Highway Diesel Fuel (HDF) Price: Affecting the Local Elevator Basis Bid

Undergraduate Research

by

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Authors Note

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Introduction

With inflation seen and felt within the supermarkets, it is only reasonable to ask, "Where did this come from?" That question, however, cannot begin to be answered without looking deep within the inner workings of the agricultural commodity markets. This paper focuses on one small aspect of the broader agricultural commodities market. That is, the relationship between Highway Diesel Fuel (HDF) prices and the local elevator basis bid for Corn and Soybeans. The local elevator basis bid, representing the difference between local cash and futures prices, is a critical factor driving commodity prices based on location, supply, and demand dynamics. Understanding how changes in HDF prices affect basis bids is essential for both producers and consumers, as it sheds light on transportation costs and market competitiveness. Through panel regression techniques, we aim to elucidate the impact of HDF prices on basis bids, providing valuable insights for market participants and academics alike.

Background

The Chicago Mercantile Exchange, or CME, is an exchange offering trading of futures and options contracts for various commodities at specified quantities, with a set quality, at a specific location, date, and time. It allows for producers and consumers of these commodities to help limit their risk exposure by trading these contracts to hedge. The cash, spot, and flat prices all refer to the final delivered price of the commodity at the given grain elevator or end-user. The elevator mainly being a local storehouse of grain more local to the farmer and provides them an easier means of getting the grain they produced to the broader market. When looking at the nearby futures prices of agricultural commodities in comparison to the local cash prices a difference between the two will commonly occur. The equation used for each given commodity that is listed on the exchange to calculate the basis value would be set up as the "Cash Price – Nearby Futures Price = Basis" (Sanders, 2016, p. 82). That difference is referred to as Basis which can either be none, positive, or negative. The Basis, which changes with time, is utilized as a means to adjust prices based on location, supply, and demand. It often helps reconcile transportation differences between regions such as the Midwest where a more negative basis is to be expected due to a higher supply as compared to a coastal export location where the basis may typically be positive (Sanders, 2016). This difference in basis is crucial to allocating a commodity across a competitive and complex spatial environment where demand varies by location. On-Highway Diesel Fuel, and diesel fuel in general is how materials move. On-Highway Diesel Fuel often referred to as HDF for simplicity is reported weekly to the United States Energy Information Administration, EIA, and allows for the public availability of fuel prices across the U.S.

Conceptual Idea

Basis is used to focus on the more physical nature of how grain is allocated and moved in a market setting. That would be, as HDF increases in price, the basis would have to become more negative to remain at a constant profit margin for the elevator with the change in fuel prices. Due to the price level of HDF being collected from across the US and aggregated into a singular Weekly US Average, the logistical cost would be easiest to measure and most consistent in the transportation.

Theoretical Model

$$\begin{aligned} CornBasis_{it} = {} & \alpha_i + \beta HDF_t + \beta Fuel.Ethanol.Production_t + \beta Stocks.Use.Lag_t \\ & + \beta Corn.Cal.Spread.Perc_t + \beta Jan_t + \beta Feb_t + \beta Mar_t + \beta Apr_t + \beta May_t + \beta Jun_t \\ & + \beta Jul_t + \beta Aug_t + \beta Sep_t + \beta Oct_t + \beta Nov_t + \varepsilon_{it} \end{aligned}$$

$$\begin{aligned} SoyBasis_{it} = {} & \alpha_i + \beta HDF_t + \beta SoyS.U.Lag_t + \beta Soy.Cal.Spread.Perc_t + \beta Jan_t + \beta Feb_t + \beta Mar_t \\ & + \beta Apr_t + \beta May_t + \beta Jun_t + \beta Jul_t + \beta Aug_t + \beta Sep_t + \beta Oct_t + \beta Nov_t + \varepsilon_{it} \end{aligned}$$

Theoretical Analysis

The method chosen to conduct the analysis was a panel regression from the plm library, utilizing the R programming language. The panel regression adjusts for each location by assigning each of them individual intercepts, α_i. The subscript " i" represents the individual location and subscript “t” represents a point in time of the observation. The panel regression helps make the regression more accurate by allowing for the more typically positive or negative levels within the basis that can present across various locations be adjusted. The addition of monthly dummy variables to the regression was necessary to remove the seasonality that exists within the basis values for both Corn and Soybeans. Figures 5 and 6 below from the Purdue Center of Commercial Agriculture Crop Basis Tool illustrates the 3-year average of nearby basis bids and seasonality over the course of one marketing year. These dummy variable values act in sync with when basis values are typically more negative or positive, only helping to decrease the variance. When the HDF value increases it is expected to have a negative impact on both Corn and Soybean basis levels. The Stocks to Use being a one-year lagged variable through the function of being lagged allows for better allocation of the prior year's harvest, leading to what would be an expected negative relationship. The Calendar Spread Percent due to most commonly being a carry where it is negative incentivizing storage would lead to the basis expectedly being decreased to disincentivize more grain from coming to market. This in thought would cause the coefficient to contain a positive value.

Hypothesis

The null hypothesis is the standard of $H_0: \beta_K = 0$ where k is the number of explanatory variables. The Alternative Hypothesis is that $H_a: \beta_K \neq 0$ where at least one explanatory variable is significant.

Data

The time range that the data was collected on started 12/2/2004 through 1/31/2024, the starting date was selected due to the earliest information of flat prices available. With the Flat Price data for each location was collected from the online data source DTN. The Deferred Futures Contract Price and Nearby Futures Contract Price Data from the Chicago Mercantile Exchange were collected from the Platform Barchart for each location and the respective commodity, Corn or Soybeans. The Calendar Spread Percent is calculated as (Nearby – Deferred)/Nearby Contract Price. This is viewed as negative indicating an incentive to store the grain, in transforming the value to a percentage this allows for the data to be proportional while still showing that incentive to store. The On-Highway Diesel Fuel Price and Fuel Ethanol Production Data was collected from the United

States Energy and Information Administration (EIA). The one-year lagged Stocks/Use number was pulled from the AgManager.info website managed by Kansas State University Department of Agricultural Economics. The data contained within AgManager.info's sheet was compiled from information collected from the United States Department of Agriculture(USDA) The World Agricultural Supply and Demand Estimates(WASDE) that is published/updated monthly. The 11 locations of grain elevators selected in the data come from across Indiana with several locations in bordering states in an effort to diversify the geographical setting within the flat prices and similarly the resulting basis. The 11 locations doubled to 22 when accounting for the flat price of corn and soybeans which both are being examined for HDF basis effects respectively. The locations are as follows in no particular order: Kokomo Grain, Emporia Indiana; Falmouth Farm Supply, Glenwood Indiana; Kokomo Grain, Edinburgh Indiana; Little John Grain, Martinsville Illinois; ADM, Brookston Indiana;ADM, Webberville Michigan; Legacy Farmers COOP, Custar Ohio; Premier COOP, Rossville Illinois; Hopkinsville Elevator, Hopkinsville Kentucky; Cargill, Chillicothe Ohio; CGB, Olney Illinois. See Figure 34 for the locations plotted on a map of the Midwest and Figures 12 through 33 for the basis of each location mapped against time.

Results

$$\begin{aligned} CornBasis_{it} = \alpha_i &- .086567HDF_t - .00000084878Fuel.Ethanol.Production_t \\ &- 1.5579Stocks.Use.Lag_t + 4.7118Corn.Cal.Spread.Perc_t + .027265Jan_t \\ &+ .015584Feb_t - .03066Mar_t - .017091Apr_t - .013106May_t + .049069Jun_t \\ &+ .21909Jul_t + .26546Aug_t + .046423Sep_t - .046423Oct_t - .024767Nov_t \end{aligned}$$

- The estimated models above follow all of the expected coefficient signs and the basis seasonality is being adjusted within the dummy variables.

Corn Results

The Corn Panel Regression Results can be seen in figure 1 and 2 below with the estimated model above. Within figure 2 the location adjusted intercepts provided by the panel regression are presented showing where values may typically be for a given location. The estimated model as a whole is significant with an F-Statistic of 308.228 on degrees of freedom(df) of 15 and 39461 with an attached probability value of $<2.22e^{-16}$. Showing the model as a whole is significant and rejecting the H_0. The attached R^2 of .10488, interpreted as 10.488% of the variation in Corn Basis is explained by the variation in the explanatory variables(HDF, Fuel.Ethanol.Production, Stocks.Use.Lag, Corn.

Cal Spread. Perc). The $\bar{R}^2$ is .10431 interpreted as 10.431% of the variation in Corn Basis is explained by the variation in the explanatory variables(HDF, Fuel.Ethanol.Production, Stocks.Use.Lag, Corn. Cal Spread. Perc) while adjusting for the degrees of freedom(df). The significance of HDF, Stocks.Use.Lag, and Corn.Cal.Spread.Perc to a significance level of 0.001 within the Corn Panel Regression. While Fuel.Ethanol.Production is only significant to a level of 0.1 within the regression. The interpretation of HDF within the estimated model we see when increased by one unit results in a -.086567 unit change in CornBasis holding the other variables constant. While when Fuel.Ethanol.Production is increased by one unit resulting in a -.00000084878 unit change in CornBasis when the other variables are held constant. The Stocks.Use.Lag when increased by one unit results in a -1.5579 unit change in Corn Basis while holding other variables constant. With the final variable of Con.Cal.Spread.Perc is increased by one unit a 4.7118 unit change in CornBasis while holding the other variables constant. The t-values of the variables all show a number drastically different from zero except for Fuel.Ethanol.Production that has a t-value of -1.7151.

Soybean Results

$$
\begin{aligned}
SoyBasis_{it} = \alpha_i &-.04294634HDF_t - .00591443SoyS.U.Lag_t \\
&+ 13.81816433Soy.Cal.Spread.Perc_t -.01807328Jan_t +.00587628Feb_t \\
&-.03786545Mar_t +.00443581Apr_t -.07082853May_t -.06034639Jun_t \\
&+.01024907Jul_t +.01747189Aug_t -.00943182Sep_t -.176709250ct_t \\
&-.08104850Nov_t
\end{aligned}
$$

- The estimated models above follow all of the expected coefficient signs and the basis seasonality is being adjusted within the dummy variables.

The results for the Soybean Panel Regression are in figure 3 and 4. Figure 4 houses the panel regression location-specific intercepts. Looking at the estimated model as a whole, an F-Statistic of 4,884.99 on degrees of freedom(df) 14 and 43103. Including a p-value of < $2.22e^{-16}$ pointing to a model that as a whole is significant where, H_0 is rejected. The R^2 for the Soybean Panel Regression is .6134 which is reasoned as 61.34% of the variation in SoyBasis is explained by the explanatory variables variables(HDF, SoyS.U.Lag, Soy.Cal.Spread.Perc). The $\bar{R}^2$ is .61319 interpreted in the manner of 61.319% of the variation in SoyBasis is explained by the explanatory variables(HDF, SoyS.U.Lag, Soy.Cal.Spread.Perc) while adjusting for the degrees of freedom(df). The explanatory variables HDF, SoyS.U.Lag, Soy.Cal.Spread.Perc is significant to a level of .001 within the Soybean Panel Regression. With t-values representing values significantly different from zero and Probability (>abv.t) of $< 2.2e^{-16}$ for each explanatory variable. Interpreting the estimate for a one-unit increase in HDF results in a -0.04294634 unit change in SoyBasis holding the other explanatory variables constant. When examining SoyS.U.Lag estimate a one-unit increase results in a -0.00591443 unit change in SoyBasis when holding the other explanatory variables constant. Looking at a one-unit change in Soy.Cal.Spread.Perc leads to a 13.81816433 unit change in SoyBasis while holding the other explanatory variables constant. The dummy variables adjust for seasonality that is related to the nature that both Corn and Soybeans are harvested once yearly and must be allocated.

Ending Comments

The model for both Corn and Soybeans show statistical significance leading to the null hypothesis being rejected. This follows the logic of having to lower the basis at the elevator level when HDF is increased to account for the need of the elevator to remain at a profitable margin to the markets that they can sell grain into. The subject could be studied at a greater level, in expanding the geographical net of locations to better express and diversify other factors that are contained in the error. The exploration into the effects of Deisel prices on Basis values can also be furthered by diving into the different grades of Deisel utilized in different modes of transportation within grain movement and allocation. HDF has provided an additional glimpse into what affects basis values for Corn and Soybeans, though as is reflected in the regression it is only a small portion of factors taken into consideration when the decision on the level to set basis values is being made.

Tables & Figures

Table 1 & 2

Corn Regression Results				
Residuals				
Min.	1st Quartile	Median	3rd Quartile	Max
-1.013	-.118	-.017	.084	78.496
Coefficients	Estimates	Std. Error	t-value	Pr(>abv t)
HDF	-.00866	.005	-16.8	<2.2e-16
Fuel Ethanol Pro.	.000	.000	-1.715	0.086
Stocks to Use	-1.558	.143	-10.92	<2.2e-16
Corn Cal Spread	4.712	.114	41.305	<2.2e-16
Jan	.027	.015	1.862	.063
Feb	.015	.015	1.043	.297
Mar	-.033	.014	-2.296	.022
Apr	-.017	.015	-1.16	.247
May	-.013	.015	-.870	.384
Jun	.049	.015	3.22	.001
Jul	.219	.015	14.779	<2.2e-16
Aug	.265	.014	18.496	<2.2e-16
Sep	.042	.015	2.810	.005
Oct	-.046	.015	-3.114	.001
Nov	-.025	.015	-1.70	.088
Loc. Intercepts				
Brookston	Chillicothe	Custar	Edinburgh	Emporia
.403	.497	.454	.471	.474
Falmouth	Hopkinsville	Martinsville	Olney	Rossville
.445	.569	.395	.474	.353
Webberville				
.323				

Table 3 & 4

Soybean Regression Results				
Residuals				
Min.	1st Quartile	Median	3rd Quartile	Max
-1.727	-.119	.002	.120	9.668
Coefficients	Estimates	Std. Error	t-value	Pr(>abv t)
HDF	-.043	.002	-25.149	<2.2e-16
Stocks to Use	-.006	.000	-22.162	<2.2e-16
Soy Cal Sread	13.818	.076	182.992	<2.2e-16
Jan	-.018	.006	-3.018	.003
Feb	.006	.006	.954	.340
Mar	-.038	.006	-6.367	.000
Apr	.004	.006	.730	.465
May	-.071	.006	-11.554	<2.2e-16
Jun	-.060	.006	-9.600	<2.2e-16
Jul	.010	.006	1.590	.112
Aug	.017	.006	2.797	.005
Sep	-.009	.006	-1.512	.131
Oct	-.177	.006	-28.918	<2.2e-16
Nov	-.081	.006	-13.416	<2.2e-16
Loc Intercepts				
Brookston	Chillicothe	Custar	Edinburgh	Emporia
.019	.118	-.042	.060	-.002
Falmouth	Hopkinsville	Martinsville	Olney	Rossville
.119	.017	.032	.044	-.020
Webberville				
-.126				

Figure 5

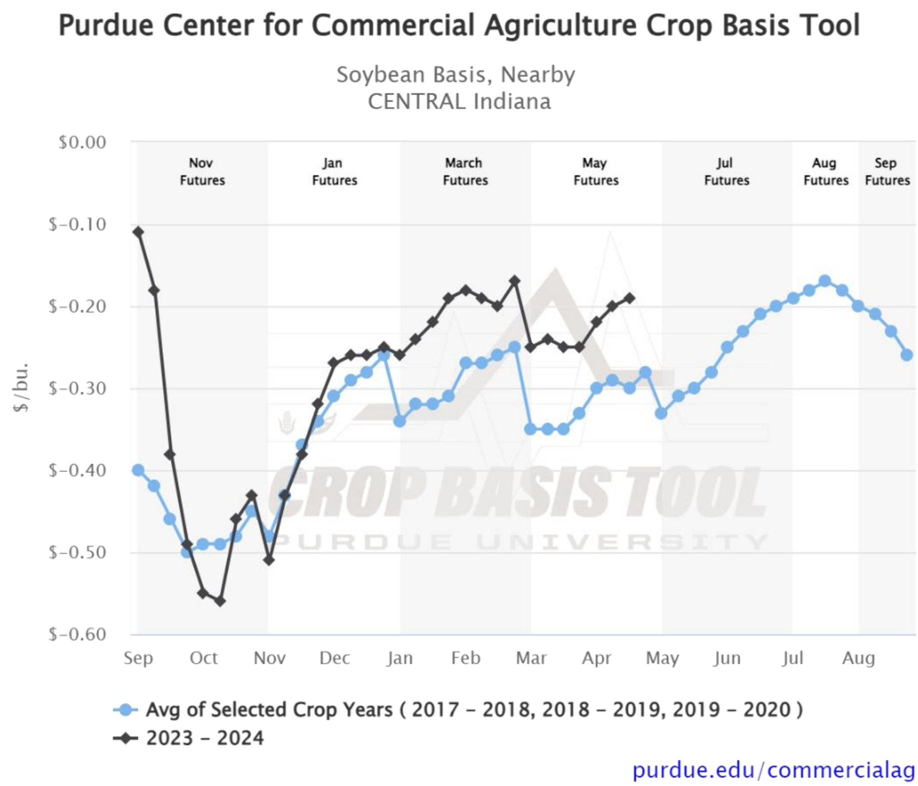
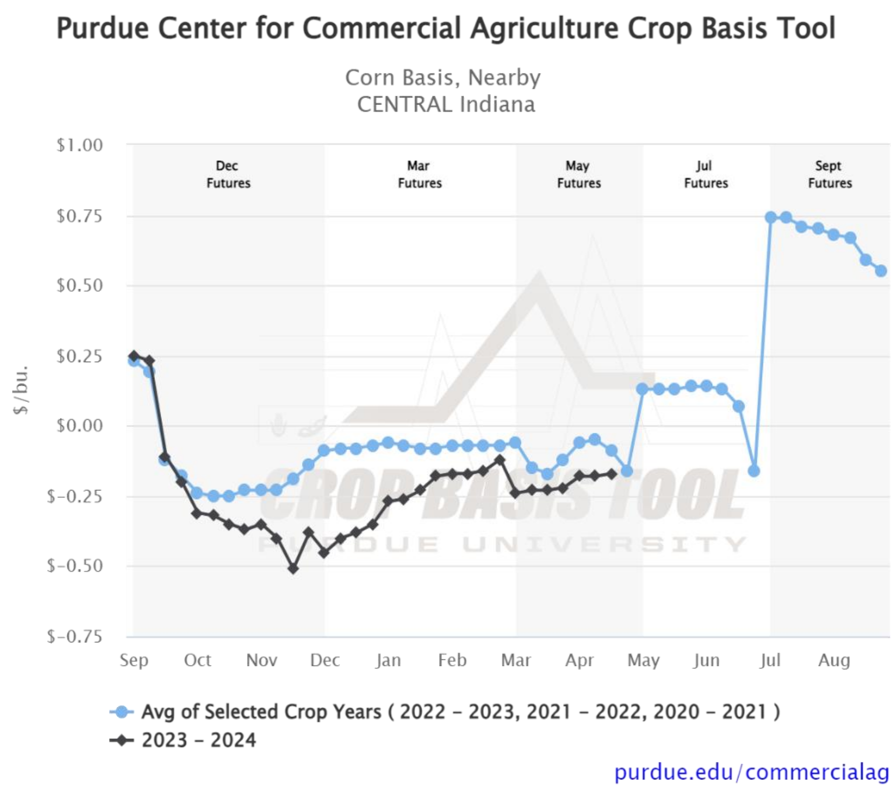


Figure 6



*Note Figures 5 and 6 from Purdue Center for Commercial Ag Illustrate Basis Seasonality.

Figure 7

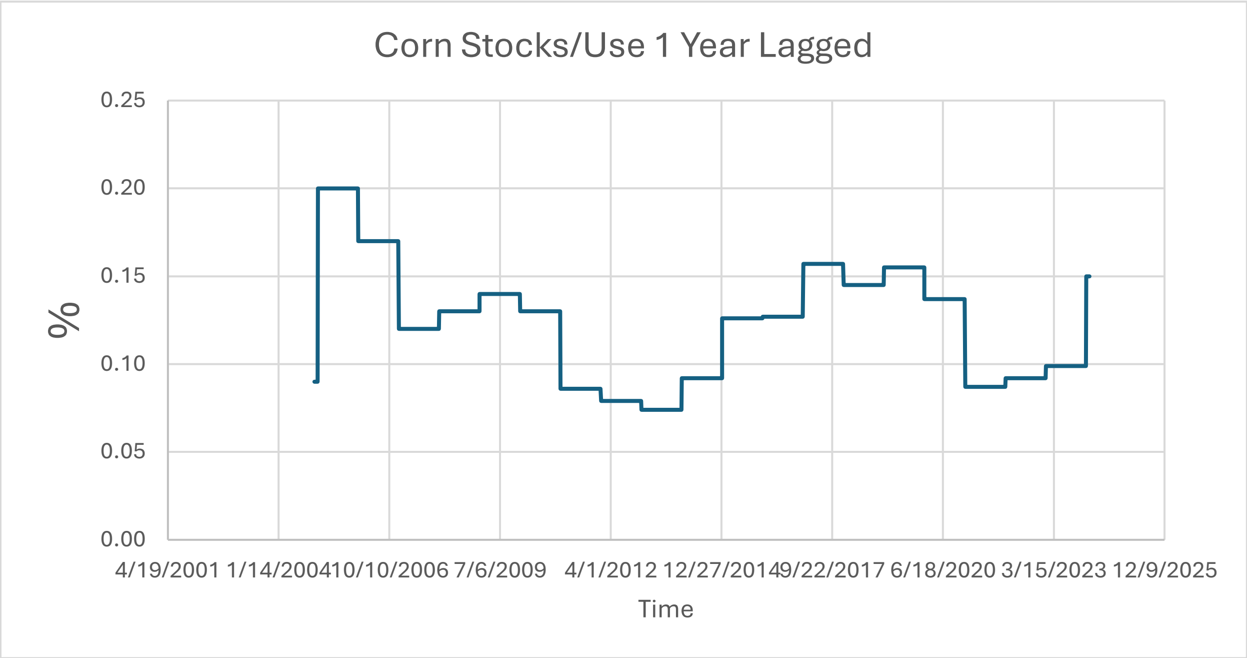
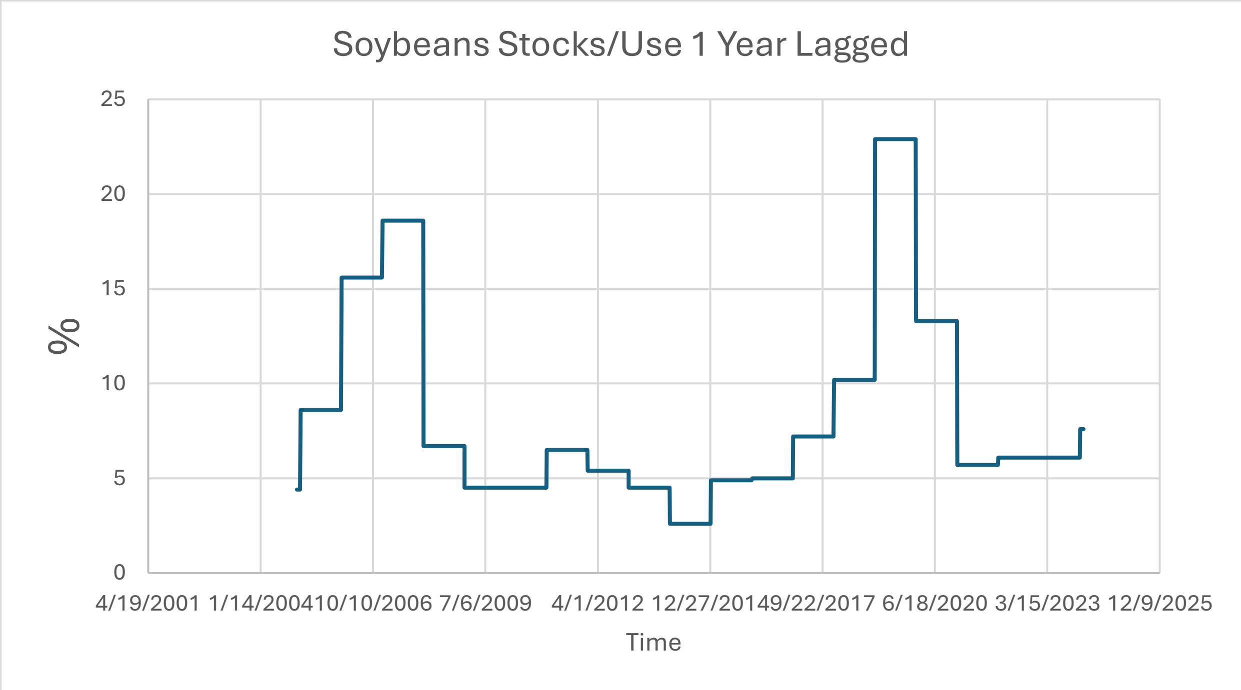


Figure 8



*Note Data in Figures 7 and 8 is from the AgManager.info website managed by the Kansas State University Department of Agricultural Economics. The stocks/use ratio is lagged by one year to represent the known information about the previous year's crop production.

Figure 9

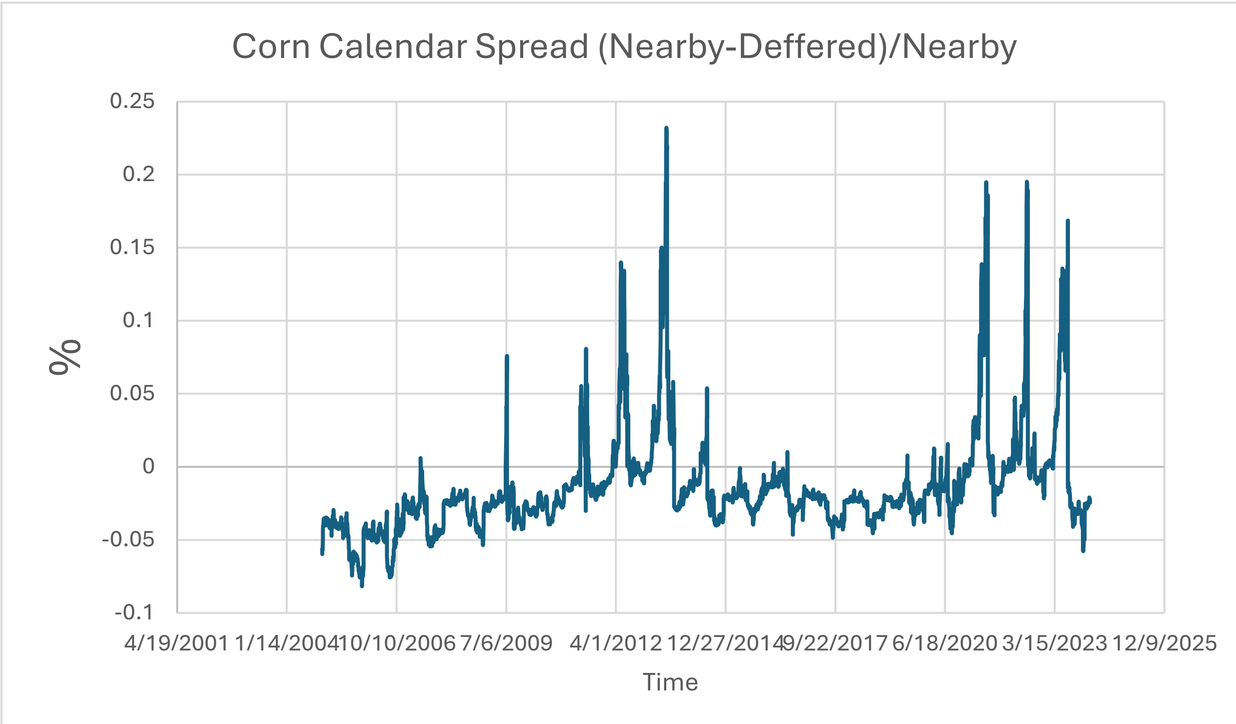
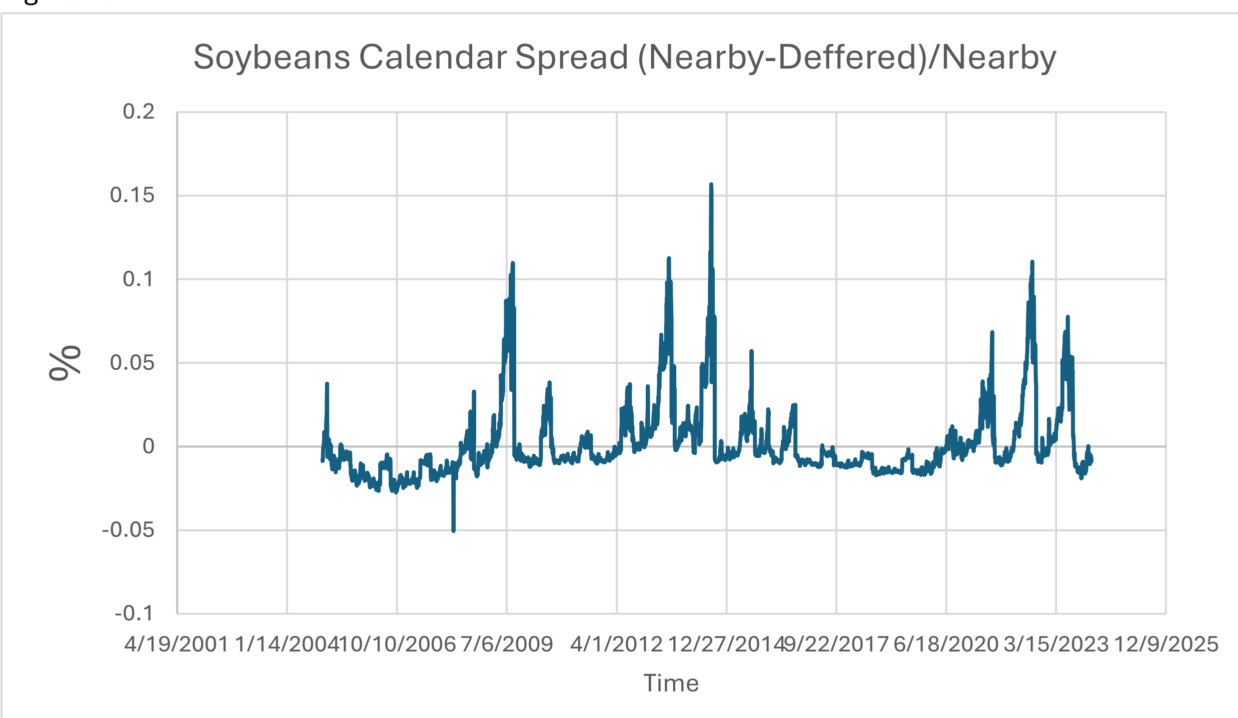


Figure 10



*Figures 9 and 10 with data from Barchart.com show the percent change with a negative value being present in a normal market where the Preferred month crop is worth more than the Nearby.

Figure 11

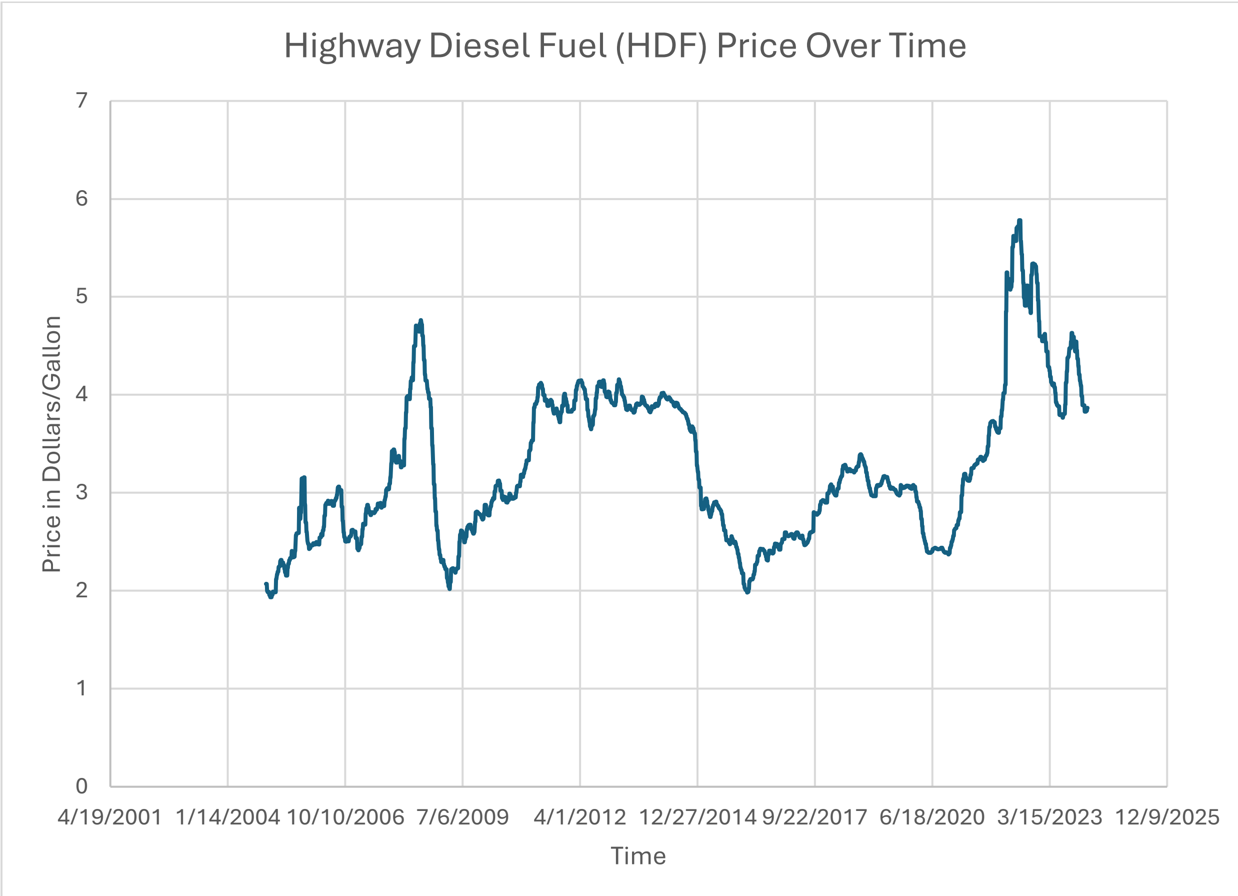
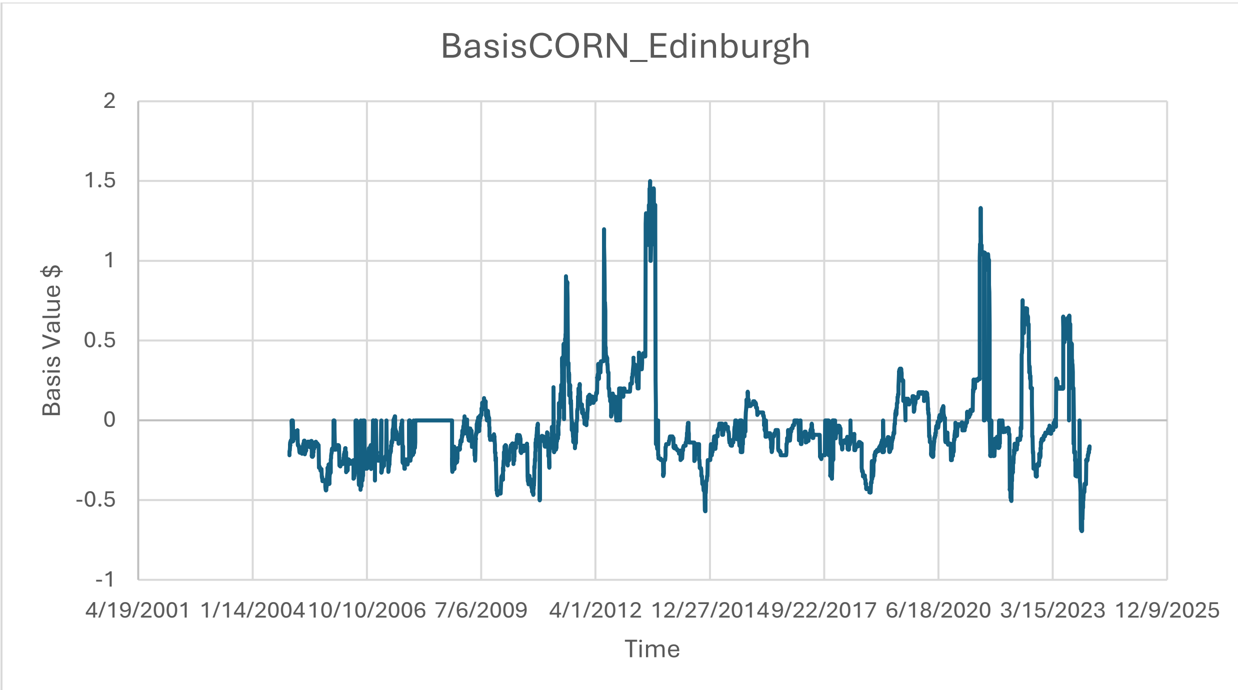


*Figure 11 HDF data is from the United States Energy and Information Administration (EIA) and is priced in Dollars/Gallon. This is a national average collected weekly and plotted over time.

The Following Figures *Note is on PG 25

Figure 12



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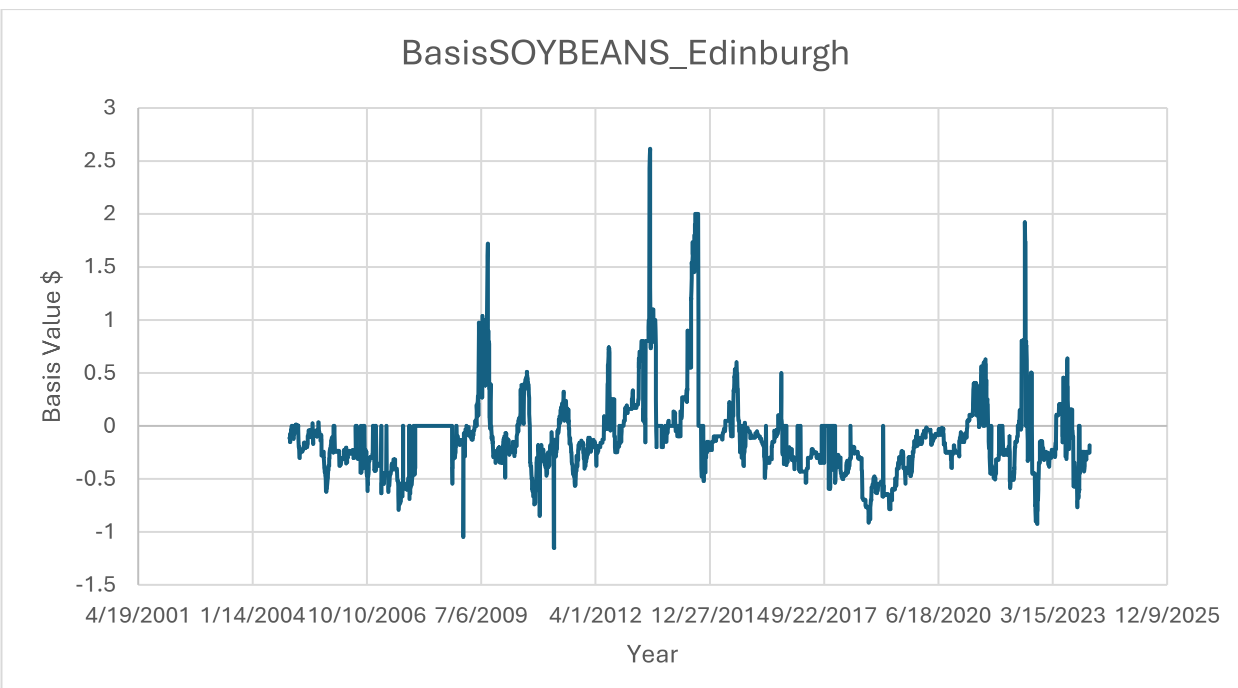

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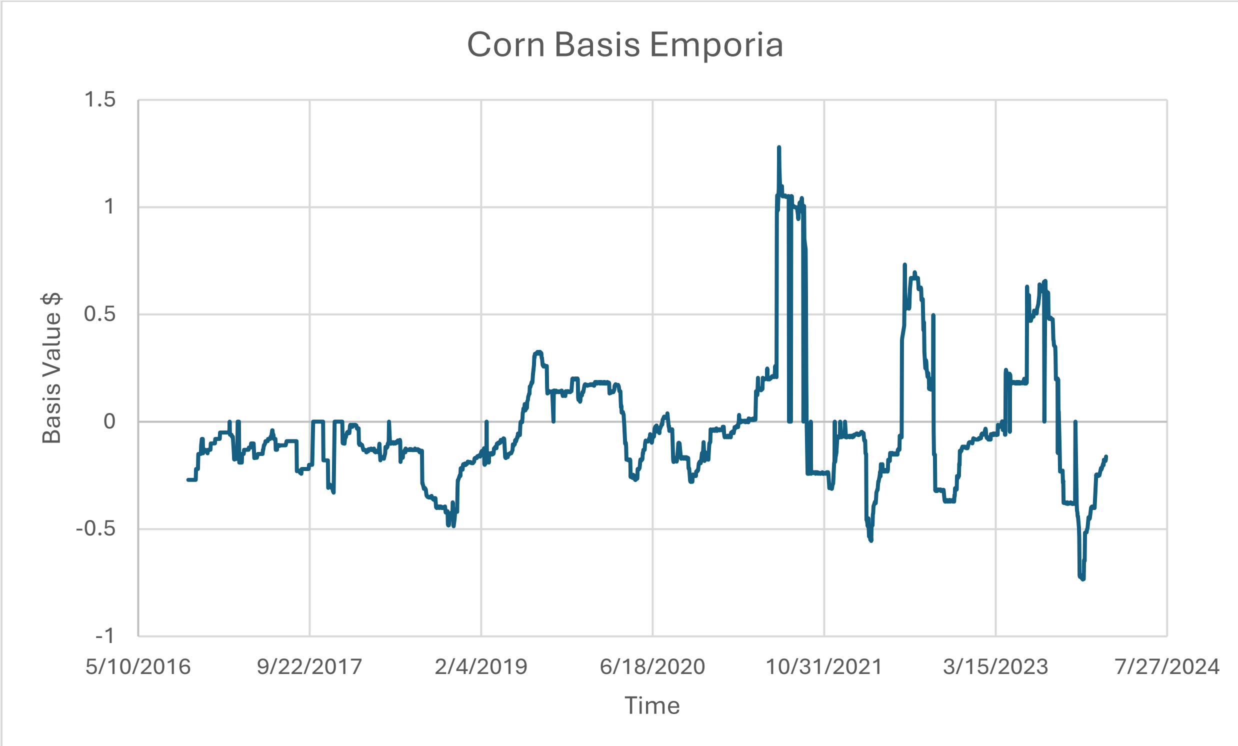
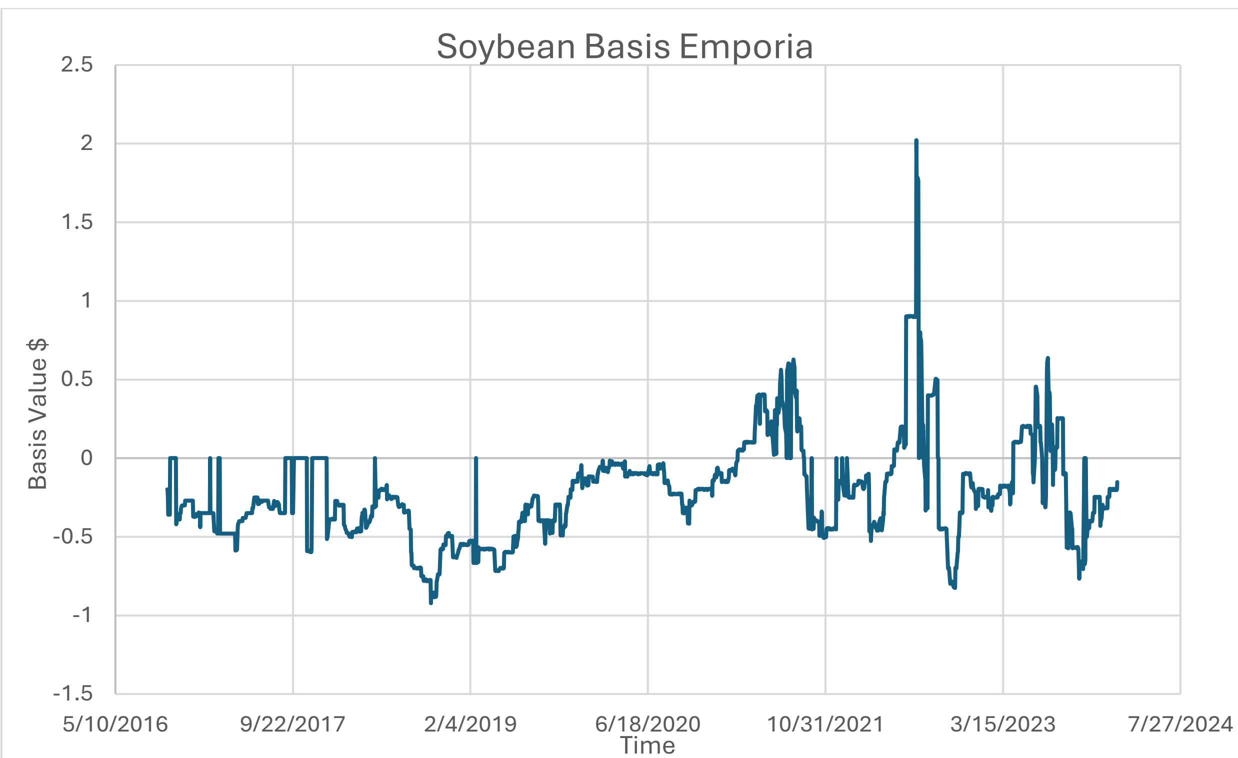


Figure 15



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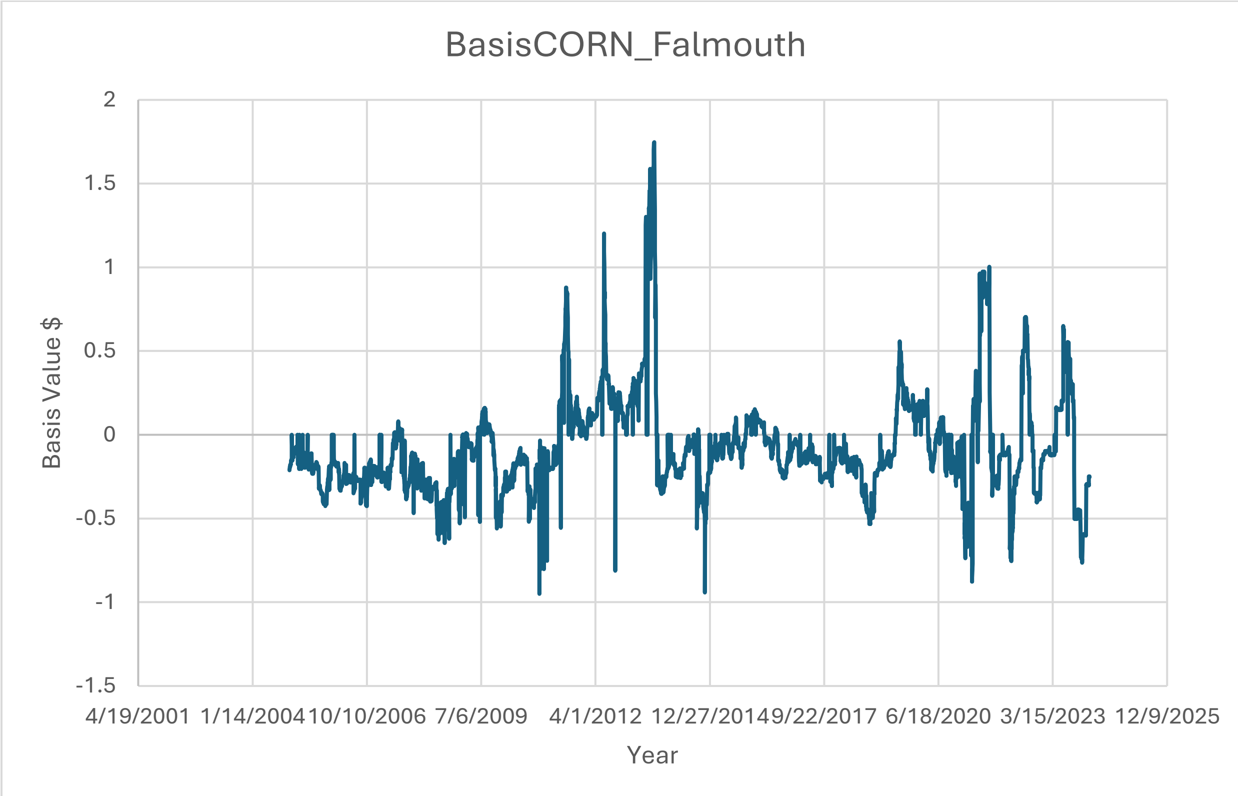

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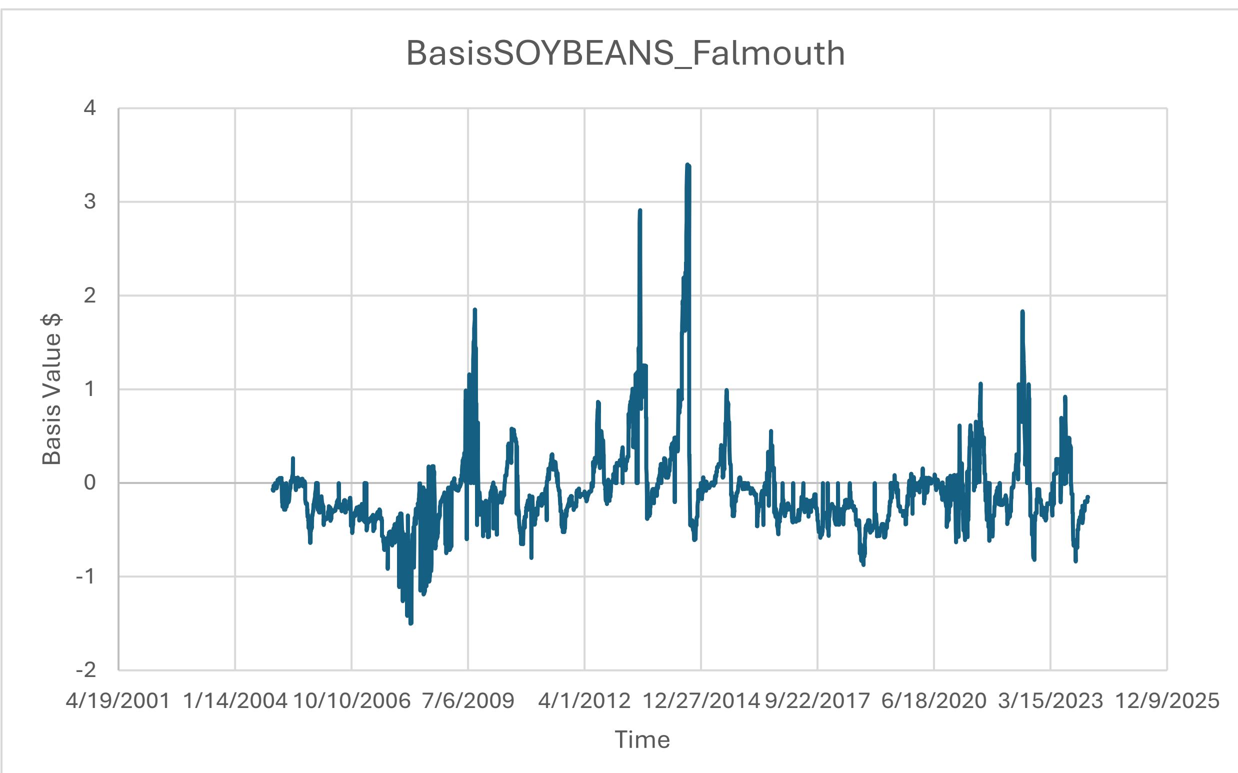

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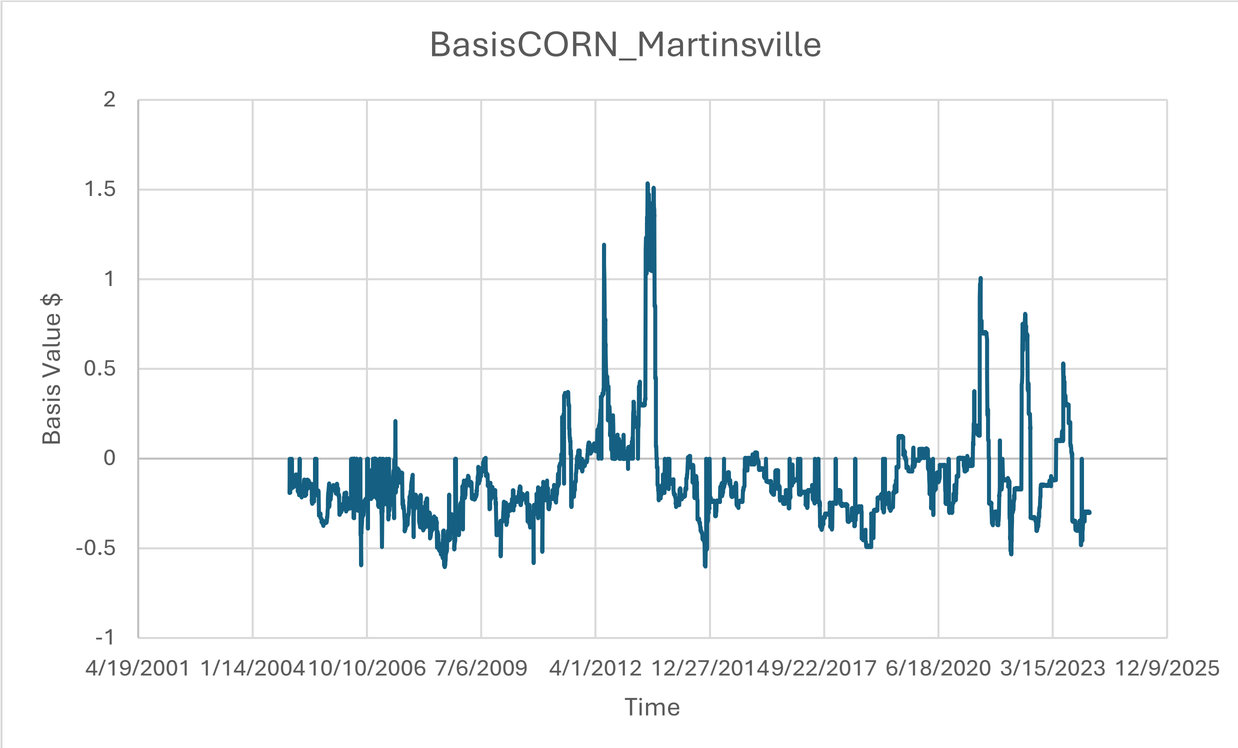

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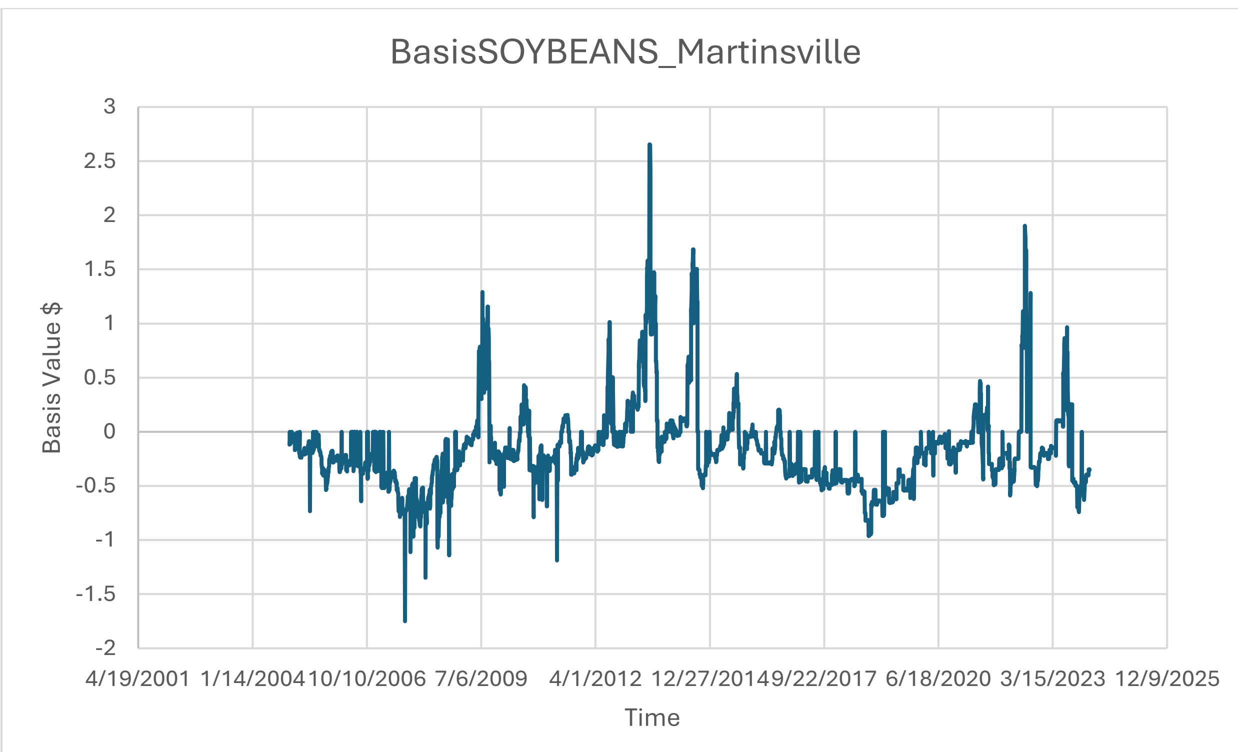

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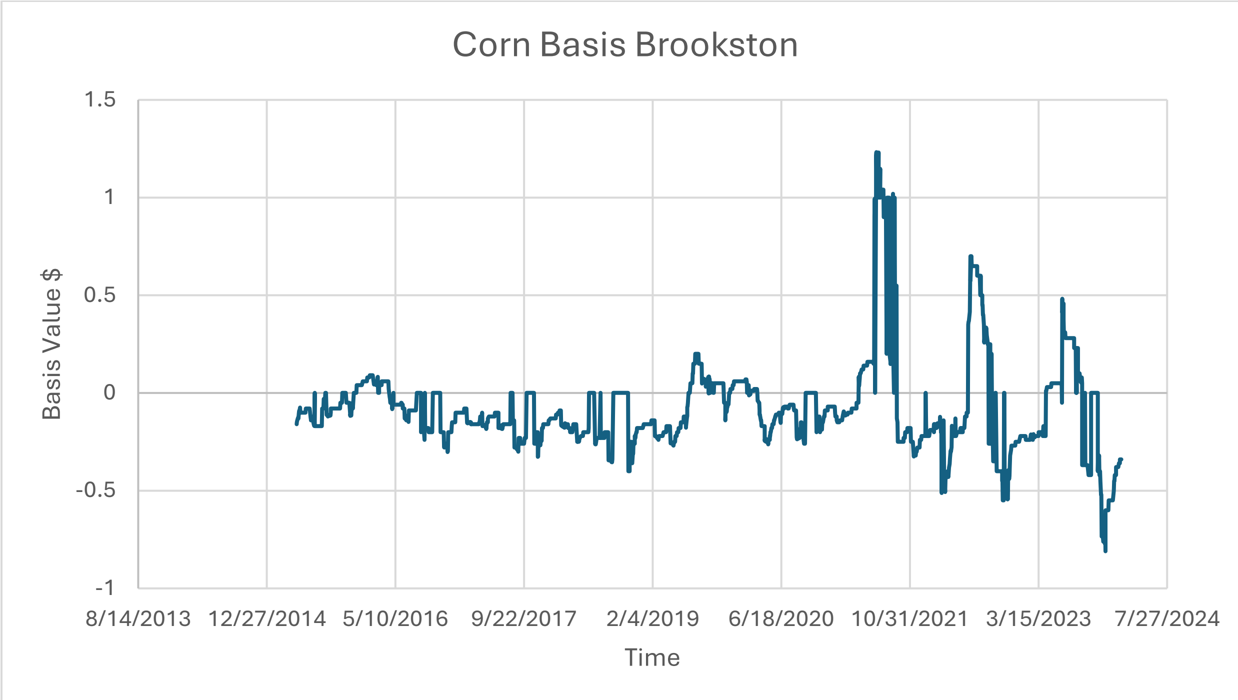

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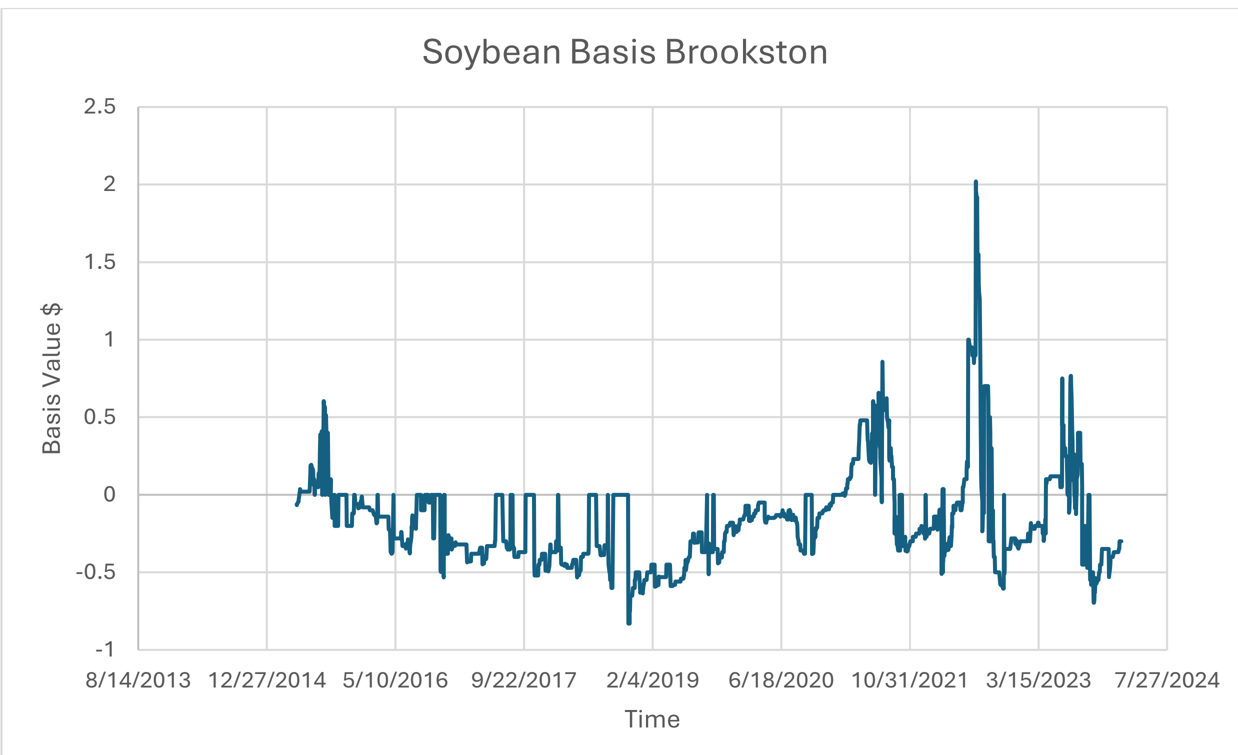

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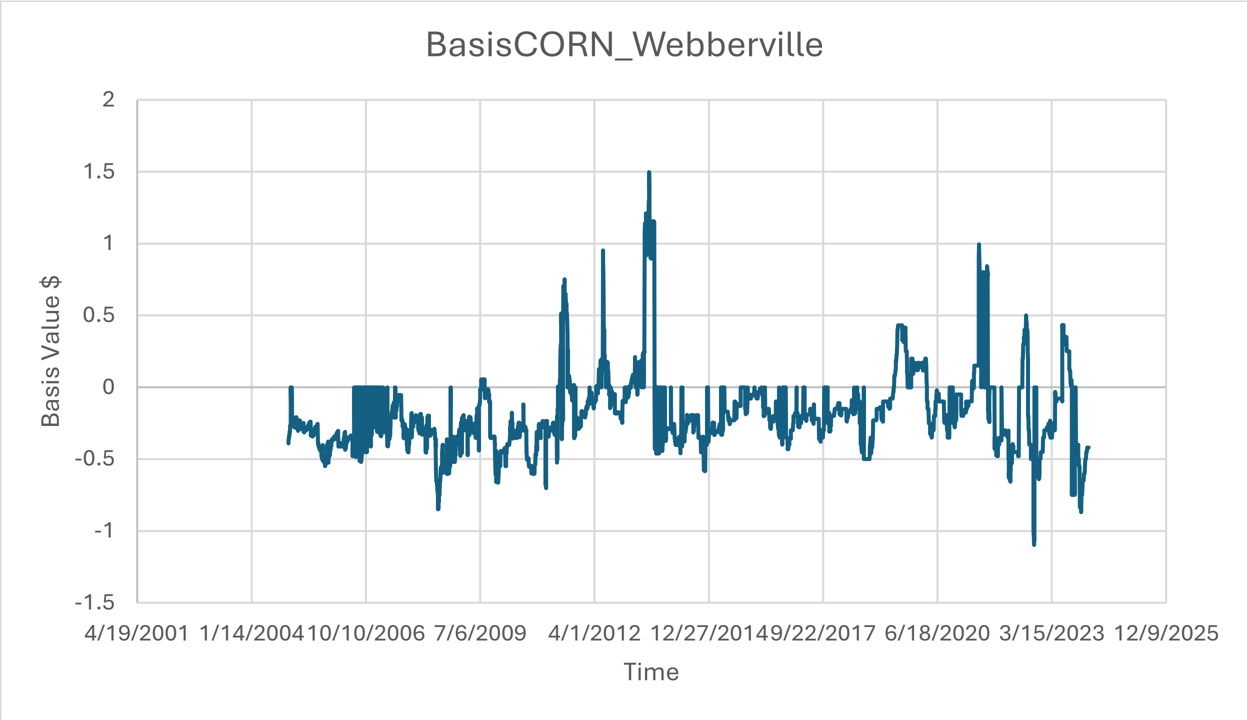

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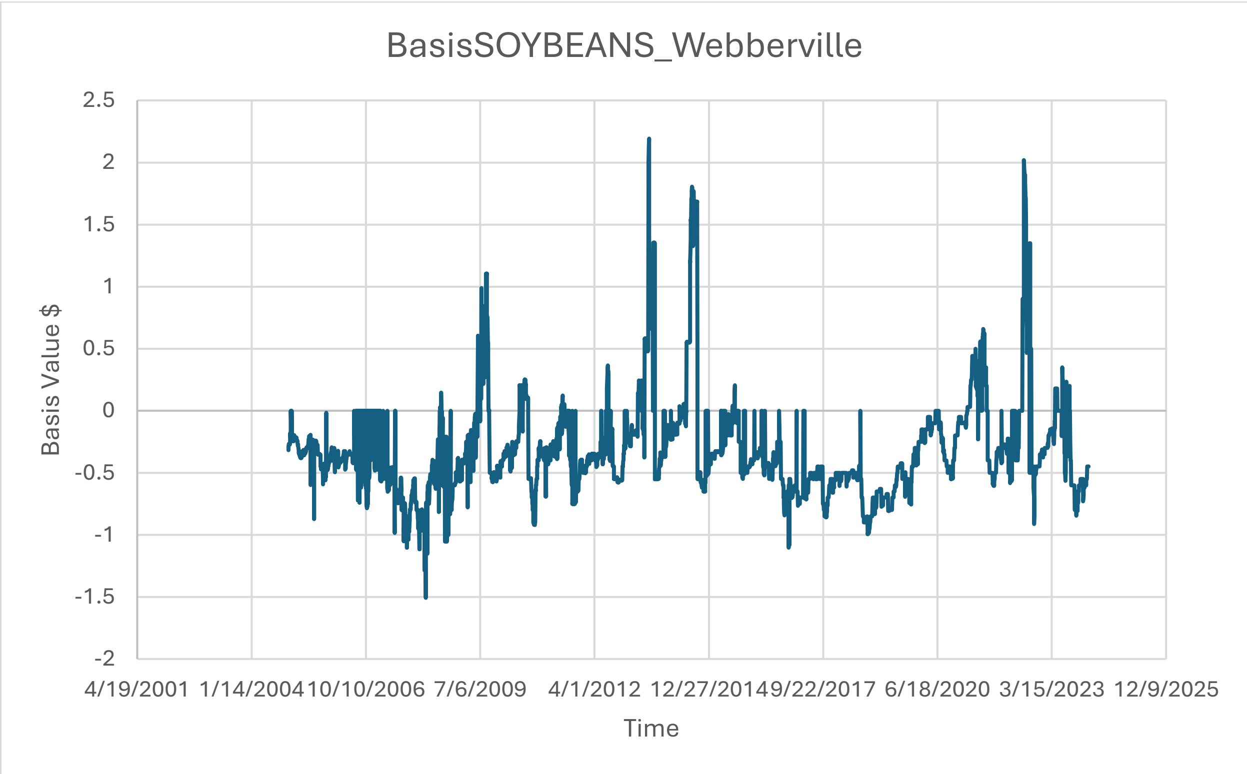

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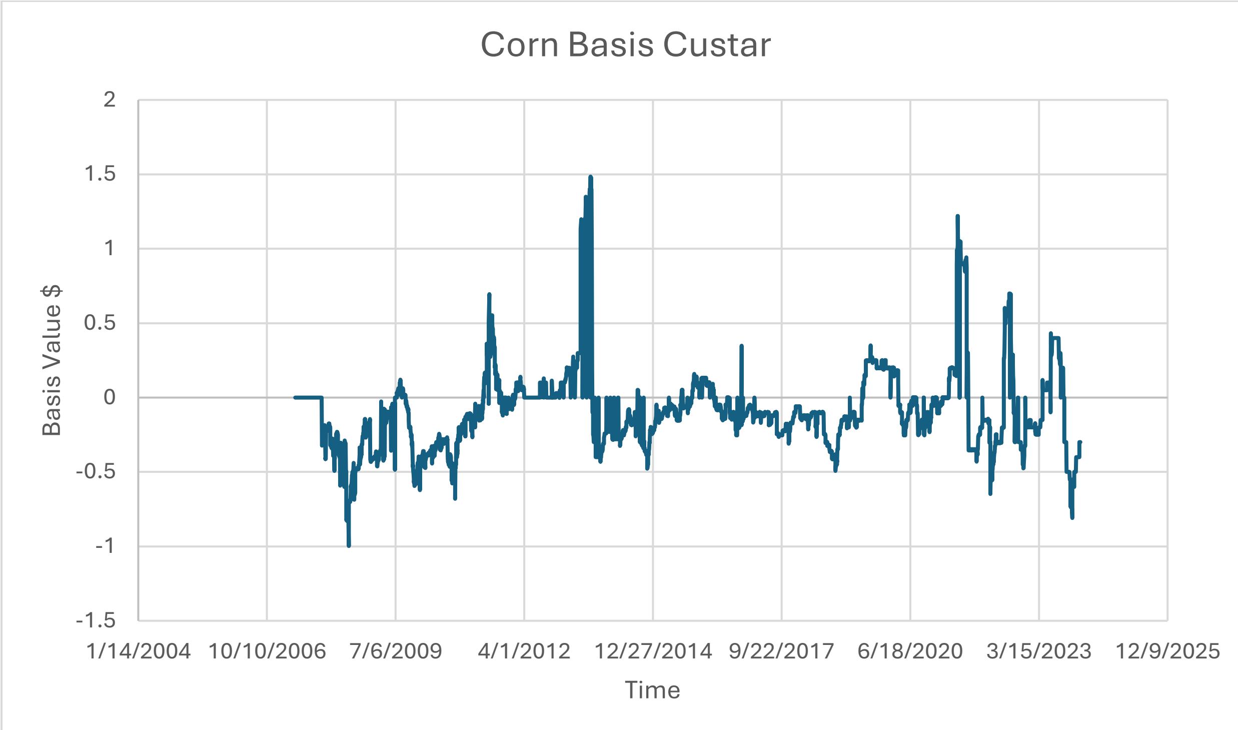


Figure 25

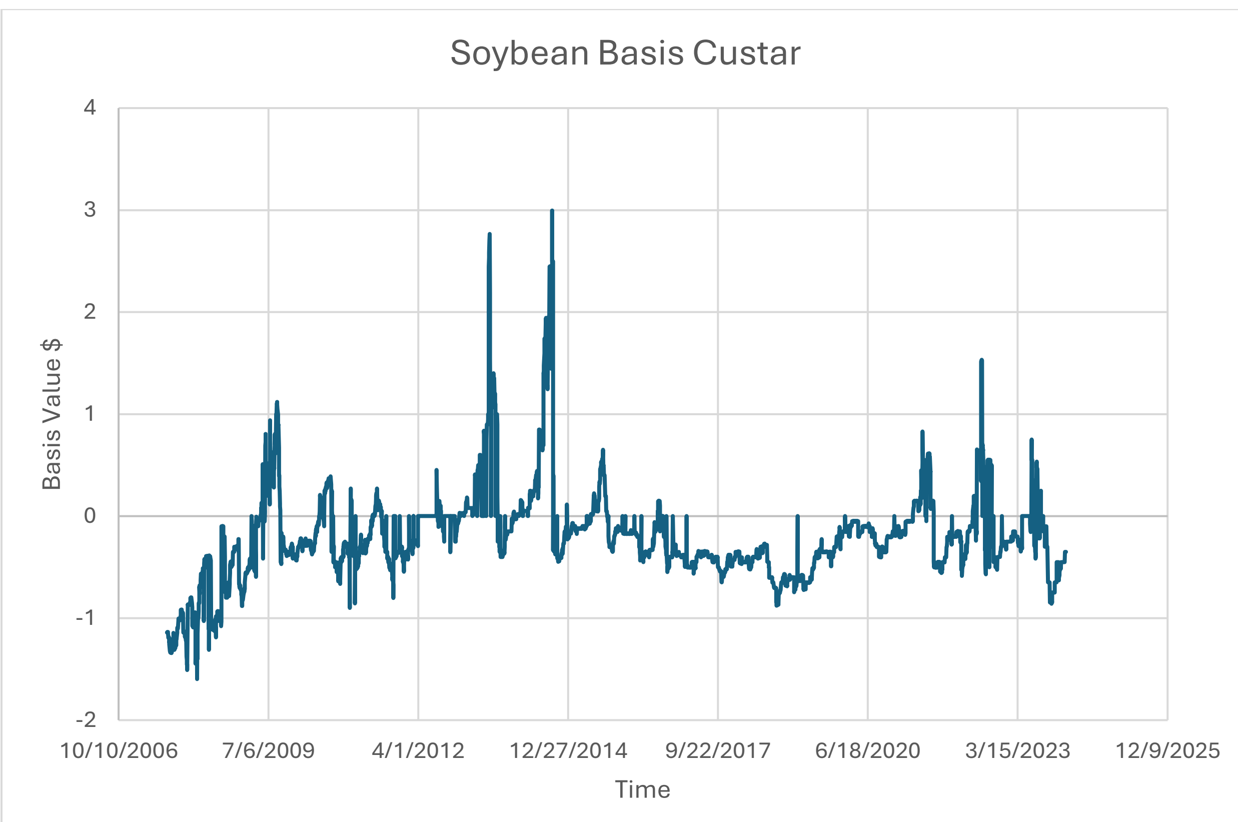
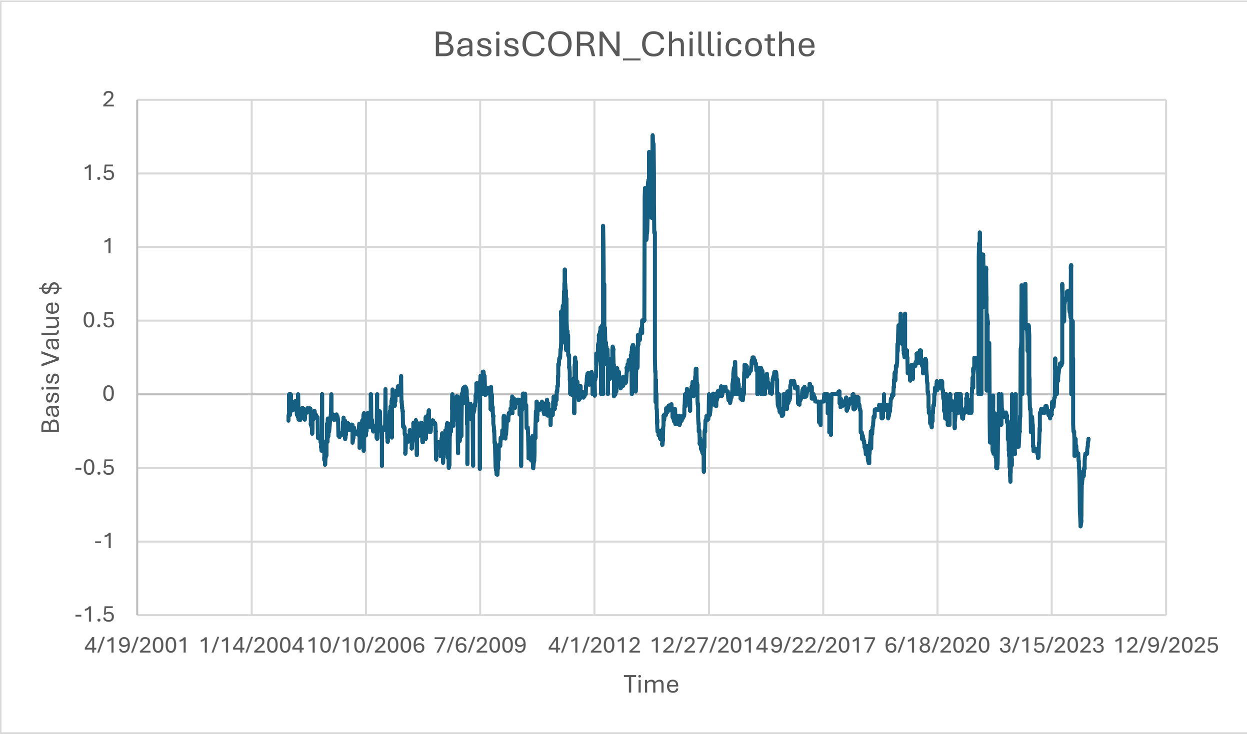


Figure 26



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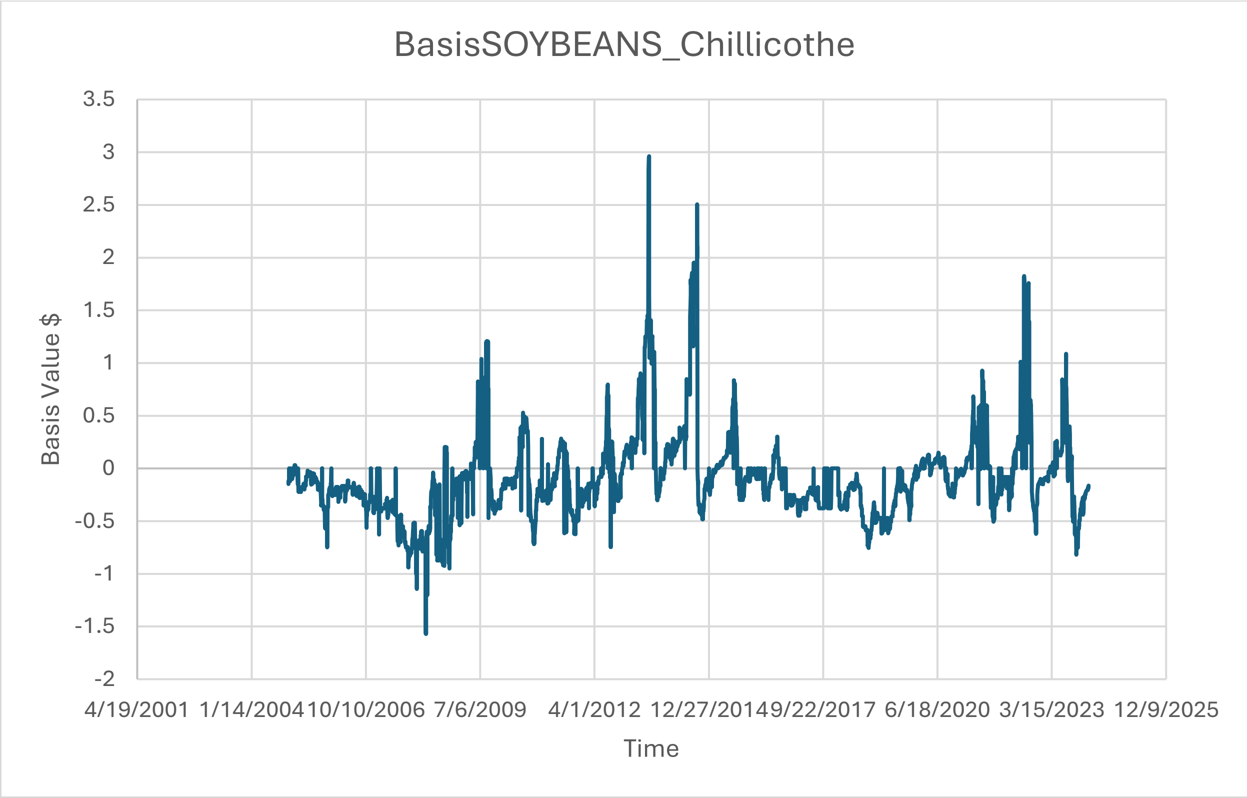

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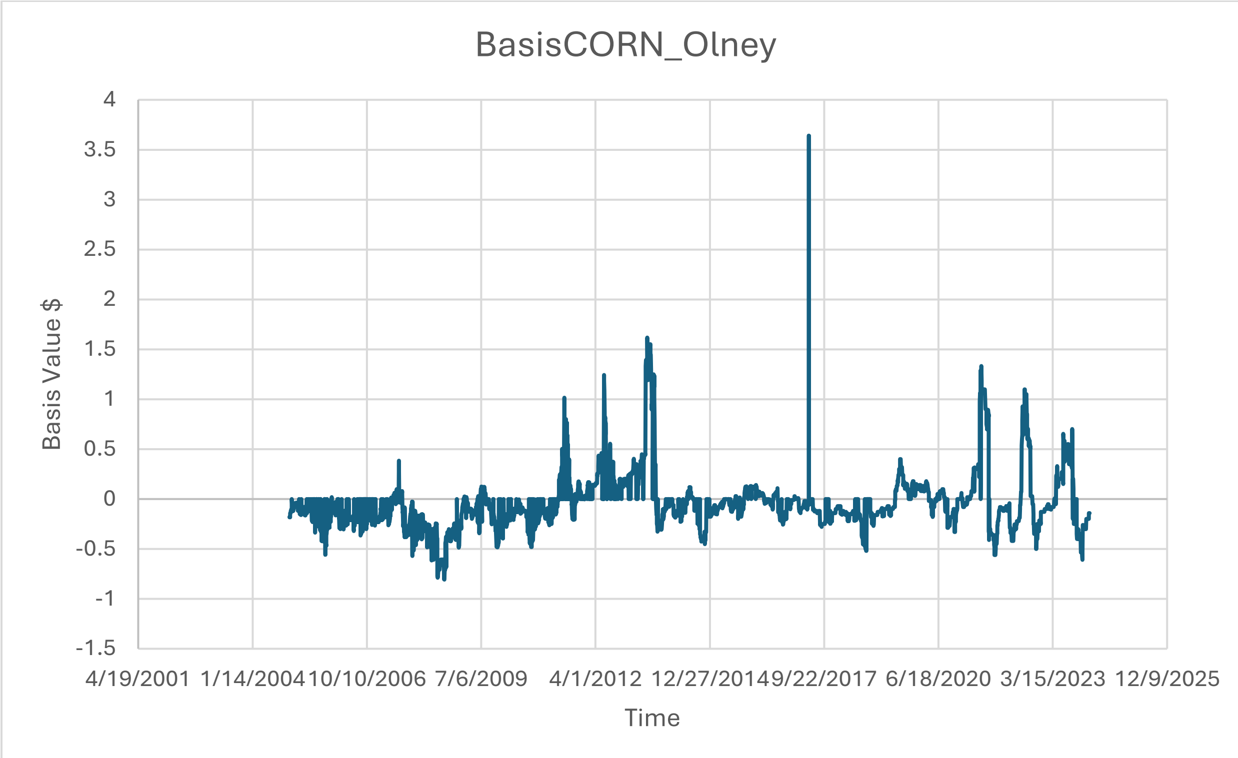


Figure 29

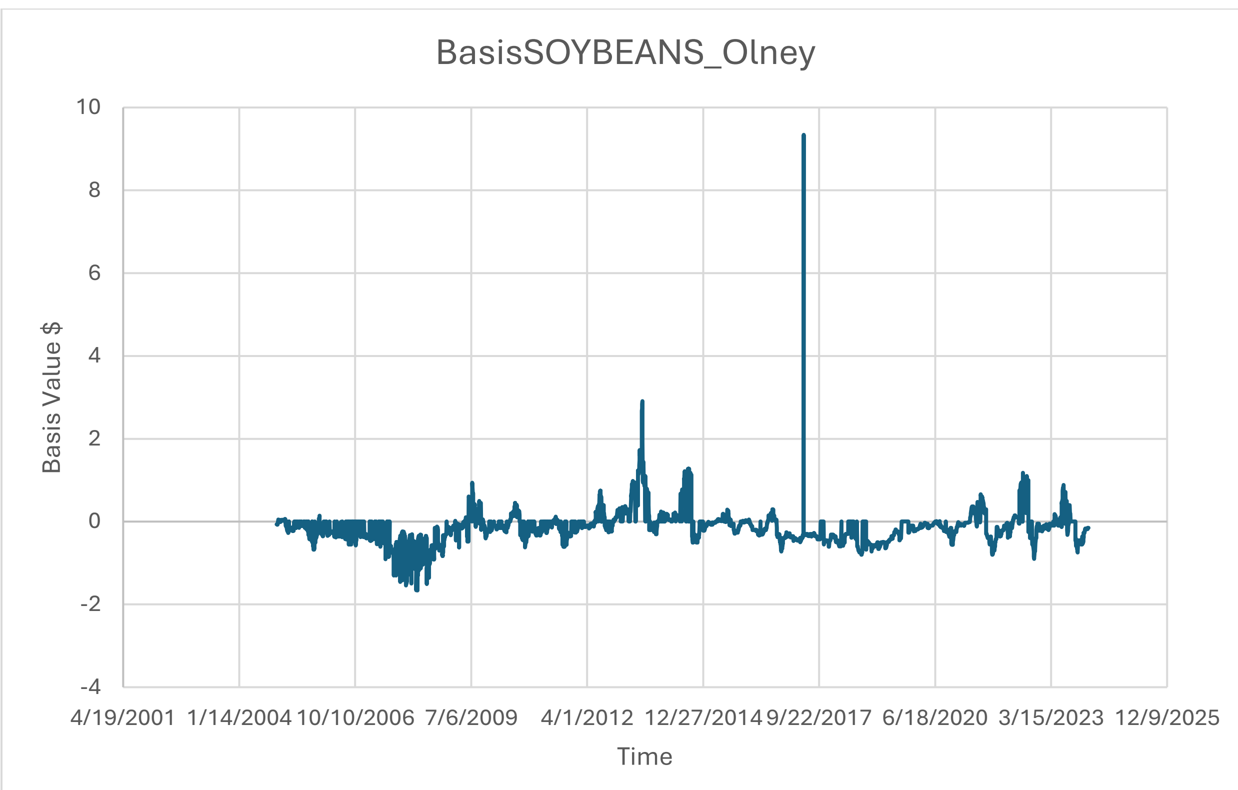


Figure 30

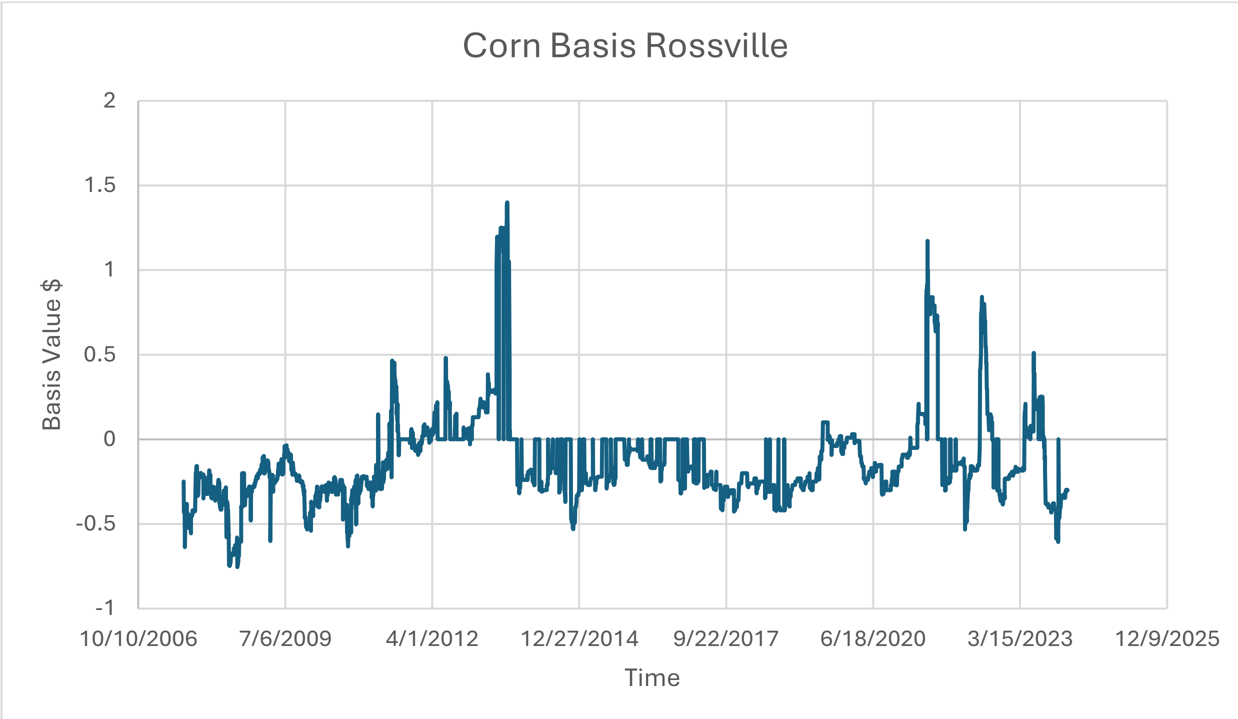


Figure 31

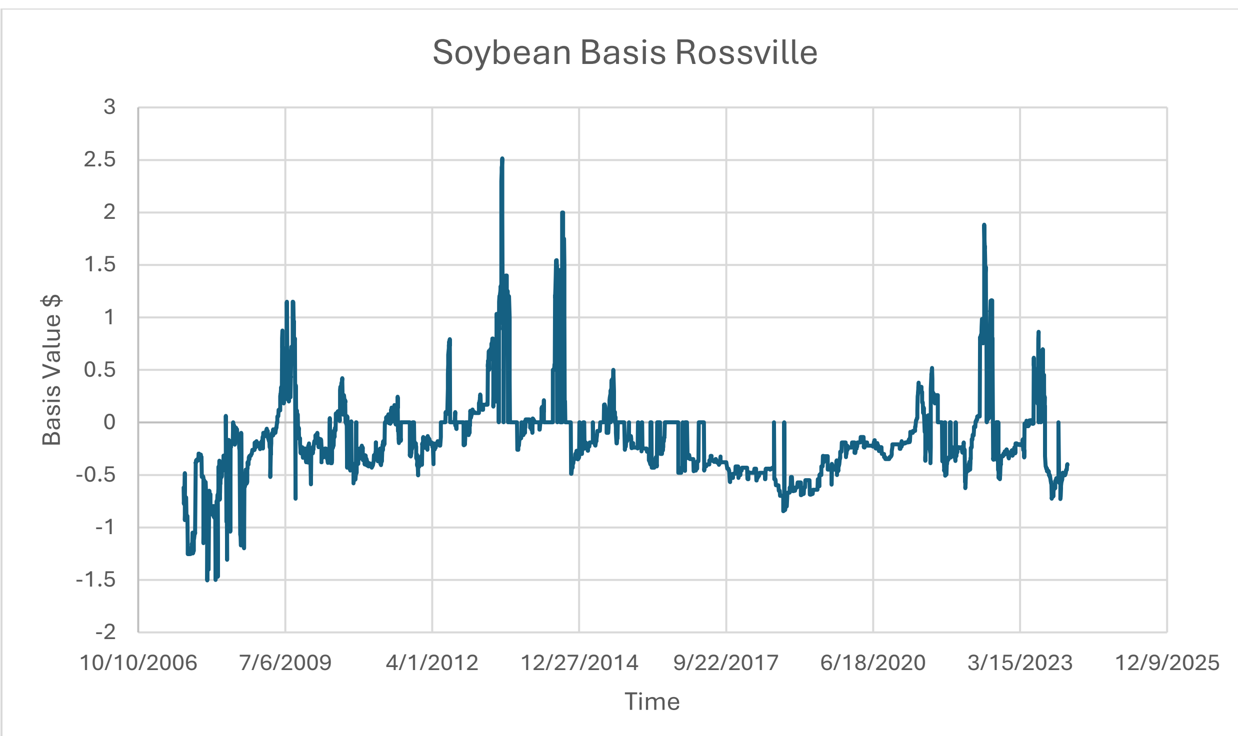


Figure 32

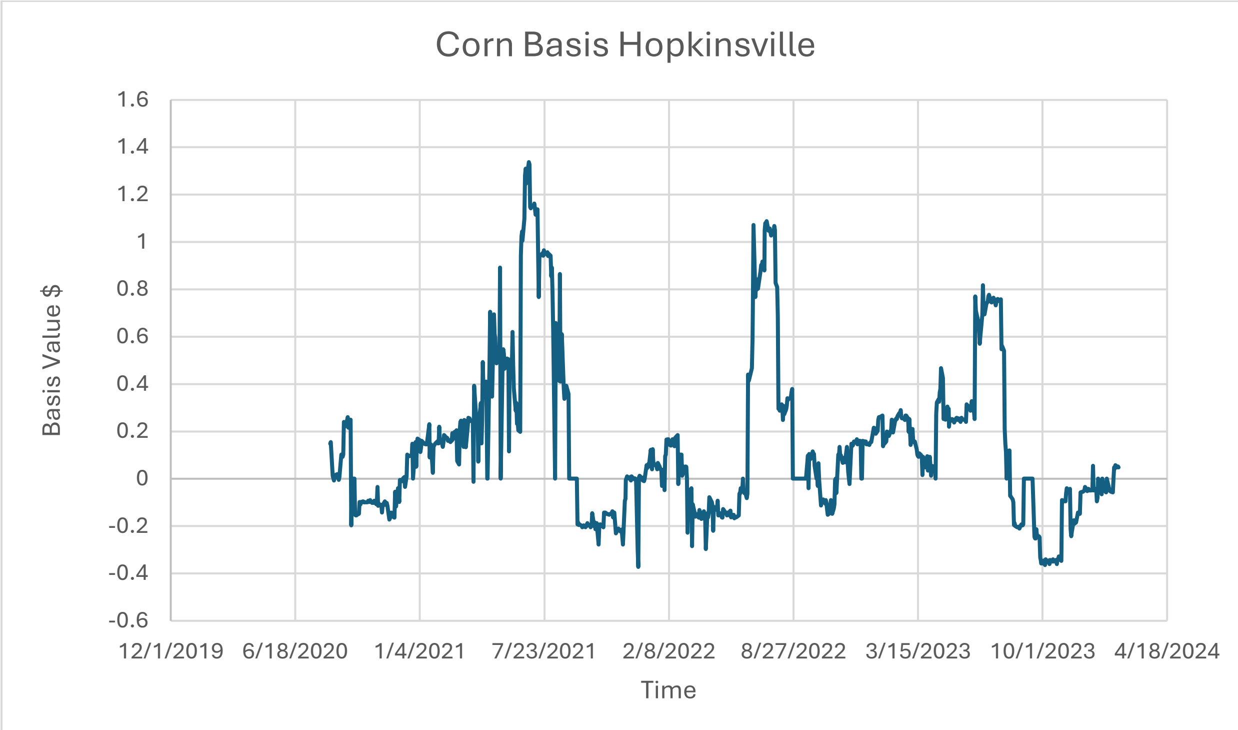
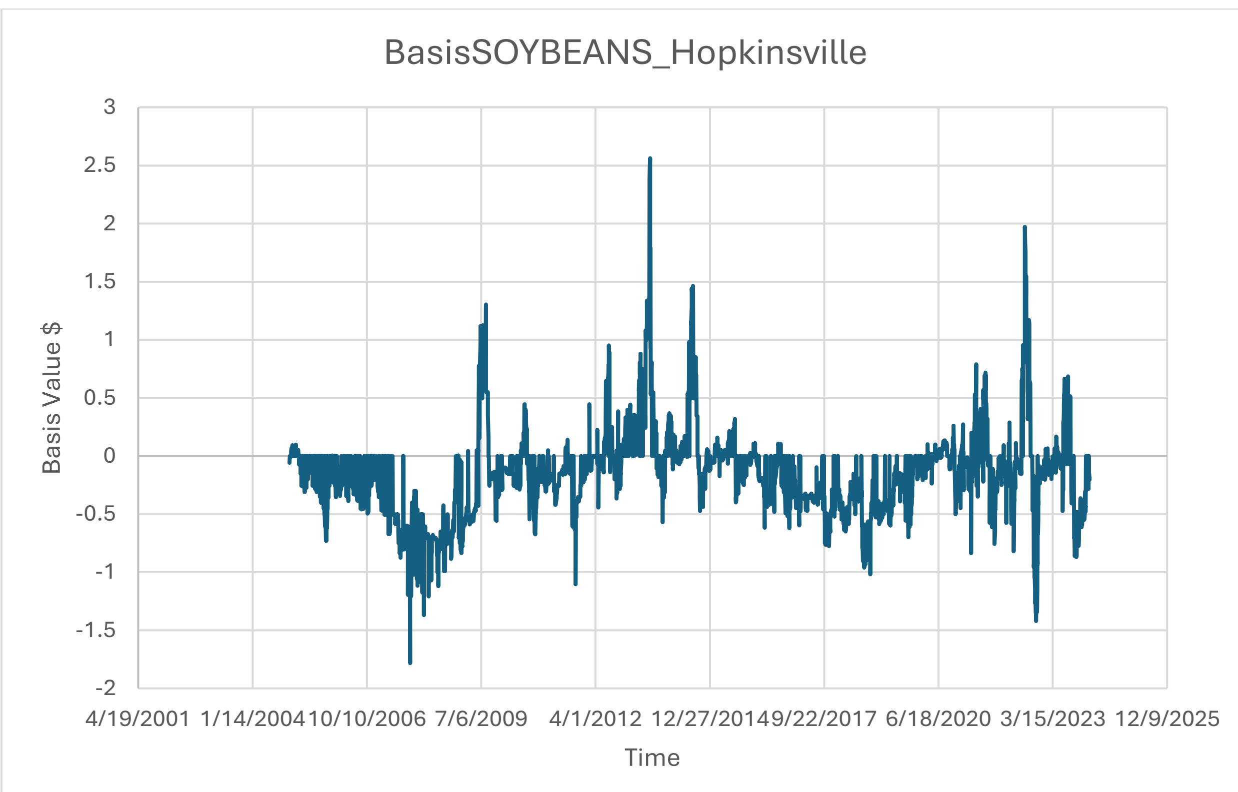


Figure 33



***Note Figures 12 through 33 above are calculated with location and commodity-specific Cash Prices from DTN subtracted from the Nearby End of Day Futures Quote from Barchart plotted over time.

Figure 34

*Figure 34 has the location of each grain elevator plotted at its exact location via Google Mymaps.

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