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Using the Soybean-to-Corn Price Ratio to Predict Corn and Soybean March Planting Intentions

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The magnitude of U.S. planted acreage of corn and soybeans will be important in determining prices for both crops during the 2017-18 marketing year. Projections of planted acreage are currently in an unusually wide range. The wide range reflects uncertainty about how generally low crop prices will impact the magnitude of acreage planted to all crops, how producers will respond to the current favorable price of soybeans relative to corn, and what will become of the nearly 3.8 million acre reduction in winter wheat seedings reported in January. USDA's 2017 planted acreage projections for corn and soybeans presented at last month's USDA Agricultural Outlook Forum reflect the consensus among market observers of less corn acreage and more soybean acreage than planted in 2016. At 90 million acres, the USDA projects 2017 corn planted acreage to be down four million acres from acreage planted in 2016. At 88 million acres, the USDA projects 2017 soybean planted acreage to be up 4.6 million acres from acreage planted in 2016.

Since corn and soybeans compete for acreage in many producing regions, analysts often use a soybean-to-corn price ratio prior to the planting season as an indicator of the relative profitability of the two crops and the likely direction and magnitude of shifts in corn and soybean acreage. For example, this article examines the relationship between the ratio of new crop soybean and corn futures during the month of February and the year-over-year change in planted acreage of the two crops. The relationship between indicators of relative profitability and corn and soybean planting intentions is logical, but actual planting decisions can be influenced by a wide range of other factors, including acreage availability, acreage planted to other crops, and spring weather conditions. A better starting point, then, might be an examination of the relationship between acreage indicators and producer planting intentions as revealed in the USDA's March *Prospective Plantings* report. Actual plantings relative to intentions could then be analyzed separately.

Here, we evaluate the performance of models using the soybean to corn price ratio, change in acres enrolled in the Conservation Reserve Program (CRP), and changes in winter wheat seedings to explain the difference between planting intentions for the current year and the previous year's acreage of corn and soybeans.

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Data and Models

Using linear regression models, we first estimate the relationship between the soybean-to-corn price ratio and the annual change in acreage intentions of each crop. There are a number of candidates for the most likely soybean-to–corn price ratio to influence planting intentions. The ratio obviously needs to reflect the pre-plant period, but that period extends over a long horizon. The ratio could be based on cash prices or futures prices and could be based on prices for the "old crop" in storage or on prices for the "new crop" being planted. We examined the performance of a number of different price ratios over different pre-plant time horizons in explaining the changes in corn and soybean planting intentions, but did not find large differences in the performance of the various ratios. Here, we present the model results based on two different ratios. The first is the ratio of November soybean futures prices and December corn futures prices during the month of February. The logic for using this ratio is that producers are most influenced by prices for the new crop close to planting and after the crop revenue insurance price is determined. The second is the average ratio of November soybean futures prices and December corn futures prices during the period October of the previous year through February of the current year. The logic for this ratio is that producers make cropping decisions and implement those decisions (e.g. make input purchases) at different times over a longer time frame.

We then expand the analysis to include annual changes in CRP enrollment as of September 30 in the year prior to planting and then to include the year-over-year change in winter wheat seedings, but not the change in CRP acreage. Both of these changes are known prior to the USDA's Prospective Plantings survey. Changes in CRP acreage and winter wheat seedings are included as potential indicators of changes in the magnitude of acreage that might be available for corn and soybean planting. The linear regression models are estimated over the period 1997 through 2016. This period follows the Freedom to Farm Act of 1996 when the influence of federal farm programs on the planting decisions of corn and soybean producers was eliminated. The model results are then used to project corn and soybean planting intentions for 2017. The four models are as follows:

Model 1: This model simply examines the relationship between planting intentions for the current year minus the previous year's planted acreage and the average ratio of November soybean futures and December corn futures prices during the month of February. The specification is as follows:

$$\text{March planting intentions acreage}_t\ (MP_t) - \text{Planted acreage}_{t-1}\ (PA_{t-1}) = a + b*(\text{February Average Harvest Price Ratio})$$

Model 2: This model examines the relationship between planting intentions for the current year minus the previous year's planted acreage and the average ratio of November soybean futures and December corn futures prices during the months of October through February. The specification, then, is the same as Model 1 except with different price ratios. The specification is as follows:

$$MP_t – PA_{t-1} = a + b*(\text{5-month Average Harvest Price Ratio})$$

Model 3: While the soybean-to-corn price ratio may reflect the relative profitability of corn and soybean production, changes in acreage intended for planting likely reflects the influence of other factors. Changes in Conservation Reserve Program (CRP) acreage, for example, could alter the annual availability of acres for planting to corn and soybeans. If a decrease (increase) in CRP acres occurs, additional acres may be added (withdrawn) to corn or soybeans. Using USDA Farm Service Agency CRP enrollment data as of September 30 of the year prior to corn and soybean planting, we calculate a year-over-year change in CRP acreage for each year in the sample period. This model examines the relationship of planting intentions for the current year minus the previous year's planted acreage to the average ratio of November soybean futures and December corn futures prices during the months of October through February and the change in CRP enrollment. We use the average price ratio over the five month period rather than the February ratio since Model 2 has a slightly higher explanatory power than Model 1. The model is as follows:

$$MP_t – PA_{t-1} = a + b*(\text{5-month Average Harvest Price Ratio}) + c*(\Delta\ \text{CRP acreage})$$

Model 4: Any change in winter wheat seedings, which is known before the March *Prospective Plantings* report is released may also impact the availability of acreage available for planting to corn and soybeans. This model examines the relationship of planting intentions for the current year minus the previous year's planted acreage to the average ratio of November soybean futures and December corn futures prices during the months of October through February and the change in winter wheat seedings from the previous year. The model is as follows:

$$MP_t - PA_{t-1} = a + b^*(\text{5-month Average Harvest Price Ratio}) + c^*(\Delta \text{ Winter Wheat acreage})$$

Results

The data used in estimating the linear regression models along with the observations for 2017 are summarized in Table 1. The model fit and coefficients along with the model forecast of the difference between acreage planted in 2016 and intentions for 2017 are summarized in Tables 2 and 3. The p values for the estimated coefficients are shown in parenthesis below each coefficient estimate. The coefficients represent the mean change in acreage response to a one unit change in the explanatory variables while holding all other explanatory variables in the prediction model constant. The p-values for each explanatory variable tests the null hypothesis that a coefficient is equal to zero. A low p-value indicates that the variable is a meaningful addition to the model.

Table 1. Data for Model Estimations

Year	Change in Soybean Planting Intentions Acreage	Change In Corn Planting Intentions Acreage	CRP Acre Change	Winter Wheat Seeding Acreage Change	February Average Harvest Price Ratio	5-month Average Harvest Price Ratio
1997	4.61	2.19	-1.69	-3.46	2.78	2.51
1998	2.00	1.24	-2.68	-1.54	2.58	2.37
1999	1.08	-1.95	-0.31	-3.17	2.34	2.30
2000	1.14	0.50	1.60	0.03	2.42	2.13
2001	2.39	-2.86	2.18	-2.37	2.28	2.01
2002	-1.11	3.35	0.36	0.82	2.19	1.89
2003	-0.78	0.13	0.15	3.62	2.37	2.12
2004	2.01	0.40	0.60	-2.06	3.17	2.42
2005	-1.30	0.48	0.20	-2.90	2.78	2.35
2006	4.86	-3.76	1.10	0.15	2.81	2.47
2007	-8.38	12.13	0.77	4.45	2.00	1.99
2008	10.05	-7.51	-2.16	1.77	2.58	2.40
2009	0.31	-1.00	-0.89	-3.49	2.47	2.14
2010	0.65	2.42	-2.42	-6.71	2.65	2.31
2011	-0.80	3.99	-0.17	4.02	2.25	2.26
2012	-1.14	3.93	-1.60	0.30	1.94	2.10
2013	-0.07	-0.01	-2.69	2.33	2.07	2.16
2014	4.65	-3.67	-1.39	-0.82	3.03	2.48
2015	1.36	-1.40	-1.26	-2.73	2.61	2.40
2016	-0.41	5.58	-0.31	-3.54	2.38	2.26
2017 Prediction Values			-0.42	-3.8	2.6	2.6

* All acreage calculation in millions of acres

Table 2. Soybean Planting Intentions Acreage Models

	Model 1	Model 2	Model 3	Model 4
R2	0.351	0.395	0.396	0.396
Adjusted R2	0.315	0.362	0.325	0.283
Standard Error	2.941	2.837	2.918	3.008
Intercept Coefficient	-25.609	-27.274	-26.883	-26.655
Intercept P Value	(0.008)	(0.004)	(0.009)	(0.016)
Price Ratio Coefficient	11.826	12.575	12.387	12.280
Price Ratio P Value	(0.005)	(0.003)	(0.007)	(0.014)
CRP Coefficient			-0.061	-0.059
CRP P Value			(0.906)	(0.911)
Winter Wheat Coefficient				-0.018
Winter Wheat P Value				(0.945)
2017 Acreage Prediction (Price Ratio = 2.6)	5.138	5.420	5.348	5.363

Table 3. Corn Planting Intentions Acreage Models

	Model 1	Model 2	Model 3	Model 4
R2	0.130	0.199	0.203	0.205
Adjusted R2	0.082	0.154	0.110	0.056
Standard Error	3.948	3.789	3.886	4.002
Intercept Coefficient	19.549	24.009	25.418	24.650
Intercept P Value	(0.107)	(0.043)	(0.051)	(0.081)
Price Ratio Coefficient	-8.356	-10.343	-11.019	-10.659
Price Ratio P Value	(.118)	(0.049)	(0.059)	(0.092)
CRP Coefficient			-0.220	-0.224
CRP P Value			(0.749)	(0.751)
Winter Wheat Coefficient				0.060
Winter Wheat P Value				(0.861)
2017 Acreage Prediction (Price Ratio = 2.6)	-2.177	-2.882	-3.141	-3.191

The base model for soybean acreage change (Model 1) indicates a very poor fit between the ratio of futures prices during February (along with an intercept term) and the change in planted acreage intentions. An R-squared of 0.35 indicates that the model explains only 35 percent of the variation in acreage changes over the sample period. The coefficient of the price ratio indicates that a 0.1 increase in the ratio would, on average, increase soybean acreage by 1.2 million acres. The standard error of the estimated acreage changes is large at 2.94 million acres.

Model 2 indicates that the 5-month price average ratio has slightly more explanatory power than the February price ratio. The R-squared is still quite low at 0.39 and the estimated price ratio coefficient indicates a 1.26 million acre increase for each increase 0.1 in the 5-month average price ratio. The standard error is also slightly lower at 2.84 million acres.

Since the 5-month average price ratio provides a better fit, we chose to use that price ratio in the models incorporating CRP and winter wheat acreage changes. The coefficient for the CRP acre change, however, is insignificant in Model 3. Model 3 also has a higher standard error and a lower adjusted R-square (which accounts for the number of variables included in a model) than does Model 2. The inclusion of CRP acreage changes provides no additional explanation for the change in soybean planting intentions.

The results for Model 4, which includes changes in winter wheat acreage rather than CRP acreage, are similar to Model 3. An insignificant coefficient for changes in winter wheat acreage and a lower adjusted R-square reveal a lack of explanatory power.

For each of the models, the price ratio coefficients are significant and provide some explanatory power for the changes in soybean acreage, but the overall fit of the models is quite poor. A forecast based on each model is provided using the October 2016 through February 2017 price ratio of 2.6. The best fitting model (Model 2) indicates a 5.4 million acre increase in soybean planting intentions for 2017. This is 0.8 million acres higher than the current USDA projection and would result in soybean planting intentions of 88.8 million acres. While the direction and magnitude of the projected change seems reasonable, the large standard error associated with the regression models suggests that the actual change could deviate substantially from the projection.

The base model for corn acreage change (Model 1) indicates a very poor fit between the ratio of futures prices during February (along with an intercept term) and the change in planted acreage intentions. An R-squared of 0.13 indicates that the model explains only 13 percent of the variation in corn acreage changes over the sample period. The coefficient for the price ratio indicates a 0.1 increase in the soybean to corn price ratio would, on average, decrease corn acreage by 0.83 million acres. The standard error for the model is large at 3.94 million acres.

Model 2 indicates that the 5-month price average ratio has slightly more explanatory power than the February price ratio. The R-squared is still quite low at 0.19 and the estimated price ratio coefficient indicates a 1.03 million acre decrease per 0.1 increase in the 5-month average price ratio. The standard error is also lower at 3.79 million acres.

Since the 5-month average price ratio provides a better fit, we chose to use that price ratio in the models incorporating CRP and winter wheat acreage changes. The coefficient for the CRP acre change, however, is insignificant in Model 3. Model 3 also has a higher standard error and a lower adjusted R-square (which accounts for the number of variables included in a model) than does Model 2. The inclusion of CRP acreage changes provides no additional explanation for the change in corn planting intentions.

The results for Model 4 which includes changes in winter wheat acreage rather than CRP acreage are similar to Model 3. An insignificant coefficient and lower adjusted R-square show a lack of explanatory power. As seen with soybean acreage estimations, the price ratio coefficients are significant and provide some explanatory power but the overall fit of the models is poor and worse than the soybean acreage models.

A forecast for change in corn planting intentions for 2017 using each model is provided using the average October 2016 through February 2017 price ratio of 2.6. The best fitting model (Model 2) indicates a 2.9 million acre decrease in corn planting intentions in 2017. This would be 1.1 million acres lower than the current USDA projection and result in corn planting intentions of 91.1 million acres. As is the case for soybeans, the direction and magnitude of the projected change seems reasonable, but the large standard error associated with the regression models suggests that the actual change could deviate substantially from the projection.

Implications

It is common to use a soybean-to-corn price ratio as an indicator of likely changes in the direction and magnitude of corn and soybean planting intentions relative to the previous year's plantings. For 2017, those ratios point to March soybean planting intentions that exceed 2016 planted acreage by 5.4 million acres and corn planting intentions 2.9 million acres less than plantings in 2016. However, our analysis suggests that the price ratio has limited power in explaining the magnitude of historical changes in planted acreage of those crops. Linear regression models of price ratios and acreage changes have very low R-square values and large standard errors. Adding changes in either CRP or winter wheat acreage to the price ratio models does not improve their explanatory power. The results suggest that caution should be used in relying too heavily on soybean-to-corn price ratios as an indicator of the magnitude of corn and soybean planting intentions in any given year.

The results imply that a variety of factors other than price ratios influence corn and soybean planting intentions. These factors likely include, cropping rotations, relative cost of producing corn and soybeans, profitability of other crops that compete for the same acreage, and the general level of crop prices that may influence the magnitude of acreage planted to all crops. USDA historical estimates of total crop acreage (planted, prevent plant, double crop, and CRP) do vary from year to year, but not always in the direction and by the magnitude suggested by the level of crop prices. Planting intentions relative to planted acreage in the previous year may also be influenced by the magnitude of prevented acres in the previous year and by changes in policy (e.g. Renewable Fuels Standards)

Some of the variability in planting estimates (all crops and individual crops) may also reflect sampling and non-sampling errors associated with surveys of planting intentions and actual planted acres. This factor is rarely discussed, with most analysts treating estimates as if they reflected a complete census of producers. The USDA indicates that sampling errors in the estimates of prospective plantings of major crops are generally between one and three percent while both types of errors for acreage estimates of major crops is between one and six percent, with errors for corn and soybeans in the lower end of the range.

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