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ECONOMETRIC MODEL AND FUTURES MARKETS COMMODITY PRICE FORECASTING

by

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Commercial forecasts of spot agricultural commodity markets have been available since 1976. These forecasts are quarterly, refer to specific cash markets, and cover a number of commodities. The firms that generate and sell these forecasts, largely to agribusiness companies, include Chase Econometrics, Doanes Agricultural Service, Data Resources, Inc. (DRI), and Wharton Econometric Forecasting Associates. In addition, the USDA also develops such forecasts. Most of these forecasts are based upon large-scale, U. S. agricultural sector models which specify formal links among individual commodities. Other firms provide qualitative rather than quantitative forecasts, i.e., range forecasts under alternative scenarios. The purpose of this paper is to compare and evaluate the price-forecasting experience and accuracy of the commercial vendors which produce point forecasts at this crucial juncture where enough data on performance have become available to make a meaningful comparison possible.

The questions addressed include the following. What is the comparative and absolute accuracy of the various vendors? Does the comparative accuracy

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of different models depend upon the forecast horizon, e.g., is one more accurate for, say, a one-quarter forecast and another more accurate for a two-quarter-or-longer term forecast? Is the relative and absolute forecast accuracy commodity dependent? What types of errors tend to be made by various firms, and how does this relate to a user's selection of forecast to purchase?

The commodities examined will include corn, wheat, soybeans, soybean oil, soybean meal, cotton, live cattle, and hogs. One-quarter through eight-quarter forecast horizons will be investigated. The issues of accuracy are addressed by computing two statistical measures of equality--root mean squared error and root mean squared percentage error--of the Chase, Doanes, DRI, Wharton, and USDA forecasts of average quarterly cash market prices over the period 1976-1978.

Also, as a reference point, this paper considers the price forecasting information contained in futures market prices. Some of the literature on futures markets questions the quality of futures prices as forecasts (Working, 1942; Tomek and Gray; Labys and Granger). Working, for example, states that "it is not true that future prices afford forecasts of price change in the sense in which one speaks of the price forecasts of a market analyst." He goes on to state, however, that "neither is it true that future prices provide no sort of forecast of price change." In addition, much of the recent conceptual work on futures markets views futures prices as rationally based expectations (Danthine; Peck; Feder, Just, and Schmitz; Turnovsky; Andersen and Danthine). Some recent empirical evidence also strongly suggests that futures

prices play an important role in the formation of producer price expectations as well (Peck; Gardner).[1]

In the case of econometric forecasting, a simple analogy can be established between the process of generating prices from futures markets and that generated from econometric models. System econometric models attempt to specify the causal links between predetermined (both exogenous and lagged endogenous) variables and jointly determined variables. In using these models for forecasting purposes, predetermined variables must be forecasted which, in turn, are transferred via estimated causal links into forecasted spot prices. Clearly, errors can arise at two levels: (1) in the forecast of the predetermined variables and (2) in the estimated causal links. Both types of errors are frequently encountered in econometric forecasting with the latter fully documented in the econometric literature as specification errors--e.g., omitted variables, inappropriate functional forms, measurement errors, aggregation, and the like. In the case of futures markets, the process has not

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[1]Much of the available literature on futures markets has interpreted futures prices as an expectation of the spot price at the specified contract date. Some of this literature has suggested that, if this expectation has appropriately formed, the futures price is an efficient price (Samuelson). Recently, however, Danthine has shown that, even if the futures price is not the expected spot price of the contract date, the market may be efficient. Others have shown that, with wealth effects and risk preferences, futures markets are not generally efficient (Figlewski). The chief difficulty with the literature on futures markets is that no comprehensive conceptual formulation has been advanced to explain their behavior. Of course, numerous partial conceptual frameworks have appeared in the literature including normal backwardation (Keynes; Hicks), convenience (Kaldor), storage (Working, 1949; Brennan), and stochastic search or informationally based theories (Grossman). None of these theories is sufficiently comprehensive to explain price levels and variations in futures markets. For example, a comprehensive formulation must admit (1) several groups of markets, both rational and irrational and informed and uninformed; (2) risk aversion; (3) wealth limitations; (4) imperfect capital markets; and (5) transaction and information costs. For further details along these lines, see Rausser and Just.

been quantitatively specified; but in a qualitative or judgmental sense, the aggregate mental process of the market must perform much the same role as the econometric model. The aggregate judgmental views of all participants must form expectations or forecasts of important exogenous influences, e.g., planning intentions, yields, consumption, export demand, etc., and transmit this information into a futures price. Errors can be made in formulating forecasts of the exogenous information or in the transmission of this information into an observed futures price.

With this relationship in mind, the futures markets can serve as a basis of comparison for specification error and exogenous forecasting error in transmission of exogenous information into future price information. Note, however, that inefficiencies in futures market prices can emanate from irrational market participants, uninformed market participants, risk aversion, wealth limitations, imperfect capital markets, and alternative transaction and information costs. Thus, there is some basis for belief that econometric models can potentially outperform futures market prices as price forecasters.

I. The Commercial Forecasts

To determine an appropriate set of time periods for comparison, it is necessary to consider the operation of the commercial forecasting firms in terms of longevity and frequency of forecast. All four commercial firms considered in this study began operation in terms of point forecasting of agricultural prices during 1976 with the first commercial forecasts in each case appearing in the latter half of 1976. The frequency and horizon of the respective forecasts thereafter are indicated in Table 1 for the eight major agricultural commodities examined by our analysis. In each case, firms made

TABLE 1

Forecast Frequency and Horizon of Major Commercial Econometric Forecasting Firm
July, 1976-December, 1978

Date of forecast	Wheat, corn, cotton and soybeans					Soybean oil and meal					Hogs and live cattle				
	Chase	Doanes	DRI[a/]	Wharton	USDA[b/]	Chase	Doanes	DRI	Wharton	USDA	Chase	Doanes	DRI	Wharton	USDA
	quarters														
1976															
July	c/				1			8		1					1
August		3	8									3	8		
September	7										7				
October	6				2					2	6				2
November		3	8					8				2	8		
December	7			8					8		7			8	
1977															
January			7												
February	7	3	8	7	2			8	7	2	7	3	8	7	1
March															
April	6	4	8	6				8	6		6	2	8	6	
May			8	6	3			8	6	3			8	6	2
June	8		8	6				8	6		8		8	6	
July			8	6				8	6				8	6	
August	8	4	8		3[d/]			8		3	8	3	8		2
September			8	6				8	6				8	6	
October	8		8	7		8		8	7		8		8	7	
November		4	8		3			8		1		2	8		3
December	8		8	7		8		8	7		8		8	7	

(Continued on next page.)

TABLE 1--continued.

Date of forecast	Wheat, corn, cotton, and soybeans					Soybean oil and meal					Hogs and live cattle				
	Chase	Doanes	DRI[a/]	Wharton	USDA[b/]	Chase	Doanes	DRI	Wharton	USDA	Chase	Doanes	DRI	Wharton	USDA
	quarters														
1978															
January			8	6				8	6				8	6	
February	8	3	8	7		8		8	7		8	3	8	7	
March			8	7	3			8	7	2			8	7	3
April	8	4	8	6		8		8	6		8	2	8	6	
May			8	6	3			8	6	3			8	6	3
June	8		8	6		8		8	6		8		8	6	
July			8	5				8	5				8	5	
August	8	4	8	5	3	8		8	5	3	8	3	8	5	3
September			8					8					8		
October	8		8	7		8		8	7		8		8	7	
November		4	8	7	3			8	7	3		2	8	7	3
December	8		8	8		8		8	8		8		8	8	

a/ Reports a forecast also for cotton price made in April, 1976, but this forecast was excluded from the analysis because other firms were not operating in comparable time periods.

b/ Note that the U. S. Department of Agriculture does not forecast cotton price.

c/ Blanks indicate no forecasts were made.

d/ Wheat price was only forecasted two quarters ahead by the U. S. Department of Agriculture in August, 1977.

forecasts on a somewhat irregular basis initially but then settled down to a regular pattern in 1977. Since April, 1977, DRI's forecasts have been monthly and cover forecast horizons from one to eight quarters. Since June, 1977 (October, 1977, for soybean oil and meal), Chase has made forecasts with one to eight-quarter horizons on a bimonthly basis. Wharton has forecasted from one to six quarters ahead nearly every month since April, 1977. Doanes has made forecasts less frequently--on a quarterly basis--for six of the eight commodities and has forecasted with a much shorter horizon of only two, three, or four quarters. The USDA has also been operating on a quarterly basis throughout this period with forecast horizons of one, two, or three quarters.

II. The Futures Market Price as a Standard of Comparison

For some commodities, several futures markets exist, while for others only a single futures market exists. Since our focus does not address a comparison of futures markets, we narrow the alternative price forecast possibilities by using the Chicago Board of Trade prices for wheat, corn, soybeans, soybean meal, and soybean oil; the New York Cotton Exchange for cotton; and the Chicago Mercantile Exchange for hogs and live cattle.

Given the specified markets and the desire to generate price forecasts, an issue arises as to the appropriate filter of futures market prices to use as a predictor of spot price for the contract month. One approach to this problem is to solve for an optimal filter of futures market prices in current months in predicting spot prices in contract months. The approach taken here, however, is more intuitive and is designed to serve as a standard of comparison with commercial forecasts for which easy access is available. Moreover, to

make the comparison fair for the econometric forecasters, the futures market price forecaster should be constructed from information available at about the same time of the month as used by the econometric firms. Most econometric firms collect information about the second week of the month for formulation of forecasts produced near the end of the month. Thus, for the purposes of this paper, we select the average of futures market closing prices for the second week of the month. This information is both readily available to every decision-maker but yet does not embody more exogenous information than is supposedly available to the econometric firms. It should be kept in mind, however, that decision-makers may actually have access to better information by using futures prices generated later in the month when econometric forecasts actually become available.

Due to the quarterly temporal dimension of the econometric forecasts, a further issue arises as to which contract month for a futures market should be used to represent the forecast horizon. That is, should an econometric forecast for live cattle price in the second quarter of, say, 1980 be compared with the corresponding April or June futures contract price? In some quarters only one contract exists so that no choice is available. In other quarters, however, two or three contracts may be applicable. For the purposes of this study, the midmonth in each quarter is used when available. If a contract does not exist for the midmonth, then the contract for the latter month is used since prices of these contracts would tend to use more of the information that would affect average quarterly spot market price than the first-month contract. Of course, the first-month contract is used if no other contract exists in the quarter. The futures contracts used in each case are indicated in Table 2.

TABLE 2

Futures Market Contract Prices Use As
Predictors of Quarterly Spot Prices

Commodity	Market	Quarter			
		I	II	III	IV
Wheat	Chicago Board of Trade	March	May	September	December
Corn	Chicago Board of Trade	March	May	September	December
Cotton	New York Cotton Exchange	March	May	July	December
Soybeans	Chicago Board of Trade	March	May	September	November
Soybean meal	Chicago Board of Trade	March	May	August	December
Soybean oil	Chicago Board of Trade	March	May	August	December
Hogs	Chicago Mercantile Exchange	February	June	August	December
Live cattle	Chicago Mercantile Exchange	February	June	August	December

III. The Basis of Comparison

Based on Table 1, the choice of an appropriate time period for the comparison is unclear. On the one hand, operations of the econometric forecasting firms were erratic until sometime in the first part of 1977. On the other hand, the need for reliable comparisons necessitates using as many forecasts as possible. In addition, because not all forecasting firms have been making forecasts at the same points in time, a concern arises about comparability. Conditions may exist which, by chance, imply more instability and involve less information for one firm's forecast than for another's. For example, part of Doanes' and DRI's forecasts for corn in 1976 are made before the corn harvest, while Wharton's only corn forecast in 1976 was made after the corn harvest was essentially complete.

In view of these considerations, two sets of comparisons are developed in this paper. The first set of comparisons is based on the best forecast available from each source by month for the period December, 1976, through December, 1978. The forecasts prior to December, 1976, are excluded from the analysis since not all four firms began forecasting on a commercial basis until that time. Also, at the time of this study, actual prices for the second quarter of 1979 were not yet available, so there was no point in considering forecasts made after December, 1978. The use of the term, "best available" forecast, implies that each firm's forecast in each month is taken to be its latest published forecast. For example, if Doanes makes a forecast in April, 1977, and then does not make another forecast until August, 1977, then the April forecast is used as Doanes' best available forecast in the months of May, June, and July. For customers who need price forecasts on

a regular basis for decision-making purposes, it seems that this type of comparison is more meaningful than simply comparing the forecasts only over the set of months in which they are actually made. Admittedly, however, the comparison should tend to be biased in favor of DRI which revises its forecasts monthly and against Doanes which revises its forecasts only quarterly.

To determine the extent of this bias and to develop more information about the actual forecasting ability of each firm as opposed to the futures market, a second set of comparisons is also constructed using only those months in which the major commercial econometric firms (excluding Doanes and USDA) actually revised their forecasts. Thus, for all of the commodities except soybean meal and oil, the comparable months are February, April, June, October, and December of 1977 plus February, April, June, August, October, and December of 1978 (Table 1). The comparison for soybean meal and oil includes only these months beginning with October, 1977 (Table 1). To develop strictly fair comparisons for Doanes and USDA, additional pairwise comparisons are made between DRI and Doanes and between DRI and USDA using only those months in which, respectively, both made new forecasts. The DRI forecasts were selected as a standard of comparison because the forecast more often, and thus more observations, can be used in making fair comparisons.

These sets of comparisons are developed using two statistical measures of quality--root mean squared error and root mean squared percentage error. Due to practical limitations on computation and the desire to simplify the reporting of results, other measures of quality are not investigated here. Moreover, other types of measures--such as mean absolute deviation and Theil U coefficients--generally lead to the same rankings of forecasts for the forecasting problem considered here (St. George, et al.).

Finally, note that each of the econometric firms do not forecast the same actual price series (Appendix A). Thus, problems arise regarding comparability due to transportation costs and other such factors which cause a divergence of prices in different markets. Also, in using futures market prices as forecasts of spot market prices, one must consider other factors such as capital costs, commissions, and risk which may be reflected in futures prices. To account for the effect of these factors in the commercial forecasts, each econometric forecast is compared to the actual respective price being forecasted. In order to avoid unduly favoring futures market prices as forecasts, the futures prices are considered as forecasts of the spot prices predicted by most of the econometric firms. These spot prices also appear to be the ones most closely related to the futures market near the time of delivery as comparison of futures prices with other spot prices has revealed (with the possible exception of soybeans).

IV. The Comparison of Forecasts

The statistics discussed above are reported in Tables 3 through 10 for the eight respective commodities. An examination of Tables 3 through 10 reveals some interesting quantitative relationships between alternative forecasters. For example, the variation in root mean squared errors and percentage errors among econometric forecasters is fairly large for given forecasting horizons for wheat, corn, and soybean meal, with differences in root mean squared percentage error ranging up to over 10 percent. For cattle--and to a lesser extent cotton, soybeans, and soybean oil--on the other hand, all econometric firms maintain similar magnitudes of error.

Generally, Chase forecasts perform better for wheat and live cattle, Wharton or DRI for corn, Wharton for cotton (in terms of comparable forecasts), and DRI for hogs; but there is no clear dominance of one forecaster

TABLE 3

Wheat: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	0.289--25 (10.9)	0.354--22 (11.9)	0.407--19 (12.7)	0.507--16 (15.3)	0.562--13 (16.8)	0.599--10 (17.6)	0.635--4 (18.7)	a/
Doanes	0.328--25 (13.1)	0.411--22 (15.7)	0.454--18 (16.1)	0.609--7 (20.8)				
DRI	0.639--25 (18.7)	0.801--22 (22.7)	0.947--19 (25.9)	1.104--16 (29.4)	1.189--13 (31.4)	1.221--10 (32.2)	1.109--7 (29.3)	1.054--3 (27.9)
Wharton	0.277--25 (9.8)	0.384--22 (12.8)	0.458--19 (14.4)	0.611--16 (18.5)	0.730--13 (21.7)	0.716--10 (21.1)	0.678--4 (19.9)	0.69--1 (20.1)
USDA	0.478--8 (20.2)	0.515--7 (19.0)	0.549--4 (18.8)					
Futures b/	0.276--25 (10.3)	0.359--22 (13.1)	0.393--19 (12.8)	0.571--3 (18.0)				
	Comparison of forecasts made in the same months							
Chase	0.264--11 (9.4)	0.343--9 (11.2)	0.387--8 (12.0)	0.518--6 (15.5)	0.565--5 (17.2)	0.650--3 (19.1)	0.725--2 (21.0)	
DRI	0.644--11 (18.6)	0.823--9 (23.0)	0.922--8 (25.2)	1.063--6 (28.5)	1.180--5 (31.2)	1.315--3 (34.5)	1.211--3 (32.1)	1.020--1 (27.1)
Wharton	0.220--11 (7.7)	0.354--9 (11.4)	0.394--8 (12.2)	0.602--6 (18.0)	0.669--5 (20.2)	0.741--3 (22.0)	0.760--1 (22.1)	
Futures b/	0.286--11 (10.8)	0.374--9 (13.3)	0.352--8 (11.2)	0.467--1 (14.8)				
Doanes	0.304--8 (12.3)	0.407--7 (15.3)	0.431--6 (15.0)	0.641--3 (21.9)				
DRI	0.629--8 (18.2)	0.811--7 (22.6)	0.951--6 (25.8)	1.092--5 (28.9)				
USDA	0.478--8 (20.2)	0.515--7 (19.0)	0.549--4 (18.8)					
DRI	0.633--8 (18.8)	0.769--7 (22.0)	0.937--6 (25.6)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of No. 1 Hard Red Winter wheat price, Kansas City.

TABLE 4

Corn: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	0.283--25 (13.7)	0.351--22 (18.0)	0.318--19 (15.5)	0.263--16 (11.8)	0.249--13 (11.0)	0.320--10 (14.5)	0.191--4 (8.7)	a/
Doanes	0.346--25 (19.3)	0.401--22 (22.4)	0.318--18 (16.9)	0.173--7 (8.2)				
DRI	0.246--25 (12.0)	0.326--22 (16.0)	0.313--19 (14.3)	0.146--16 (6.4)	0.137--13 (6.0)	0.287--10 (12.8)	0.163--7 (7.4)	0.056--3 (2.4)
Wharton	0.243--25 (11.8)	0.297--22 (14.3)	0.250--19 (12.2)	0.251--16 (11.3)	0.280--13 (12.6)	0.307--10 (13.8)	0.447--4 (20.1)	0.589--1 (26.3)
USDA	0.392--8 (21.5)	0.419--7 (22.1)	0.238--5 (11.5)					
Futures b/	0.278--25 (13.7)	0.397--22 (19.9)	0.400--19 (18.8)	0.049--3 (2.2)				
	Comparison of forecasts made in the same months							
Chase	0.316--11 (15.5)	0.323--9 (16.5)	0.209--8 (9.7)	0.242--6 (10.5)	0.242--5 (10.7)	0.364--3 (16.6)	0.049--2 (2.2)	
DRI	0.267--11 (13.3)	0.300--9 (14.5)	0.162--8 (7.1)	0.134--6 (5.7)	0.143--5 (6.3)	0.445--3 (19.9)	0.063--3 (2.7)	0.040--1 (1.7)
Wharton	0.255--11 (12.9)	0.252--9 (11.9)	0.209--8 (9.5)	0.160--6 (6.9)	0.305--5 (13.9)	0.246--3 (11.2)	0.230--1 (10.2)	
Futures b/	0.333--11 (16.7)	0.426--9 (20.9)	0.354--8 (16.3)	0.032--1 (1.2)				
Doanes	0.339--8 (19.1)	0.399--7 (22.5)	0.264--6 (12.6)	0.177--3 (8.5)				
DRI	0.266--8 (13.3)	0.310--7 (15.4)	0.252--6 (10.3)	0.125--5 (5.5)				
USDA	0.392--8 (21.5)	0.419--7 (22.1)	0.238--5 (11.5)					
DRI	0.276--8 (13.5)	0.372--7 (17.9)	0.312--6 (13.0)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of No. 2 Yellow corn price, Chicago.

TABLE 5

Cotton: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	7.417--25 (13.0)	10.542--22 (19.2)	12.298--19 (21.9)	11.890--16 (20.0)	9.247--13 (14.7)	5.081--10 (8.2)	4.853--4 (7.7)	a/
Doanes	6.848--25 (11.9)	8.796--22 (15.3)	9.366--18 (15.8)	8.495--7 (13.3)				
DRI	5.456--25 (9.6)	8.564--22 (15.6)	10.977--19 (20.4)	13.190--16 (24.8)	10.948--13 (20.1)	6.970--10 (12.2)	8.865--7 (15.4)	11.757--3 (20.4)
Wharton	8.419--25 (15.6)	9.680--22 (18.1)	10.958--19 (20.3)	9.921--16 (18.4)	8.503--13 (15.9)	8.135--10 (13.9)	12.722--4 (20.3)	7.610--1 (11.7)
Futures b/	8.390--25 (15.1)	11.267--22 (21.6)	11.652--19 (22.7)	11.534--6 (21.9)				
	Comparison of forecasts made in the same months							
Chase	7.281--11 (12.8)	11.504--9 (20.9)	12.384--8 (22.0)	12.442--6 (20.0)	7.407--5 (12.3)	4.933--3 (7.6)	4.579--2 (7.2)	
DRI	6.106--11 (10.9)	9.776--9 (17.9)	12.071--8 (22.7)	12.830--6 (23.9)	5.294--5 (9.7)	5.039--3 (8.6)	5.711--3 (10.3)	8.800--1 (16.2)
Wharton	6.388--11 (11.0)	9.316--9 (17.5)	9.261--8 (16.5)	8.073--6 (13.0)	4.986--5 (8.4)	4.684--3 (7.7)	13.600--1 (21.0)	
Futures b/	9.198--11 (16.6)	11.629--9 (22.7)	10.687--8 (20.7)	8.570--2 (13.6)				
Doanes	6.546--8 (11.4)	9.332--7 (16.4)	10.172--6 (17.4)	9.173--3 (14.3)				
DRI	5.664--8 (10.0)	9.696--7 (16.8)	13.098--6 (24.8)	13.535--5 (25.3)				

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of average price received by farmers, United States.

TABLE 6

Soybeans: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	1.619--25 (25.5)	1.216--22 (18.0)	1.168--19 (17.2)	1.325--16 (19.1)	1.394--13 (19.9)	1.255--10 (17.8)	0.889--4 (13.1)	a/
Doanes	1.386--25 (21.2)	1.139--22 (17.3)	1.177--18 (18.3)	1.079--7 (17.0)				
DRI	1.431--25 (22.3)	1.414--22 (21.5)	1.141--19 (17.5)	1.194--16 (17.4)	1.400--13 (19.9)	1.035--10 (14.6)	1.053--7 (15.3)	1.620--3 (22.8)
Wharton	1.509--25 (23.2)	1.498--22 (23.9)	1.465--19 (22.7)	1.369--16 (19.5)	1.489--13 (21.5)	1.165--10 (16.7)	0.569--4 (8.5)	0.190--1 (2.8)
USDA	1.644--8 (28.6)	1.080--7 (17.5)	0.870--5 (13.4)					
Futures b/	1.361--25 (22.4)	1.215--22 (19.6)	1.113--19 (17.9)	1.003--9 (15.5)				
	Comparison of forecasts made in the same months							
Chase	1.632--11 (26.5)	1.276--9 (19.9)	1.145--8 (16.9)	1.474--6 (21.3)	1.411--5 (19.6)	0.705--3 (10.5)	0.850--2 (12.2)	
DRI	1.500--11 (24.5)	1.461--9 (23.4)	1.183--8 (18.6)	1.232--6 (17.8)	1.522--5 (21.3)	0.482--3 (7.2)	0.943--3 (13.6)	1.740--1 (24.1)
Wharton	1.602--11 (25.4)	1.624--9 (27.0)	1.587--8 (24.7)	1.478--6 (21.2)	1.676--5 (24.0)	0.818--3 (12.2)	0.699--1 (10.3)	
Futures b/	1.560--11 (26.1)	1.179--9 (19.7)	1.076--8 (17.5)	0.990--4 (14.9)				
Doanes	1.377--8 (21.0)	1.001--7 (16.3)	1.231--6 (19.1)	1.156--3 (18.2)				
DRI	1.522--8 (24.3)	1.408--7 (22.4)	1.205--6 (18.3)	1.250--5 (18.2)				
USDA	1.644--8 (28.6)	1.080--7 (17.5)	0.870--5 (13.4)					
DRI	1.448--8 (23.1)	1.376--7 (22.2)	1.103--6 (17.0)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of No. 1 yellow soybean price, Chicago.

TABLE 7

Soybean Oil: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	5.100--15 (19.4)	7.016--12 (26.2)	7.285--9 (27.9)	8.192--6 (31.8)	8.424--3 (33.0)	a/		
DRI	5.879--25 (23.3)	6.324--22 (24.8)	5.845--19 (22.1)	6.033--16 (23.6)	6.962--13 (26.7)	4.281--10 (16.3)	4.276--7 (16.5)	6.293--3 (24.5)
Wharton	5.329--25 (20.7)	5.188--22 (20.7)	4.428--19 (17.0)	4.408--16 (17.2)	6.290--13 (23.5)	6.394--10 (23.9)	8.811--4 (33.8)	6.870--1 (26.5)
USDA	5.591--7 (20.8)	4.998--6 (19.4)	5.652--3 (21.4)					
Futures[b/]	4.493--25 (18.5)	4.949--22 (19.8)	5.101--19 (19.6)	5.037--10 (19.2)				
	Comparison of forecasts made in the same months							
Chase	4.339--8 (16.6)	7.103--6 (26.4)	6.951--5 (26.5)	8.326--3 (32.3)	8.251--2 (32.3)			
DRI	3.931--8 (15.4)	6.640--6 (24.3)	6.248--5 (23.6)	7.782--3 (30.2)	9.315--2 (36.5)			
Wharton	3.844--8 (14.5)	5.768--6 (21.4)	5.716--5 (21.8)	6.071--3 (23.6)	6.445--2 (25.2)			
Futures[b/]	3.248--8 (12.6)	5.537--6 (20.4)	5.559--5 (21.1)	5.625--2 (21.9)				
USDA	5.591--7 (20.8)	4.998--6 (19.4)	5.652--3 (21.4)					
DRI	5.569--8 (22.3)	6.285--7 (25.3)	6.161--6 (23.1)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of crude tank f.o.b. price, Decatur.

TABLE 8

Soybean Meal: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	18.893--15 (10.6)	22.398--12 (12.3)	31.588--9 (17.2)	44.847--6 (24.1)	46.691--3 (24.5)	a/		
DRI	43.527--25 (25.4)	45.950--22 (27.4)	27.271--19 (16.0)	32.287--16 (18.1)	41.550--13 (22.9)	27.456--10 (14.8)	27.338--7 (14.8)	40.393--3 (21.5)
Wharton	45.202--25 (28.7)	48.196--22 (30.2)	42.145--19 (25.2)	39.865--16 (22.3)	41.435--13 (23.8)	32.799--10 (18.2)	16.809--4 (10.0)	11.589--1 (6.4)
USDA	39.462--7 (23.4)	34.820--6 (20.9)	25.602--3 (13.8)					
Futures b/	40.994--25 (26.6)	35.104--22 (22.2)	27.512--19 (17.1)	23.359--10 (13.7)				
	Comparison of forecasts made in the same months							
Chase	16.388--8 (9.3)	23.626--6 (13.0)	27.877--5 (15.1)	44.326--3 (24.0)	46.445--2 (24.4)			
DRI	18.106--8 (10.7)	30.449--6 (17.0)	30.765--5 (17.5)	43.772--3 (23.9)	61.641--2 (32.4)			
Wharton	17.174--8 (9.8)	28.727--6 (16.0)	36.133--5 (19.6)	43.526--3 (23.3)	48.556--2 (25.5)			
Futures b/	11.628--8 (6.8)	14.861--6 (8.3)	15.813--5 (8.6)	24.467--2 (13.0)				
USDA	39.462--7 (23.4)	34.820--6 (20.9)	25.602--3 (13.8)					
DRI	46.523--8 (29.9)	51.413--7 (32.9)	45.424--6 (26.9)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of bulk 44 percent protein price, Decatur.

TABLE 9

Hogs: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	5.391--25 (11.5)	8.182--22 (17.0)	10.777--19 (21.9)	13.013--16 (26.2)	13.776--13 (27.7)	13.240--10 (26.4)	14.189--4 (28.3)	a/
Doanes	6.094--25 (12.9)	8.536--18 (18.0)	11.201--6 (23.1)					
DRI	5.152--25 (11.0)	6.904--22 (14.4)	8.238--19 (16.8)	8.926--16 (17.9)	9.743--13 (19.1)	6.848--10 (13.3)	8.464--7 (16.4)	8.000--3 (15.4)
Wharton	6.187--25 (13.2)	8.242--22 (17.0)	9.757--19 (19.7)	10.817--16 (21.4)	11.018--13 (21.5)	7.247--10 (14.1)	5.788--4 (11.5)	4.040--1 (8.0)
USDA	7.386--8 (15.9)	10.632--6 (21.8)	13.880--3 (27.5)					
Futures b/	4.799--25 (10.3)	8.208--22 (17.2)	10.434--19 (21.7)	13.198--9 (27.1)				
	Comparison of forecasts made in the same months							
Chase	5.264--11 (11.2)	7.939--9 (16.5)	10.680--8 (21.5)	13.281--6 (26.6)	13.995--5 (27.9)	12.762--3 (25.7)	14.162--2 (27.7)	
DRI	5.727--11 (12.0)	7.492--9 (15.6)	8.637--8 (17.7)	10.667--6 (21.3)	9.838--5 (19.2)	5.969--3 (11.9)	9.539--3 (18.4)	9.240--1 (17.7)
Wharton	6.546--11 (13.7)	8.625--9 (17.7)	10.008--8 (20.1)	11.621--6 (23.0)	11.986--5 (23.1)	4.187--3 (8.4)	7.650--1 (15.2)	
Futures b/	4.657--11 (9.8)	7.588--9 (15.8)	10.338--8 (21.2)	14.935--2 (30.3)				
Doanes	5.450--8 (11.5)	9.0003--7 (18.9)	11.201--3 (23.1)					
DRI	5.228--8 (11.1)	7.102--7 (14.8)	8.454--6 (17.2)					
USDA	7.386--8 (15.9)	10.632--6 (21.8)	13.880--3 (27.5)					
DRI	4.583--8 (9.7)	6.198--7 (12.9)	7.657--6 (15.7)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of seven market average price, barrows and gilts.

TABLE 10

Live Cattle: Comparison of Various Commercial Price Forecasters, December, 1976, Through December, 1978

Forecast	Best monthly forecast available Forecast horizon (quarters) 1	2	3	4	5	6	7	8
	root mean squared error--number of observations (root mean squared percentage error)							
Chase	5.191--25 (9.9)	6.606--22 (12.7)	8.486--19 (15.6)	10.453--16 (17.8)	12.520--13 (21.1)	14.545--10 (24.3)	15.200--4 (25.6)	a/
Doanes	6.119--25 (11.9)	6.579--18 (12.5)	6.928--6 (12.8)					
DRI	5.788--25 (10.3)	6.887--22 (12.4)	8.143--19 (14.7)	10.653--16 (18.1)	13.449--13 (22.0)	11.813--10 (19.1)	16.148--7 (26.0)	20.806--3 (31.9)
Wharton	6.026--25 (11.0)	7.227--22 (13.6)	8.098--19 (14.5)	10.787--16 (17.6)	12.383--13 (19.7)	11.920--10 (19.0)	6.057--4 (11.1)	5.790--1 (10.6)
USDA	7.332--8 (12.9)	10.869--6 (18.9)	14.905--3 (24.6)					
Futures b/	5.245--25 (9.9)	7.860--22 (14.3)	10.034--19 (17.8)	12.749--9 (21.8)				
	Comparison of forecasts made in the same months							
Chase	5.154--11 (9.0)	6.692--9 (12.4)	7.562--8 (13.0)	10.533--6 (18.1)	13.784--5 (22.4)	10.982--3 (20.2)	17.399--2 (27.2)	
DRI	5.838--11 (10.2)	7.170--9 (12.6)	8.203--8 (14.4)	10.973--6 (18.8)	15.737--5 (25.1)	9.032--3 (16.6)	19.769--3 (31.4)	25.280--1 (38.6)
Wharton	6.495--11 (11.8)	7.955--9 (14.8)	8.192--8 (13.9)	11.192--6 (18.4)	15.111--5 (23.6)	6.688--3 (12.3)	6.880--1 (12.6)	
Futures b/	5.298--11 (9.8)	8.561--9 (15.2)	9.934--8 (17.1)	15.263--3 (25.6)				
Doanes	5.948--8 (11.1)	6.687--7 (12.4)	6.928--3 (12.8)					
DRI	6.008--8 (10.5)	6.725--7 (11.7)	9.464--6 (16.5)					
USDA	7.332--8 (12.9)	10.869--6 (18.9)	14.905--3 (24.6)					
DRI	6.026--8 (10.6)	7.033--7 (12.4)	7.878--6 (14.1)					

a/ Blanks indicate no forecasts were made.

b/ Futures price as a predictor of Choice 1,100-1,300 pound slaughter steer price, Omaha.

over another in most cases when all horizons are considered. Throughout these comparisons, however, one must bear in mind that very few observations were available for some of the longer horizons. Moreover, for most of the four-quarter-and-longer forecasts as well as some three-quarter forecasts, the number of observations differs among forecasters (Tables 3 through 10); thus, results for the longer horizons are less reliable.

Finally, on the basis of Tables 3 through 10, consider the quantitative accuracy of forecasts with respect to time horizon. Generally, one would expect short horizon forecasts to be more accurate than long horizon forecasts. Forecast error, indeed, tends to increase with forecast horizon for wheat, hogs, cattle, and most soybean derivative forecasts. On the other hand, the forecasts for soybean price seem to be more accurate for longer horizons than for short horizons. This observation may be due to an unusual market trend over the particular period of this study. But it could also be due to the relatively volatile nature of the soybean market. For example, the soybean futures market is generally thought to be a more active and fluctuating market which makes it relatively attractive to speculators. For this reason, phenomena unrelated to the cash market may play a greater role in short-run trading and price fluctuations so that the more predictable market movements only tend to occur over a longer time horizon. Indeed, comparing across commodity markets on the basis of root mean squared percentage errors, the soybean market seems to be much less predictable in the short run than other commodity markets (with the possible exception of soybean derivative markets). The corn and wheat markets, which are generally thought to be much less active and more stable, are more predictable over all horizons (in a mean forecast sense) than the other commodities.

V. Econometric Forecasting Versus Futures Markets

One objective of this paper is to examine performance of various econometric models using the futures market prices as a standard of comparison. To develop some summary information in this respect, rankings of the five econometric and one futures forecasts were tabulated. To conserve space, these tabulations are reported by commodity only for the futures forecasts in Table 11.[1] The complete tabulations reveal that no one model performs consistently better over all commodities (Chase is better for wheat and cattle, Wharton or DRI for corn, Wharton for cotton (in terms of comparable forecasts) and DRI for hogs. This variation in performance may be due to a randomness in characteristics vis-a-vis important market phenomena in 1977 and 1978.

Comparing the econometric forecasts with the futures prices, however, reveals some interesting observations. First of all, futures prices tend to dominate the econometric models in forecasting soybean oil and soybean meal prices. In fact, soybean meal is the only commodity where any forecast completely dominates all others over all time horizons (in the comparable forecast case). Also, however, futures prices perform quite well as forecasters for wheat, soybeans, and hogs. Over all commodities and horizons, the average rank of the futures forecast is approximately 2.5 which suggests that, at the mode, the econometric models are not able to forecast as well as the futures market. In terms of the earlier discussion, it appears that either futures market inefficiencies are not serious and/or that econometric models do a poorer job of including all relevant exogenous forces, forecasting them, and

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[1] The complete tabulations are available upon request.

TABLE 11

Ranking of Futures Root Mean Squared Errors
of Various Commodities by Horizon
December, 1976, Through December, 1978

Commodity	Best monthly forecast available				Forecast made in the same month			
	Forecast horizon (quarters)							
	1	2	3	4	1	2	3	4
Wheat	4½	2	1	2	3	3	1	1
Corn	3	4	6	1	4	6	6	1
Cotton	4	5	4	3	5	5	2	2
Soybeans	1	3	2	1	3	2	1	1
Hogs	1	3	3	4	1	2	3	4
Live cattle	2	5	5	4	2	5	5	4
Soybean oil	1	1	2	2	1	2	1	1
Soybean meal	3	3	3	1	1	1	1	1

transforming them into price forecasts than the aggregate intelligence of the futures market. By comparison, average ranks of comparable forecasts over the first three forecast horizons (these horizons where all forecasters produce forecasts) for each respective forecaster are: Chase, 3.27; Doanes, 3.17; DRI, 3.5; Wharton, 3.19; USDA, 4.19; and futures, 2.75.[1]

Turning to issues related to time horizon, since traders in the futures market are often closer to cash market phenomena and are often able to make use of new information more quickly than econometric firms, one might expect futures markets to perform better as a short-term forecaster. On the other hand, econometric forecasts may be based on better structural information and more careful, longer run forecasts of the more important exogenous forces. Thus, econometric forecasts may be expected to be superior for a longer forecasting horizon.

Indeed, examining only the results for comparable forecasts on the right-hand side of Table 11, the econometric forecasts are generally favored on average for a one-quarter horizon in the case of corn and cotton; corn, cotton, and cattle for a two-quarter horizon; corn and cattle for a three-quarter horizon; and hogs and cattle for a four-quarter horizon. On the other hand, the futures market outranks all commercial econometric forecasts in three of eight cases for a one-quarter horizon, one of eight cases for a two-quarter horizon, four of eight cases for a three-quarter horizon, and finally five of eight cases for a four-quarter horizon. Thus, there is no apparent increase in superiority of the econometric forecasts with time horizon as one might expect.

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[1]Note that these average ranks are slightly biased against Doanes and, to a lesser extent, USDA since they do not produce forecasts for some of the commodities; thus, average ranks are a bit higher in the commodities which they forecast than in those they do not.

In fact, it appears that the futures markets prices carry a significant amount of useful information even on the long-term contracts. If econometric models can develop better forecasts than futures markets for long forecasting horizons, it may be only at considerably longer time horizons than for which futures contracts presently exist. The results of this paper thus suggest that there may be some positive social benefits to the development of longer term contracts in the futures markets. Of course, one must bear in mind, however, that these results are developed on the basis of a rather short period of observation of the commercial econometric forecasting firms, and perhaps their performance will improve with time and further refinement.

VI. Decomposition of Forecast Error

Some additional information regarding the value of various price forecasts for individual decision-makers can be gleaned from a decomposition of forecast errors. For the case where both estimated and actual prices are varying in time, the mean squared error can be decomposed following

$$\frac{1}{n}\sum_{t=1}^{n}(Y_t - X_t) = (\bar{Y} - \bar{X})^2 + \frac{1}{n}\sum_{t=1}^{n}(X_t - \bar{X})^2 + \frac{1}{n}\sum_{t=1}^{n}(Y_t - \bar{Y})^2$$

$$+ \frac{2}{n}\sum_{t=1}^{n}(Y_t - \bar{Y})\,(X_t - \bar{X})$$

$$= (\bar{Y} - \bar{X})^2 + \sigma_X^2 + \sigma_Y^2 - 2\sigma_{XY}$$

where Y and X are predicted and actual prices, n is the number of observations for a given forecaster and time horizon, $\bar{Y}$ and $\bar{X}$ represent respective sample means, σ^2 and σ^2 represent respective sample variances, and σ_{XY} is the

sample covariance of X and Y. Thus, the mean squared error decomposes into the bias squared, the variance of the forecast, the variance of the actual price, and the covariance between the two. These decompositions are reported in Tables 12 through 15 in terms of the absolute portion of mean squared error attributable to each component. Observations corresponding to only new forecasts are used in each case for the calculations.

One of the interesting implications of Tables 12 through 15 is that not all forecasters seem to be making the same types of errors. For example, in wheat the futures forecast makes most of its errors because of variability in futures prices. This implies that a longer filter might, although not necessarily, average out some of the variability and provide a better forecast. The USDA, on the other hand, makes a large share of its wheat price forecasting errors because of covariance between actual and predicted prices, such as might be the case when turning points are missed. The commercial firms such as Chase, DRI, and Wharton make a larger share of their wheat price errors because of bias. Somewhat similar conclusions hold for soybeans.

These same conclusions do not hold for other commodities, however. For example, the econometric firms are remarkably unbiased for cotton, while forecast errors for most econometric models are much more attributable to covariance <u>viz-a-viz</u> the futures market. All forecasters commit most of their errors because of bias in hog price forecasting.

It is interesting to consider the extent to which bias can be traded off for lower forecast variance or for lower covariance between forecast and actual prices by choosing one forecast versus another. In point of fact, if a firm's profits are inversely related to forecast error, then a risk-neutral

TABLE 12

Wheat and Corn: Decomposition of Forecast Error by Forecaster, December, 1976, Through December, 1978

Forecast	Component	Wheat				Corn			
		Forecast horizon (quarters)							
		1	2	3	4	1	2	3	4
Chase	Bias	0.013	0.038	0.09	0.203	0.004	0.008	0.009	0.006
	Forecast variance	0.075	0.059	0.044	0.018	0.061	0.043	0.037	0.054
	Actual variance	0.153	0.141	0.094	0.053	0.037	0.036	0.027	0.017
	Covariance	-0.158	-0.114	-0.063	-0.017	-0.023	0.035	0.026	0.009
Doanes	Bias	0.007	0.037	0.093	0.338	0.012	0.014	0.001	0.002
	Forecast variance	0.069	0.053	0.074	0.016	0.067	0.059	0.054	0.075
	Actual variance	0.106	0.102	0.064	0.006	0.033	0.030	0.020	0.011
	Covariance	-0.076	-0.023	-0.024	0.01	0.005	0.056	0.024	-0.059
DRI	Bias	0.308	0.434	0.666	0.992	0.003	0.010	0.008	0.001
	Forecast variance	0.169	0.201	0.123	0.099	0.032	0.041	0.041	0.024
	Actual variance	0.149	0.142	0.116	0.060	0.037	0.036	0.027	0.017
	Covariance	-0.218	-0.136	-0.009	0.067	-0.012	0.018	0.020	-0.022
Wharton	Bias	0.015	0.058	0.105	0.261	0.007	0.018	0.026	0.033
	Forecast variance	0.116	0.075	0.051	0.043	0.037	0.024	0.021	0.028
	Actual variance	0.153	0.141	0.094	0.053	0.037	0.036	0.027	0.017
	Covariance	-0.209	-0.127	-0.041	0.015	-0.022	0.008	-0.012	0.016
USDA	Bias	0.001	0.007	0.076	a/	0.030	0.023	0	
	Forecast variance	0.100	0.081	0.075		0.065	0.062	0.072	
	Actual variance	0.109	0.108	0.029		0.034	0.033	0.007	
	Covariance	0.043	0.109	0.092		0.024	0.064	-0.017	
Futures	Bias	0.001	0.010	0.032	0.316	0.016	0.041	0.049	0.001
	Forecast variance	0.118	0.075	0.064	0.008	0.034	0.037	0.045	0.030
	Actual variance	0.153	0.141	0.094	0	0.037	0.036	0.027	0.027
	Covariance	-0.197	-0.098	-0.035	0.001	-0.011	0.042	0.037	-0.056

a/ Blanks indicate no forecasts were made.

TABLE 13

Cotton and Soybean: Decomposition of Forecast Error by Forecaster, December, 1976, Through December, 1978

Forecast	Component	Cotton				Soybean			
		Forecast horizon (quarters)							
		1	2	3	4	1	2	3	4
Chase	Bias	0.51	2.35	2.11	13.71	0.125	0.278	0.408	0.781
	Forecast variance	68.67	49.16	57.88	54.81	1.462	0.343	0.316	0.487
	Actual variance	43.28	30.02	26.34	20.33	1.075	0.641	0.331	0.244
	Covariance	-57.45	29.61	64.89	52.51	-0.040	0.218	0.309	0.243
Doanes	Bias	5.06	7.06	16.80	37.73	0.221	0.277	0.342	0.418
	Forecast variance	44.85	33.11	16.30	6.24	1.090	0.487	0.551	1.057
	Actual variance	43.28	30.02	23.76	11.60	0.917	0.502	0.198	0.028
	Covariance	-46.30	7.17	30.84	16.58	-0.308	0.030	0.293	-0.340
DRI	Bias	6.97	9.57	4.21	0.55	0.086	0.169	0.196	0.572
	Forecast variance	49.63	49.50	68.70	115.42	1.156	0.699	0.611	0.765
	Actual variance	23.35	15.24	10.35	9.43	1.075	0.641	0.331	0.244
	Covariance	-50.19	- 0.97	37.21	48.56	-0.270	0.491	0.163	-0.157
Wharton	Bias	0.01	2.49	3.80	0.33	0.127	0.129	0.188	0.308
	Forecast variance	27.53	35.72	45.47	42.95	1.048	0.938	1.034	1.182
	Actual variance	43.28	30.02	26.34	20.33	1.045	0.641	0.331	0.244
	Covariance	0.05	25.47	44.47	34.81	0.026	0.536	0.592	0.140
USDA	Bias	a/				0.006	0.271	0.220	0.308
	Forecast variance					1.538	0.520	0.185	1.182
	Actual variance					0.886	0.654	0.152	0.244
	Covariance					0.159	0.799	0.125	0.140
Futures	Bias	26.169	38.374	30.052	0	0.001	0	0.005	0.056
	Forecast variance	75.770	63.666	43.333	39.029	1.297	0.560	0.407	0.438
	Actual variance	43.282	30.022	26.346	30.240	1.075	0.641	0.331	0.305
	Covariance	-74.822	- 5.102	36.042	63.766	-0.522	0.275	0.495	0.206

a/ Blanks indicate no forecasts were made.

TABLE 14

Soybean Meal and Soybean Oil: Decomposition of Forecast Error by Forecaster, December, 1976, Through December, 1978

Forecast	Component	Soybean meal				Soybean oil			
		Forecast horizon (quarters)							
		1	2	3	4	1	2	3	4
Chase	Bias	236.3	428.0	755.6	2,007.6	18.187	45.326	50.805	66.857
	Forecast variance	146.9	30.2	131.5	8.0	6.720	1.691	1.696	0.108
	Actual variance	100.4	78.4	96.4	21.3	2.210	0.588	0.235	0.032
	Covariance	- 126.7	- 35.0	14.2	- 25.7	- 1.100	1.620	0.341	0.115
DRI	Bias	21.3	13.6	68.3	433.2	4.373	4.564	8.569	30.201
	Forecast variance	1,160.3	1,045.0	410.8	515.0	17.917	17.114	15.139	7.936
	Actual variance	976.6	499.0	169.5	123.3	8.162	6.959	5.552	3.489
	Covariance	- 263.8	553.6	94.9	- 29.1	4.116	0	4.912	5.223
Wharton	Bias	9.9	0.5	0.9	1.8	3.664	4.886	6.529	14.592
	Forecast variance	1,448.5	1,412.3	1,067.4	1,118.4	9.159	6.936	5.564	6.052
	Actual variance	976.6	499.0	169.5	123.3	8.162	6.959	5.552	3.489
	Covariance	- 391.9	410.9	538.3	345.5	7.418	8.135	1.964	- 4.695
USDA	Bias	51.7	86.8	27.8	a/	7.417	19.213	28.693	14.592
	Forecast variance	820.4	545.5	200.0		14.765	5.645	0	6.052
	Actual variance	1,053.0	785.6	130.6		6.693	7.278	3.251	3.489
	Covariance	- 363.2	874.2	297.0		- 3.937	9.796	0	- 4.695
Futures	Bias	35.9	36.5	26.8	0	2.083	4.469	7.408	13.886
	Forecast variance	1,238.5	527.6	286.3	274.3	11.436	6.601	5.855	5.079
	Actual variance	976.6	499.0	169.5	145.6	8.162	6.959	5.552	3.867
	Covariance	- 570.5	169.0	274.2	125.6	- 1.488	6.462	7.213	2.541

a/ Blanks indicate no forecasts were made.

TABLE 15

Live Cattle and Hogs: Decomposition of Forecast Error by Forecaster, December, 1976, Through December, 1978

Forecast	Component	Live cattle				Hogs			
		Forecast horizon (quarters)							
		1	2	3	4	1	2	3	4
Chase	Bias	2.11	5.12	19.51	66.37	16.85	54.00	98.96	157.06
	Forecast variance	34.47	16.99	9.27	3.47	30.59	11.77	6.66	3.30
	Actual variance	71.24	66.77	58.98	45.82	15.82	12.44	10.95	6.13
	Covariance	-80.87	-45.26	-15.74	- 6.40	-34.20	-11.27	- 0.42	2.83
Doanes	Bias	3.03	9.08	21.46	66.37	25.30	66.42	108.64	157.06
	Forecast variance	25.47	17.87	0.66	3.47	22.03	12.85	4.66	3.30
	Actual variance	71.24	61.81	33.87	45.82	15.82	13.10	13.53	6.13
	Covariance	-62.30	-45.48	- 8.01	- 6.40	-26.01	-19.51	- 1.35	2.83
DRI	Bias	4.06	8.16	34.72	79.46	7.85	21.79	43.63	57.44
	Forecast variance	49.26	38.70	30.52	9.25	38.02	32.44	22.43	16.92
	Actual variance	71.24	66.77	58.98	45.82	15.82	12.44	10.95	6.13
	Covariance	-91.06	-66.20	-57.92	-21.05	-35.15	-19.00	- 9.15	- 0.82
Wharton	Bias	3.16	7.63	28.14	66.18	22.39	42.02	72.97	90.08
	Forecast variance	36.59	25.96	11.68	1.40	21.22	12.89	7.08	11.49
	Actual variance	71.24	66.77	58.98	45.82	15.82	12.44	10.95	6.13
	Covariance	-74.67	-48.13	-33.21	2.93	-21.15	0.57	4.19	9.30
USDA	Bias	11.35	49.78	211.81	66.18	25.95	71.88	190.49	90.08
	Forecast variance	36.33	8.22	1.20	1.40	32.25	22.02	0.23	11.49
	Actual variance	74.47	65.08	31.48	45.82	17.30	14.35	2.40	6.13
	Covariance	-79.40	-14.15	- 8.79	2.93	-30.29	- 7.85	- 1.41	9.30
Futures	Bias	7.96	27.41	60.31	124.74	9.02	51.13	94.11	163.84
	Forecast variance	53.03	38.48	24.01	9.10	33.93	23.33	18.68	9.66
	Actual variance	71.24	66.77	58.98	51.34	15.82	12.44	10.95	7.62
	Covariance	104.72	70.89	42.62	22.65	35.73	19.53	14.87	6.91

firm may prefer lower bias and be willing to live with higher variance. A risk-averse firm, however, may be willing to use biased forecasts to get greater precision. Also, if costly adjustments are incurred when forecasts are highly variable, then cost-efficiency criteria may also favor lower forecast variance over reduced bias, etc. With this in mind, the results in Table 12, for example, imply that a risk-neutral firm dealing in short-term wheat may find futures prices quite adequate forecasters, while a similar risk-averse firm with high cost of adjustment may far prefer the lower variability of the Chase, Doanes, or even DRI forecast even though the bias is substantially higher.

These considerations suggest that econometric forecasters with similar overall forecasting ability may be able to substantially differentiate their product to capture specific segments of the market. For example, in soybean price forecasting, the futures prices may appeal to a risk-neutral decision-maker, while increasingly risk-averse decision-makers or those with higher adjustment costs may turn to Wharton and then to Chase or Doanes as bias is traded for reduced forecast variance (based on one- to three-quarter horizons). Some of these trade-offs are particularly remarkable for soybean oil and meal where Chase makes most of its errors due to bias, while other forecasters are nearly unbiased.

In the latter case particularly, however, it must be borne in mind that the Chase results are based on fewer observations--a situation which will naturally tend to reflect forecast errors as bias rather than variance. This latter phenomena is clearly manifest by the tendency toward bias as forecast horizons increase in each of Tables 12 through 15. For all longer horizons,

the predicted and actual prices are much closer in time and thus tend to have lower respective variances. For this reason, most of the discussion in this section is in the context of one- to three-quarter horizons where the number of observations is more comparable across forecasters. This, of course, explains why results for forecast horizons of length five through eight are not reported here.

Finally, comparing the decomposition of errors across commodities, it is interesting to observe the apparent ability to correlate forecasts with actual prices after removing factors such as bias and variability. For firms interested in turning points and magnitudes of changes, this consideration, reflected by the covariance component, may have overriding importance. A high correlation is reflected by a negative covariance component, i.e., one that makes up for errors due to bias and variance. In most cases the correlation declines with forecast horizon, thus indicating more forecast ability in the short run; but some of this decline may be due to sample size for the same reasons cited above. Comparing across commodities, however, it appears that correlations are highest for live cattle and are also quite high for wheat, cotton, and hogs. On the other hand, covariances generally offer no compensating influence (the covariance component is positive) for soybean derivatives and corn and particularly for soybeans. In the latter cases the results thus imply that either the distinguishable components in such prices cannot be indentified or that greater modeling effort is needed to capture turning points.

VII. Summary and Conclusions

The results of this paper may be summarized by returning to the questions raised in the introduction. Are futures markets more or less accurate than the econometrically based forecast? The evidence is not overwhelmingly in

favor of either. However, the results as a whole suggest surprising accuracy in the futures markets prices as forecasters in comparison with the econometric forecasts. Futures markets prices seem to be a clear favor for soybean meal and oil. On the other hand, some of the econometric forecasts seem to be preferable for livestock commodities where results for other commodities are mixed.[1]

Does the absolute and comparative accuracy depend upon the forecast horizon? Is the relative and absolute forecasting accuracy commodity dependent? The effect of the forecast horizon on absolute forecast accuracy apparently depends to a large extent on the characteristics of individual markets. Specifically, the change in forecasting accuracy over alternative horizon links depends critically upon the volatility of the underlying market. For active and fluctuating markets such as soybeans, the longer term forecasts are more accurate than short-term forecast. For more stable markets such as wheat and hogs, on the other hand, absolute accuracy decreases dramatically for forecast horizon. Examining relative accuracy, there are also some striking differences among commodities. For the commodities, the accuracy of econometric forecasts relative to futures market prices seems to clearly improve with the time horizon of the forecast as we would expect. The fact that these trends are not apparent for the grain markets may reflect greater (relative)

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[1]It should be pointed out that the models examined here, viz., by Chase, Doanes, DRI, Wharton, and the USDA, have numerous purposes in addition to forecasting prices. The purpose for constructing these models include forecasting acreage response, domestic demand, export demand, inventory carryover, etc., as well as performing evaluations of policy impacts or general scenario analysis. Hence, it is quite possible that an econometric model designed with the specific purpose of forecasting prices could outperform the large-scale models examined in this paper.

availability information in the futures trading of grains. This result is perhaps associated with more inelastic short-term supply response and more accurate estimates of the acreages than of cattle numbers. The fact that econometric forecasts do not dominate futures market prices for any of the existing contract horizons seems to indicate that positive social benefits may be forthcoming from trading of longer horizon futures contracts.

The decomposition of the forecast error into bias squared, the variance of the forecast, the variance of the actual price, and the covariance between the actual and forecast price provided some useful results. In particular, the futures market was generally more accurate in terms of bias while the econometric models were more accurate in terms of variance. Hence, a risk-neutral participant in the cash wheat market may find futures prices quite adequate forecasters while a similar risk-averse participant with a high cost of adjustment may prefer the lower variability of Chase, Doanes, or even the DRI forecast. For firms interested in turning points and magnitudes of changes, the covariance component obtained from the decomposition of the forecast error has overriding importance. For some commodity forecasts, a high correlation reflected by a negative covariance component compensates for the errors due to bias and variance.

Of course, before the results presented in this paper are operationalized in an actual decision context, much remains to be accomplished. First, composite forecasts of futures markets and econometric models using various time-varying parameter schemes (conditional upon the performances of individual forecasters) should be examined (Rausser and Just). Second, some attempt should be made to deal directly with the "basis" determination as well as the magnitude of the bias and its changing structure over the forecast horizon for

both econometric and futures market forecasts. Third, once the above tasks are completed, the results should be integrated with risk management frameworks to assess the real value of information provided by individual econometric forecasts, futures market forecasts, or by composites of these various individual forecasts.

Appendix A

The price series forecasted by the econometric firms considered in this study are as follows:

Wheat: Chase and Wharton--No. 1 Hard Red Winter wheat, Kansas City (dollars per bushel).

Doanes--Average price received by farmers, United States (dollars per bushel).

DRI--Average of Kansas City, Minneapolis, Portland, and St. Louis prices (dollars per bushel).

Corn: Chase, DRI, and Wharton--No. 2 Yellow corn, Chicago (dollars per bushel).

Doanes--Average price received by farmers, United States (dollars per bushel).

Cotton: Chase, Doanes, and Wharton--Average price received by farmers, United States (cents per pound).

DRI--Upland cotton lint price, U. S. Department of Agriculture (cents per pound).

Soybeans: Chase, DRI, and Wharton--No. 1 Yellow soybean price, Chicago (dollars per bushel).

Doanes--Average price received by farmers, United States (dollars per bushel).

Soybean meal: Chase, DRI, and Wharton--Bulk, 44 percent protein price, Decatur (dollars per ton).

Soybean oil: Chase, DRI, and Wharton--Crude tank f.o.b. price, Decatur (cents per pound).

Hogs: Chase, Doanes, DRI, and Wharton--7-market average price, barrows and gilts (dollars per hundredweight).

Live cattle: Chase, Doanes, DRI, and Wharton--Choice 1,100-1,300 pounds slaughter steer price, Omaha (dollars per hundredweight).

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