Futures Markets as Inverse Forecasters for Post-Harvest Wheat Prices

by

Robert S. Firch

FUTURES MARKETS AS INVERSE FORECASTERS FOR POST-HARVEST WHEAT PRICES

Robert S. Firch*

In a paper titled "Futures Markets as Inverse Forecasters of Post-Harvest Prices for Storable Agricultural Commodities", Firch presented evidence from the study of cotton, soybean, and corn futures prices that strongly suggests that these futures markets are not only poor direct forecasters of prices over the planting to harvest period but that in fact market responses to the futures prices cause futures prices to move inversely with the forecast. This paper presents the results of a study of wheat futures prices and finds what appears to be substantial evidence supporting the inverse forecast hypothesis and indirectly the "paradox of the public forecast" hypothesis outlined in the earlier paper.

The Paradox of the Public Forecast

Briefly stated, the "paradox of the public forecast" says that if a forecast is available to all market participants, believed to be a

*Robert S. Firch is Professor of Agricultural Economics at the University of Arizona.

reasonably accurate forecast, available far enough in advance that market participants can make substantial changes in plans and deviates substantially from long-run equilibrium prices then the forecast must necessarily be inaccurate. Other researchers may characterize this phenomena as a self-defeating prophecy, but I believe that that terminology understates the nature and severity of the problem.

Research on Inverse Forecast of Post-Harvest Wheat Futures Prices

Following the experience gained in researching the behavior of cotton, soybean, and corn futures prices, the basic approaches to be used in researching wheat futures prices were well-established (Firch). The general inverse forecast model previously developed and used here is specified below:

P_t+1 - is the post-harvest futures price at planting time

P_t - is the post-harvest future price at harvest

SV - is a selected shifter variable such as the wheat carryover stock level or the price of another crop

Figure 1 illustrates the above general model. A negative relationship is hypothesized between the post-harvest future price at planting time (P_t) and the change in the post-harvest futures price between planting and harvest time (P_t+1-P_t), hence, the line with the negative slope is the inverse forecast relation. The inverse forecast line is shifted to right or left by changing the value of wheat carryover or the futures price of soybeans in cotton and corn models or futures price of corn in the soybean inverse forecast model. The intersection of the inverse forecast line and the horizontal axis is a particularly significant price and this is emphasized by the dashed vertical line. The model forecasts that any P_t to the right of the dashed line will be followed by falling futures price, and any price P_t that is to the left of the dashed line will be followed by rising futures price.

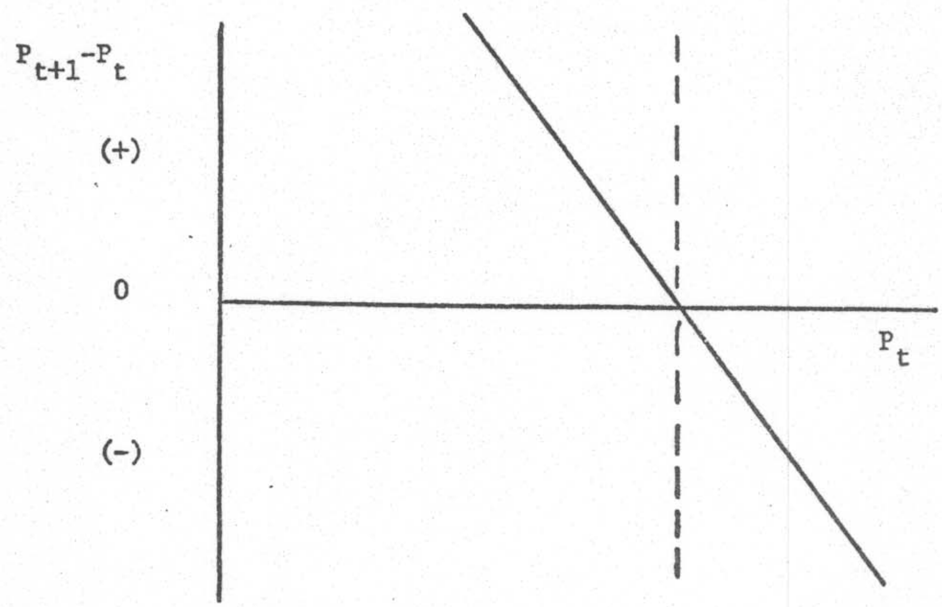

Figure 1. The Inverse Forecast Model

Futures prices and spot prices were collected from back issues of the Wall Street Journal in order that the prices would be exactly those available to any interested market participant. These prices were deflated using quarterly values of the GNP Implicit Price Deflator. The July futures contracts on wheat mature approximately July 20. Since this maturity comes relatively early in the harvest of wheat when compared with the maturity of November soybean contracts and December contracts on cotton and corn, it was decided that both July and September futures contracts for each of the three futures markets should be explored. It was assumed that the Kansas City (KC) and Chicago (CBT) wheat futures represented winter wheat that is planted in the late summer and early fall. The Minneapolis (MPLS) wheat futures were assumed to represent wheat that is planted in the spring.

In order to be fairly certain that the optimum "planting period" date was researched, the futures prices on the July and September CBT and KC contracts were collected for the first and fifteenth days of the months of August through November. The MPLS July and September futures prices were collected for the first and fifteenth days of the months of March through May and June 1. The July and September futures prices were also collected for July 1, July 10, September 1, and September 10.

In most years, the trading on the September KC futures contract began after most or all of the August through November dates had passed. For this reason the KC September futures contract was not researched. The July 1 and September 1 ending dates produced consistently better results in forecasting correct direction of planting period to month of maturity futures price changes and smaller standard errors of the equations. For this reason, research results on July 10 and September 10 ending dates are not reported in this paper. The research revealed substantial tendencies for the CBT September and MPLS July futures to perform as inverse forecasters, but the results are so dramatically more pronounced for the CBT July and MPLS September contracts that these and the KC July contracts will be the only combinations of market and contract reported in this paper.

The futures price for each planting period date was plotted and regressed as a predictor of the change in that futures price to the July 1 or September 1 end of period. The data plots strongly suggested that the system generating the data made very large changes between 1963 and 1964 and again between 1972 and 1973. The wheat futures contracts representing the wheat harvested in the years 1955 through 1981 were then divided on this basis into three nine-year time periods. Most of the research then focused on the years since 1972 since this is likely to be most representative of the way these markets are expected to perform in the immediate future in contrast with the earlier time periods when wheat prices were more heavily influenced by government programs.

This research gives primary attention to forecasting the <u>direction</u> of futures price change from planting to harvest on the belief that this is the dominant need for the farmer considering offers to forward contract or sell futures contracts prior to the harvest of his crop and for what the research results may tell us about the performance of these markets. Standard errors on the equations were used as a secondary criterion of performance when alternate formulations produced identical success in forecasting the direction of futures price changes.

Plotting residuals from the planting date to July 1 or September 1 change in futures as a function of planting date futures price showed a dramatic potential correlation with June 1 carryover stocks of wheat. Various definitions of carryover stocks of wheat were extensively tested as secondary explanatory variables, and hard red winter and all wheat less white and durum wheats showed consistently better performance in forecasting correct direction of change and lower standard errors on the equations. The research on cotton and corn futures prices showed that planting time soybean futures prices were an important secondary variable, and corn futures at planting time were important in explaining soybean futures price changes. KC futures at planting time had minimal value in improving forecasts of CBT futures price changes, and the reverse formulation was also ineffective. The forecast of corn futures price changes as a function planting-time futures prices of corn and soybeans was less effective than similar formulations for cotton and soybeans. Substituting corn carryover stocks for the soybean futures price in the equations for corn futures price changes reduced their performance in forecasting direction of change and raised the standard error of the equations.

The price of wheat rose by about 100 percent during the summer of 1973 following the Russian wheat purchase. This extreme and virtually unprecedented price change caused the futures price changes over the summer of 1973 and futures price in summer and fall of 1973 to lie substantially outside the range of data for the 1974-81 period. In addition, trading on CBT and KC futures contracts maturing in July of 1973 began trading later than in the years since 1973. For these reasons some of the regression equations in this study cover the period beginning in 1974 rather than 1973.

An Overview of the Evidence Supporting the Existence of Inverse Forecasts

Table 1 shows the accuracy of the inverse forecast model in forecasting direction of futures price changes on an exclusively in-period basis (if 1973-81 data were used in estimating the equation and then the equation was used to forecast the direction of change for each of the years in the 1973-81 period). In addition to the problem of in-period tests of forecasting there is the additional problem of very low numbers on degrees of freedom. But, these problems are unavoidable because in the nature of the system only one observation is generated each year, and the Government has substantially changed its role in commodity pricing in the period 1955-81. In theory, a random forecast such as flipping a coin should give the correct direction forecast fifty percent of the time. Therefore, the inverse forecast model must give correct direction forecasts substantially more than fifty percent of the time if it is to have any value.

Of the 18 combinations of time-period and commodity represented in

Table 1. Accuracy in Forecasting Direction of Futures Price Changes for Cotton, Soybeans, Corn and Wheat

	Prior to 1973		After 1972		All Years	
	Correct forecasts	Years in period	Correct forecasts	Years in period	Correct forecasts	Years in period
	(Number of years)					
Cotton	10	15	8	8	18	23
Soybeans	12	18	7	8	19	26
Corn	15	15	5	8	20	23
SUBTOTAL	37	48	20	24	57	72
Wheat (CBT)	12	18	8	9	20	27
Wheat (KC)	15	18	9	9	24	27
Wheat (MPLS)	14	18	8	8	22	26
SUBTOTAL	41	59	35	36	66	50
TOTAL	78	102	45	50	123	152

Table 1, 12 have at least 75 percent correct direction forecasts, and the lowest success rate was corn in the years after 1972 with 5 of 8 correct direction forecasts. The inverse forecast model seems to be most effective for cotton followed by wheat (CBT, KC, MPLS), soybeans and corn. Although it is slightly less obvious in the years prior to 1973 it appears that there is some evidence of the inverse pattern in those years when Government programs dominated commodity pricing.

Forecasted Changes in Wheat Futures Prices

The preceding section of this paper presented a summary of direction forecasts with all of the forecasts tested on an in-period basis. The tables in this section (Tables 2-5) show actual and forecasted values for individual years and a limited number of out-of-period forecasts. A box has been drawn around those forecasted changes in futures prices from planting to harvest that are in the opposite direction from the actual futures price changes so these errors in direction forecast can be easily identified.

The forecasts, which use only planting-time futures price as a predicting variable and only in-period forecasts, give correct direction forecasts seven of eight years for July CBT futures with August 1 beginning date and July KC futures with August 15 beginning date.

Tables 2, 4, and 6 have out-of-period forecasts for 1980 and 1980-81. Tables 3 and 5 have out-of-period forecasts for 1980, 1980-81, and 1979-81. In the five tables, the only error in direction of an out-of-period

Table 2. Forecasted and Actual July CBT Wheat Futures Price Changes from August 1 to July 1

Year of harvest	Actual change	Changes predicted using only CBT wheat futures prices and data for: 1974-81	Changes predicted using CBT wheat futures prices and June 1 stocks of soft red, hard red winter and hard spring wheat and data for: 1974-81	1974-80	1979-79
		(Dollars per bushel in 1972 values)			
1974	1.32	-.11	1.28	1.27	1.27
1975	-1.14	-.95	-.97	-.95	-.95
1976	-.01	-.33	-.24	-.23	-.23
1977	-.91	-.06	-1.01	-.97	-.98
1978	.46	.78	.49	.51	.51
1979	.97	.60	1.08	1.08	1.07
1980	.16	.18	.14	.15	.15
1981	-.82	-.08	-.73	-.70	-.70

Table 3. Forecasted and Actual July CBT Wheat Futures Price Changes from November 1 to July 1

Year of harvest	Actual change	Changes predicted using only CBT wheat futures prices and data for:	Changes predicted using CBT wheat futures prices and June 1 stocks of hard red winter wheat and data for:			
		1973-81	1973-81	1973-80	1973-79	1973-78
		(Dollars per bushel in 1972 values)				
1973	.88	.56	1.45	1.40	1.40	1.32
1974	.86	-.41	.26	.24	.24	.21
1975	-1.55	-1.07	-1.08	-1.04	-1.04	-1.02
1976	-.11	-.34	-.44	-.40	-.40	-.42
1977	-.37	.36	-.15	-.09	-.09	-.13
1978	.31	.53	.04	.10	.10	.05
1979	.84	.40	.64	.65	.64	.59
1980	.02	.05	-.02	.01	.01	-.02
1981	-.95	-.15	-.76	-.69	-.69	-.70

Table 4. Forecasted and Actual July KC Wheat Futures Price Changes from August 15 to July 1

Year of harvest	Actual change	Changes predicted using only KC wheat future prices and data for:	Changes predicted using KC wheat futures prices and June 1 stocks of soft red, hard red winter and hard spring wheat and data for:		
		1974-81	1974-81	1974-80	1974-79
	(Dollars per bushel in 1972 values)				
1974	.68	-.45	.36	.36	.36
1975	-1.09	-.62	-.59	-.59	-.58
1976	-.29	-.41	-.61	-.60	-.60
1977	-.96	-.09	-1.02	-1.00	-.99
1978	.43	.42	.37	.38	.39
1979	.83	.30	1.03	1.04	1.04
1980	.03	.08	.02	.03	.03
1981	-.53	-.43	-.46	-.44	-.44

Table 5. Forecasted and Actual July KC Wheat Futures Price Changes from September 1 to July 1

Year of harvest	Actual change	Changes predicted using only KC wheat futures prices and data for: 1973-81	Changes predicted using KC wheat futures prices and June 1 stocks of hard red winter wheat and data for: 1973-81	1973-80	1973-79	1973-78
			(Dollars per bushel in 1972 values			
1973	.72	.41	1.15	1.12	1.12	1.02
1974	.67	-.42	.02	.02	.02	.01
1975	-.97	-.52	-.35	-.33	-.33	-.33
1976	-.14	-.30	-.43	-.40	-.40	-.40
1977	-.84	.02	-.59	-.54	-.53	-.55
1978	.44	.48	.17	.20	.21	.13
1979	.78	.33	.55	.56	.56	.48
1980	-.03	.03	-.04	-.02	-.01	-.05
1981	-.64	-.05	-.05	-.46	-.45	-.47

Table 6. Forecasted and Actual September MPLS Wheat Futures Prices from April 1 to September 1

Year of harvest	Actual change	Changes predicted using only MPLS wheat futures prices and data for:	Changes predicted using MPLS wheat futures prices and June 1 stocks of hear red winter wheat and data for:		
		1974-81	1974-81	1974-80	1974-79
			(Dollars per bushel in 1972 values)		
1974	.50	.14	.28	.28	.29
1975	.30	.12	.29	.29	.30
1976	-.49	.11	-.18	-.17	-.17
1977	-.40	.04	-.30	-.28	-.28
1978	-.02	.03	-.34	-.32	-.32
1979	.65	.02	.70	.70	.72
1980	.24	.05	.27	.28	.29
1981	-.22	.05	-.17	-.16	-.16

forecast is 1980 based on 1973-78 data in Table 3; the forecasted change was for a 2-cent per bushel decline when the actual price change was a 2-cent per bushel increase. Because the period of basically free-market pricing of wheat has been only about nine years, and that period was partially disrupted by the Russian wheat purchase, the opportunities for out-of-period test of direction forecasts is quite limited. But, the inverse forecast model seems to offer substantial promise in forecasting direction of post-harvest wheat futures price changes from planting to harvest time.

The primary objective of the research on the inverse forecast model has been to develop equations that will forecast the correct direction of change in post-harvest futures prices from planting time to harvest time. But the equations produce a direction forecast while forecasting the amount of change. Table 7 presents additional information about each of the equations, which the research found produced correct in-period forecasts for each of the years in 1973-80 or 1974-80. Comparing the standard deviation of the futures price change with the standard error of the equation provides some insight into the value of the equations in forecasting the amount of futures price change. This value of the equations varies considerably from one equation to another. Multiple coefficient of determination values are not reported because in theory and in fact, the two explanatory variables are so highly intercorrelated that the R^2 values become meaningless. In general, the equations are not very successful in forecasting the exact amount of change in futures prices. This should not be surprising because the inverse forecast model ignores all of the information, such as weather conditions that becomes available in the period between planting and harvest.

The final column in Table 7 shows the solution of each of the equations for the value of the planting-time futures price which forecasts no change in price when stocks of wheat are at the average level for the years included in the equation. With the variation in beginning date, stock variable and inclusion or exclusion of 1973 data the neutral planting period price is surprisingly stable from one equation to another. This suggests that the negatively sloped line, which is really the essence of the inverse forecast model, is very stable in location if the stock variable is held constant. This stability is important in establishing the credibility of the inverse forecast model.

One legitimate criticism of the research presented in Tables 1-6 is that the actual carryover stock levels on June 1 have been used as explanatory variables. The forecast is made at planting time, however, the actual carryover is not known until as much as 10 months after the time the forecast is made. On this basis the appropriate variable would be expected carryover (at planting time) rather than actual carryover. While the actual carryover becomes a stationary number that has wide acceptance for its accuracy, the expected carryover is a transitory number that is the subject of many individual forecast models

Table 7. Characteristics of Inverse Forecast Equations

Futures market	Beginning date	Years included	Stock variable	Standard deviation of futures price changes	Standard error of forecast equation	Planting period futures price that forecasts no change in futures price
				(Dollars per bushel in 1972 values)		
CBT	August 1	1974-80	HRW[a]	.91	.30	2.73
CBT	August 1	1974-80	A-(W+D)[b]	.91	.16	2.72
CBT	August 15	1974-80	HRW	.80	.45	2.79
CBT	September 1	1974-80	HRW	.73	.46	2.79
CBT	September 1	1974-80	A-(W+D)	.73	.41	2.79
CBT	November 1	1973-80	HRW	.82	.48	2.77
KC	August 15	1974-80	HRW	.77	.44	2.77
KC	August 15	1974-80	A-(W+D)	.77	.35	2.78
KC	September 1	1973-80	HRW	.70	.50	2.75
KC	September 1	1973-80	A-(W+D)	.70	.51	2.74
KC	October 15	1973-80	A-(W+D)	.74	.51	2.74
KC	November 1	1973-80	HRW	.77	.50	2.74
MPLS	April 1	1974-80	HRW	.43	.25	2.69
MPLS	May 15	1974-80	HRW	.43	.33	2.69
MPLS	June 1	1974-80	HRW	.47	.35	2.68

[a] HRW is stocks of hard red winter wheat.

[b] A-(W+D) is stocks of wheat of all types except white and durum.

of widely varying levels of sophistication.

The USDA estimates of expected carryover have varying levels of credibility by market participants. The <u>Wheat Situation</u> that is issued by the USDA reports expected carryover, but the first availability of USDA's expected carryover has changed over time. The November issue of the <u>Wheat Situation</u> was the earliest to report expected carryover for the marketing years ending in 1973-76. August issues of the <u>Wheat Situation</u> reported expected carryover for marketing years ending in 1977-79, and the July issues have reported expected carryover for marketing years ending since 1979. The point of this discussion is that any <u>expected carryover</u> variable that can be constructed will be nearly as suspect as the <u>actual carryover</u> variable that has been used.

In order to respond to potential criticism that the results reported in the preceding tables are not valid because they use an explanatory variable whose value is unknown at the time the forecast is made, a simple model for predicting the June 1 carryover was developed. This model has the actual carryover as a function of the USDA first estimate of carryover for the following June 1 and the futures price at time of forecast. The predicted carryover values are then inserted in the equations that were used to generate the forecasts in Tables 2-5 and the results appear in Tables 8 and 9. Close examination of Tables 8 and 9 in relation to Tables 2-5 shows that the inverse forecasts, using predicted carryover, perform almost as well as the forecasts using actual carryover. The equations and data used in predicting carryover are rather crude. However, this seems to be sufficient

Table 8. Actual and Forecasted Changes in July Wheat Futures Prices Using Actual and Predicted June 1 Carryovers of Wheats other than White and Durum

Year of harvest	July CBT Wheat Futures August 1 to July 1: Actual change	Change predicted using: Actual carryover 1974-81 data	Predicted carryover 1974-81 data	Predicted carryover 1974-79 data	July KC Wheat Futures August 15 to July 1: Actual change	Change predicted using: Actual carryover 1974-81 data	Predicted carryover 1974-81 data	Predicted carryover 1974-79 data
	(Dollars per bushel in 1972 values)							
1974	1.32	1.28	1.09	1.08	.68	.36	.09	.09
1975	-1.14	-.97	-1.30	-1.27	-1.09	-.59	-.89	-.88
1976	-.01	-.24	.12	.12	-.29	-.61	-.20	-.20
1977	-.91	-1.01	-.39	-.37	-.92	-1.02	-.36	-.34
1978	.46	.49	.62	.64	.43	.37	.53	.54
1979	.97	1.08	.55	.55	.83	1.03	.49	.51
1980	.16	.14	.25	.26	.03	.02	.20	.20
1981	-.82	-.73	-.90	-.87	-.55	-.46	-.76	-.73

Table 9. Actual and Forecasted Changes in July Wheat Futures Prices Using Actual and Predicted June 1 Carryover of Hard Red Winter Wheat

Year of harvest	July CBT Wheat Futures November 1 to July 1: Actual change	Change predicted using: Actual carryover 1973-81 data	Change predicted using: Predicted carryover 1973-81 data	Change predicted using: Predicted carryover 1973-81 data	July KC Wheat Futures September 1 to July 1: Actual change	Change predicted using: Actual carryover 1973-81 data	Change predicted using: Predicted carryover 1973-81 data	Change predicted using: Predicted carryover 1973-78 data
	(Dollars per bushel in 1972 values)							
1973	.88	1.45	.83	.76	.72	1.15	1.02	.90
1974	.86	.26	.14	.10	.67	.02	-.002	-.01
1975	-1.55	-1.08	-1.38	-1.29	-.97	-.35	-.68	-.62
1976	-.11	-.44	-.11	-.12	-.14	-.43	-.19	-.18
1977	-.37	-.15	.49	.45	-.84	-.59	-.30	-.29
1978	.31	.04	.09	.09	.44	.17	.20	.15
1979	.84	.64	.25	.24	.78	.55	.30	.25
1980	.02	-.02	.20	.18	-.03	-.04	.27	.20
1981	-.95	-.76	-.57	-.53	-.64	-.05	-.15	-.56

demonstration that the inverse forecast model is not absolutely dependent on knowing actual carryover many months in advance of the end of the marketing year. These results also strengthen the author's long-held belief that expected carryover is the focus which participants use in analyzing expected supply, demand, and prices for storable commodities. It seems possible that research could find a predicting model for carryover, which would allow better inverse forecasts than those obtained using actual carryover.

No effort was made to predict carryover used in Table 6 because the required period for the prediction is only from April 1 to June 1. Over that short horizon the predicted and actual carryover should be nearly interchangeable variables.

What Underlies the Inverse Forecast Model?

It appears that the inverse forecast model performs as well as it does because market participants accept the futures price as a meaningful forecast of the post-harvest price, and the forecast becomes available at such an early point in time that substantial responses are generated by the futures price. Why do the market participants fail to understand the inverse forecast mechanism and make appropriate adjustments? It appears that the market participants operate with a much more naive pricing model, which has the post-harvest futures price at planting as a simple linear function of the current spot price. The following equations illustrate this relationship:

CBT Wheat (1975-81):

$$[\text{Price of July futures on November 1}] = .4216 + .8789\ [\text{Spot price on November 1}] \qquad R^2 = .9540$$

KC Wheat (1975-81):

$$[\text{Price of July futures on August 15}] = .1368 + .9942\ [\text{Spot price on August 15}] \qquad R^2 = .9634$$

MPLS Wheat (1975-81):

$$[\text{Price of September futures on April 1}] = .4993 + .7583\ [\text{Spot price on April 1}] \qquad R^2 = .9481$$

The slope coefficient less than 1.0000 on the CBT and MPLS equations suggests that the market discounts deviations from average levels of spot price in determining the futures price at planting time. The KC July futures price was approximately \$.12/bushel higher than the spot price on August 15 during the period 1975-81. If this is really the process that determines the post-harvest futures price at planting time then the next question must be, what determines the spot price at planting time? The following equations suggest that carryover (expected carryover?) determines the spot price at planting time.

CBT Wheat (1975-81):

$$[\text{Spot price on November 1}] = .6672 + .8180E + 12\ \left[\frac{1}{\text{June 1 stock of hard red winter wheat}}\right] \qquad R^2 = .8953$$

<u>KC Wheat (1974-81)</u>:

$$[\text{Spot price on August 15}] = 1.1965 + .9184E{+}12 \left[\frac{1}{\text{June 1 stock of wheat other than white or durum}}\right]$$

$$R^2 = .8883$$

<u>MPLS Wheat (1974-81)</u>:

$$[\text{Spot price on April 1}] = 1.3820 + .4816E{+}12 \left[\frac{1}{\text{June 1 stock of hard red winter wheat}}\right]$$

The causation seems to be that carry over levels affect spot price at planting time, and then spot prices influence futures prices since equations with futures prices as a direct function carry over levels produced substantially lower correlations than futures prices as functions of spot prices.

References

Firch, Robert S. "Futures Markets as Inverse Forecasters for Post-Harvest Prices for Storable Agricultural Commodities." Chicago Board of Trade Seminar Proceedings, 1981.