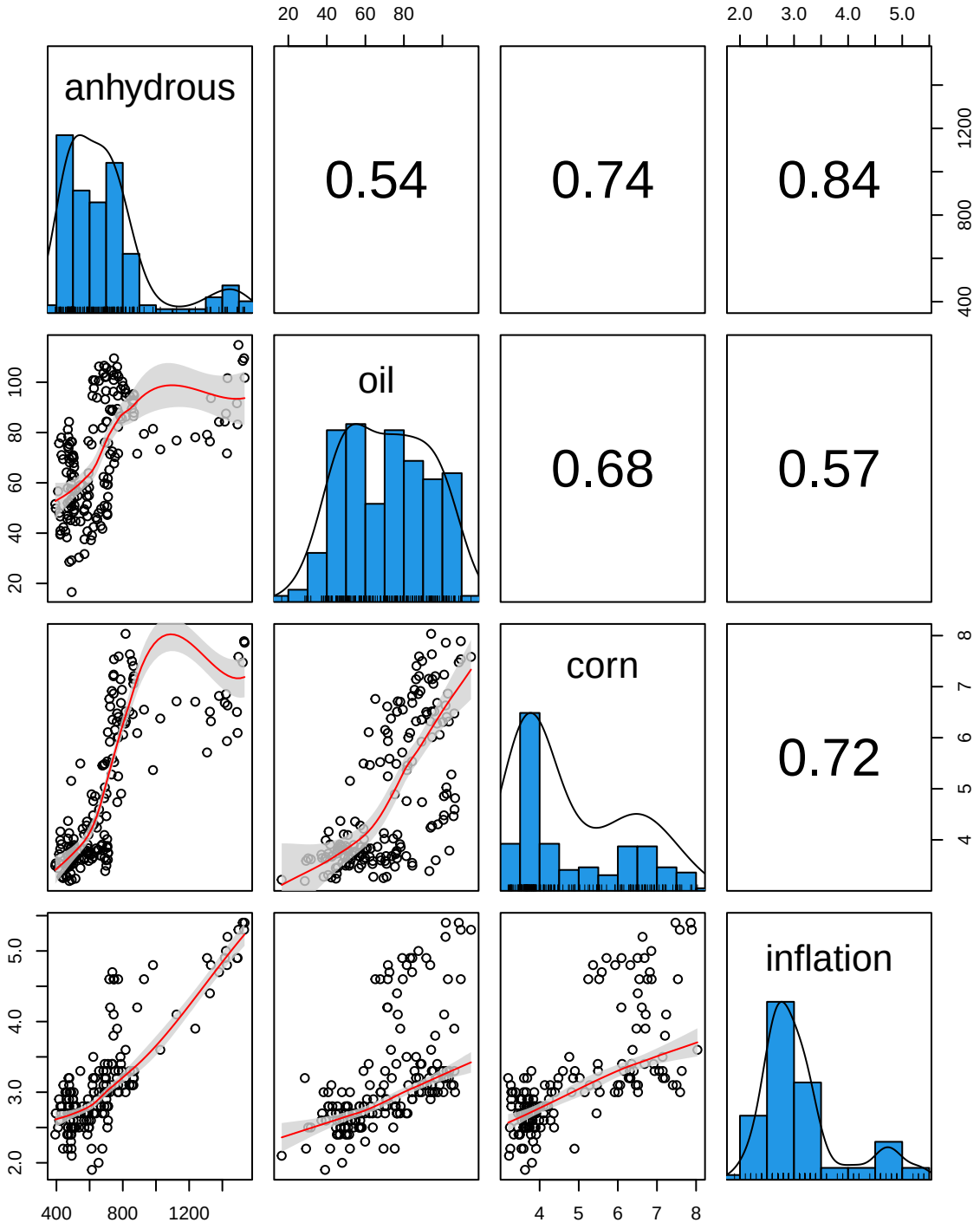

Figure 2: Correlation Comparison of Factors in Price Estimation Model

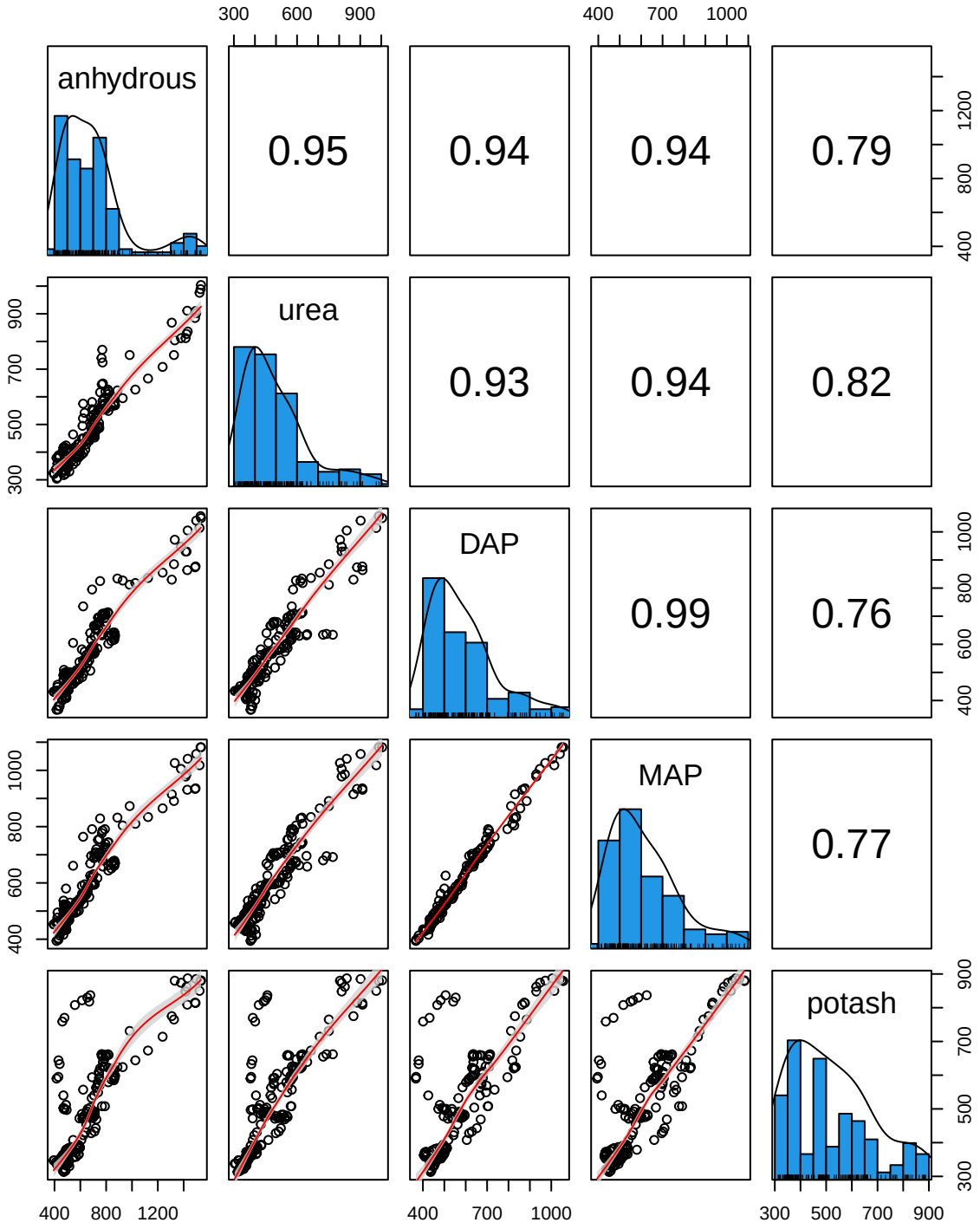

Figure 3: Correlation Comparison of Other Fertilizers

Figure 4: Actual Anhdrous Price vs Predicted Price - Long Term

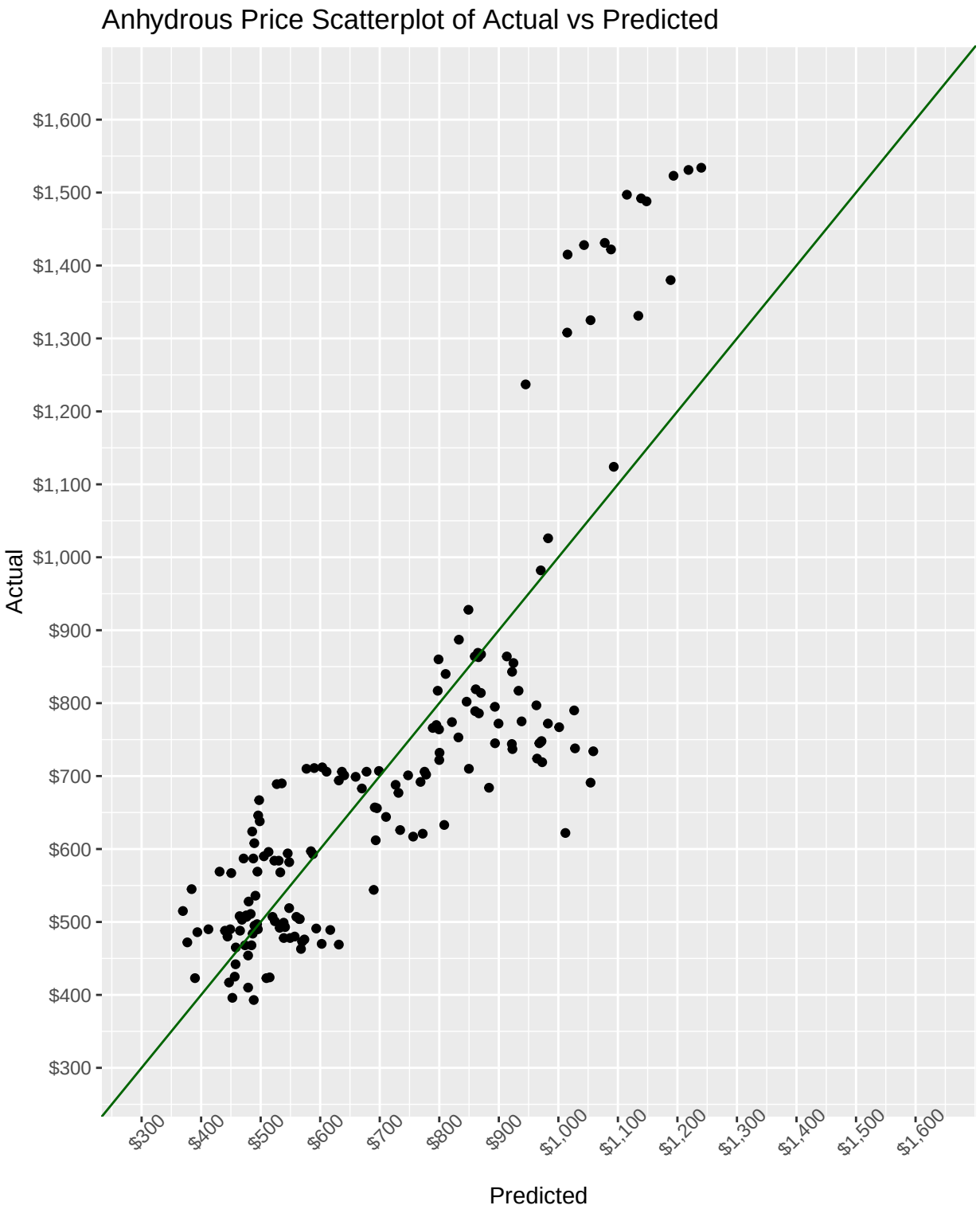

Figure 5: Model Analysis - Scatterplot of Actual vs Predicted

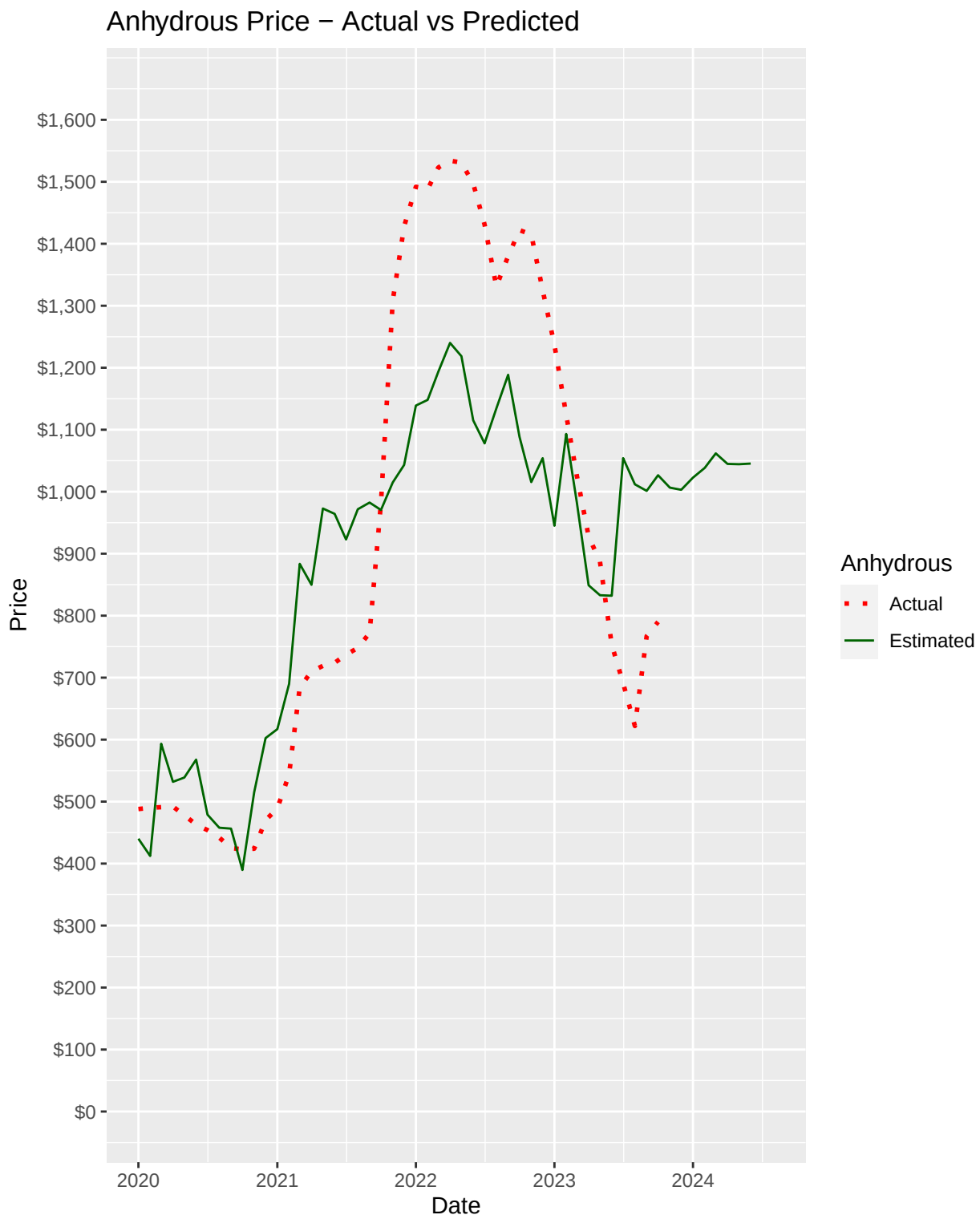

Figure 6: Actual Anhdrous Price vs Predicted Price - Short Term

Term	Coefficient	P-value
Intercept	-288.25	< 0.001
Oil (lag 6 mo)	2.65	< 0.001
Corn	53.28	< 0.001
Inflation (lead 2 mo)	168.63	< 0.001

Figure 7: Regression Model