COMMODITY FUTURES PRICE THEORY

FOR

SEMI-STORABLE PRODUCTS

by

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ABSTRACT

The objective of this paper is to specify and test a basic futures price theory for semi-storable products. Both live and feeder cattle are tested as examples because it is expected that they will have some characteristics of both perfectly storable and perfectly nonstorable products. Feeder cattle proves to be more storable.

A new variation on commodity futures price theory is needed because many new products traded on futures markets do not fit the description of a perfectly storable or perfectly nonstorable commodity. This new variation should relate to products that are "semi-storable" in nature.

The two theories of abstract commodities to be discussed in this study (storable and nonstorable commodity futures price theory) are useful for defining the extremes of existing theory, just as the theories of perfect competition and pure monopoly do. But what is needed now is a theoretical explanation of the price behavior of products which have some of the characteristics of both "storable" and "nonstorable" products. This new theory would serve the same function as that performed by the theories of monopolistic competition and oligopoly -- to explain the behavior of markets which fall somewhere between the two extremes.

The major objective of this paper is to specify and test a basic futures price theory for semi-storable products. Both live and feeder cattle will be used as examples because of the relatively large amount of futures price data available compared to other products not considered to be "storable", and due to the maturity of the two markets, indicated by the volume of futures trade. Corn will be analyzed also as an example of storable product price performance.

A new futures price theory for semi-storable commodities is needed because a great majority of products will probably be classified between the two extremes of being perfectly storable or being perfectly nonstorable. Also, participants in semi-storable product markets need a more accurate explanation of expected price behavior.

The ability of producers to vary market supplies is a major difference between the markets for a storable, semi-storable, and nonstorable commodity. The supply of a storable commodity, such as corn, can be varied easily. At any point in time any amount up to 100 percent of stocks in storage can be sold in the market, but there is no minimum amount which <u>must</u> be sold. Perfectly nonstorable products must be marketed immediately upon completion of the production process to avoid loss due to perishability. There is also no flexibility available in the scheduling of the production and harvest processes. Therefore, producers of storable commodities can hold inventories until they receive an acceptable price from the market; producers of nonstorable commodities cannot hold inventories, which forces them to accept the market price prevailing at the time the production process ends, whether or not it is profitable. The position of semi-storable commodity producers is somewhere between the two extremes.

The Theory and Methodology

The major propositions of the futures price theory for semi-storable commodities are that (1) all prices will be related due to producers' tendency to use current cash and distant futures prices in their production planning, and that (2) the more "storable" a commodity, the more "accurate" will be the pricing function its futures market performs. The strength of the relationship between prices depends on the ease with which market inventories can be altered over time, space, and product form. Whereas storable product inventories can be altered very easily and nonstorable product inventories cannot be altered at all in the short run, semi-storable products will have some of the characteristics of both storable and nonstorable commodities. Semi-storable products will have some flexibility in their market inventories in the short run, like storables, but that flexibility will be limited by the same production and marketing problems faced by nonstorables. Therefore, it is opportunity for arbitrage which determines the level of "storability" of a product.

The theoretical implications and a test of the price theory for semi-storable commodities can be expressed as:

(1) $1 > r(CP_t, FP_{t+i}) > r(FP_t, FP_{t+i}) > 0$

(2) $1 > r(CP_t, FP_{t-i}) > r(CP_t, CP_{t-i}) > 0$

where r is the coefficient of correlation between the variables,

CP_t is the cash price at time t,

CP_{t-i} is the cash price at time t minus i,

FP_t is the current futures price for a contract maturing at time t,

FP_{t+i} is the current futures price for a contract maturing at time t plus i, and

FP_{t-i} is the futures price at time t minus i for a contract maturing at time t.

Expressions 1 and 2 attempt to specify the relationships described in the two general propositions. Expression 1 states that the correlation between current cash and futures prices is greater than the correlation between two futures contracts, and both correlations are between one and zero. The correlation for (CP_t, FP_{t+i}) should exceed the correlation for (FP_t, FP_{t+i}) because it is expected that all futures contract prices are affected by cash prices, but the amount of the adjustments made by traders for different contracts will vary due to the independent supply situations expected to exist at each contract maturity date. Expression 2 states that the correlation between cash and futures prices is greater than the correlation between cash prices at two different points in time, and both are between one and zero. No hedgers would use futures markets if there was no correlation between current futures prices and cash prices received at contract maturity. This correlation is expected to exceed that which has been found to exist between cash prices. The theories for perfectly storable and perfectly nonstorable commodities, respectively, are:

$$(3)\quad r\,(CP_t, FP_{t-i}) = r\,(CP_t, FP_{t+i}) = r\,(FP_t, FP_{t+i}) = r\,(CP_t\; CP_{t-i}) = 1$$

$$(4)\quad r\,(CP_t, FP_{t+i}) = r\,(FP_t, FP_{t+i}) = r\,(CP_t, CP_{t-i}) = 0 < r\,(CP_t, FP_{t-i})$$

using the same notation. Expression 3 states that there is perfect correlation between all cash and futures prices over time. This indicates that perfectly storable commodities will always have a full carrying charge market within crop years.

Expression 4 states that the only correlation between cash or futures prices of nonstorables is between futures contracts and the cash price at the contract maturity date. The clear implication here is that the more correlation which exists in the prices for a commodity, the more "storable" that the product is perceived to be by traders.

To test whether, in fact, all prices are related for a particular product the existence of a significant relationship between combinations of both cash and futures prices for live cattle, feeder cattle, and corn are considered. In each case simple regression analysis is used to determine the degree of correlation between the sets of price data. The data used is weekly average prices for each live cattle futures contract to mature from April 1968 through February 1980 and similar data for each feeder cattle futures contract to expire from May 1972 through March 1980 and each corn contract to mature from May 1968 to March 1980. Time lags ranging from one to eight months are used to provide greater insight into the significance of the results.

Futures prices for both live and feeder cattle are compared with cash prices from their respective markets to determine the degree of pricing accuracy. The ability of futures markets to accurately estimate distant cash prices is tested using least-squares analysis with the simple model: $CP_t = a + bFP_{t-i}$ where CP_t is the cash price at delivery and FP_{t-i} reflects the futures price during the i-th month before maturity. In these models if FP_{t-i} is an accurate forecast of CP_t, there will be a significant relationship between the two price series.

Empirical Results and Analysis of Price Dependence

Current price theory expects no relationship to exist between current cash prices and current futures quotes for deferred delivery contracts of a nonstorable commodity because the prices are for two independent production and marketing periods. In markets for storable commodities current cash and distant futures prices are expected to be strongly related. It is believed that there is one price within each market area, the cash price, and that all other prices are related to that one price by the cost of storage over time (Jain). To test whether, in fact, there is a significant relationship between current cash and futures prices of live and feeder cattle, Pearsonian correlation coefficients are computed. The results of these calculations are presented in Table 1.

With inspection of Table 1 it is clear that the general hypothesis of independence between current cash and current futures prices of beef cattle is rejected for all time lags considered. All of the correlation scores, R, are high and all the associated F-test scores are statistically significant at the 95 percent confidence level.

The existence of correlation between cash and futures prices of beef cattle leads to the expectation that futures prices of individual cattle contracts may be correlated also. It has long been hypothesized that no such correlation should exist; it is believed that prices of individual futures contracts for a nonstorable commodity should be independent of one another (Leuthold {77}, Skadberg and Futrell, Tomek and Robinson).

To clarify this confusion over the classification of the cattle markets the theory of independence between prices of individual futures contracts is tested. The proposition states that during any period of time the prices of all available cattle futures contracts will be independent of one another.

The major conclusion drawn from the results presented in Table 2 is that the proposition of independence between prices of individual cattle futures contracts is rejected overall. It appears that cattle feeders, as hedgers in the live cattle futures market, play a major role in creating price dependence between contracts. The proposition of price independence between individual live cattle futures contracts could be rejected for contract combinations with delivery dates

TABLE 1. Relationships Between Current Cash and Current Futures Prices ($r\{CP_t, FP_{t+i}\}$)

Futures Contracts To Mature In -	Live Cattle Correlation (R)	Feeder Cattle (R)	Corn (R)
1 month	.958	.961	.975
2 "	.921	.960	.957
3 "	.867	.951	.923
4 "	.859	.943	.933
5 "	.831	.936	.899
6 "	.852	----	.876
7 "	.831	----	.892
8 "	.865	----	.849

TABLE 2. Relationships Between Futures Contracts $\{r(FP_t, FP_{t+i})\}$

Time Lag In Months	R Scores Hi	R Scores Low	R Scores Median	Insignificant Scores
		Live Cattle[a/]		
2	.995	.273	.851	0
4	.991	.044	.741	2
6	.992	.009	.670	8
8	.989	.004	.681	21
		Feeder Cattle[b/]		
1	.996	.445	.917	0
2	.991	.830	.931	0
3	.980	.451	.918	0
4	.988	.172	.913	1
		Corn[c/]		
2	.998	.504	.946	0
4	.994	.517	.929	0
6	.990	.500	.925	0
8	.990	.427	.921	0

[a/] Seventy-two contracts maturing from April 1968 through February 1980.

[b/] Fifty-six contracts maturing from May 1972 through March 1980.

[c/] Sixty contracts maturing from March 1968 through December 1979.

two, four and six months apart, but might not be rejected for contracts maturing eight months apart. It is noted that most fed cattle are in the feedlot six months or less, which is the longest period of time that a cattle feeder might hold a true hedge in the futures market. Therefore, when considering dates six or eight months apart (or longer) there are clearly two feeding periods involved providing a wider range of choices for cattle feeders.

Empirical Results and Analysis of Price Accuracy

The second proposition being tested states that the pricing function of a futures market for a storable product will be more accurate than that of a nonstorable product. In other words, current futures prices and cash prices at the distant maturity dates of those futures contracts will be strongly related for a perfectly storable commodity. For a perfectly nonstorable commodity, the two price series will be correlated less strongly. For a perfectly storable product there is only one production and marketing period to be considered by a futures trader in forming his price estimate. Therefore, it is possible that the trader will have much more accurate data available concerning market supplies of a storable product than the information that would be available for a nonstorable product. For a perfectly nonstorable product there may be a number of supply periods to be considered.

The results presented in Table 3 indicate the level of pricing accuracy of live cattle, feeder cattle, and corn futures markets. The general observation which can be made about the results presented is that the futures markets appear to do a more accurate job of pricing for shorter time lag periods.

The new empirical results for live cattle and corn presented in this study agree with those of Leuthold's (1974) study while extending similar analysis to feeder cattle. The level of correlation for feeder cattle is nearly identical to that for both live cattle and corn for the various time lags. This indicates that

TABLE 3. Pricing Accuracy of the Futures Markets[a/] $\{r(CP_t, FP_{t-i})\}$

Months Prior to Delivery	Live Cattle (R)	Feeder Cattle (R)	Corn (R)
1	.96	.93	.93
2	.81	.87	.83
3	.79	.81	.63
4	.74	.70	.63
5	.72	.65	.57
6	.75	---	.51
7	.75	---	.43
8	.72	---	.38

[a/] Fifty-five feeder cattle contracts maturing from May 1972 to March 1980, seventy-two live cattle contracts maturing from April 1968 to February 1980, and sixty corn contracts maturing from March 1968 to December 1979.

TABLE 4. Correlation Between Cash Prices $\{r(CP_t, CP_{t-i})\}$

Time Lag In Months	Live Cattle (R)	Feeder Cattle (R)	Corn (R)
1	.90	.91	.85
2	.81	.84	.78
3	.59	.64	.62
4	.47	.52	.50
5	.33	.39	.32
6	.25	---	.29
7	.24	---	.11
8	.16	---	.11

the feeder cattle futures market performs its forecasting function as accurately as do both the other products. These results make it impossible to accept the proposition that storable products have more accurate futures markets than do non-storables without testing additional products. The results in Table 3 appear to indicate that all three products tested perform a forecasting function with decreasing accuracy over increasingly longer time periods.

The results presented in Table 4 indicate the decreasing degree of accuracy current cash prices have in forecasting distant cash prices. Clearly, current cash prices will be an accurate predictor only if price levels do not change. If information related to supply and/or demand factors changes over time, prices must change. The longer the time period being considered, the more opportunity there will be for price level changes.

Conclusions

It appears that feeder cattle are more "storable" than live cattle, although both can be classified as "semi-storable" commodities. The empirical evidence presented in Tables 1 through 4 support expressions 1 and 2 in the proposed theory of semi-storable commodity futures prices stated earlier. There is some correlation in the price series for both products, but in most cases the amount of correlation in feeder cattle prices is greater than that for live cattle. As discussed earlier, the source of correlation in the prices of any commodity is the degree of flexibility available in the production and marketing processes for that product. It was shown that feeder cattle producers have more options open to them than do live cattle producers, and producers of corn (for example) have more options available than do either feeder or live cattle producers. Feeder cattle prices were also just as accurate, in general, as were live cattle and corn futures prices.

These conclusions indicate that traders in feeder cattle futures should expect price behavior with more "storable" characteristics than should live cattle traders.

Therefore, feeder cattle traders can rely more on the well-documented price theory for perfectly storable commodities while live cattle traders must use much of the relatively untested commodity futures price theory for perfectly nonstorable products. It must be remembered, however, that live cattle was found to be a semi-storable product rather than a perfectly nonstorable commodity.

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