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Stocks and Spreads in Futures Markets

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The main purpose of the investigation on some aspects of which this is a preliminary report is twofold. In the first place we hope to contribute to a better understanding of the operation of futures markets, considered as a means of regulating the distribution of a commodity over time. Secondly we hope to put the pure theory of forward trading, which is of wide significance for economic dynamics, on a firmer basis by a more realistic approach and a verification with factual observations. The present outline refers only to empirical work on commodity futures.

The characteristic feature of futures markets is the simultaneous quotation of prices for delivery at different times, usually in association with a spot market. The differences between the simultaneous prices of different futures are known as "spreads;" the difference between the spot price and the price of the nearest future is often called "basis." Our work here refers only to spreads, which will always be expressed in percentage terms; thus a July-October spread of -8.5 percent means that at a given time the price of the October future is 8.5 percent below the price of the July future. These spreads will occasionally be called "discounts" when they are negative in the above notation and "premiums" when they are positive. Furthermore "near" futures, as distinct from "distant" ones, are those which expire closest to the date at which they are quoted. We shall also speak of "early" and "late" futures, the former being those that expire in the early part of the crop year. For instance, as corn is harvested in the fall the December future is always early, but it is near in October and distant in February.

In dynamic problems such as the present one we can usually adopt either a stock or a flow approach. It appears that the former is more convenient for our purpose. Future contracts then emerge as a type of security which at maturity entitles the creditor to a certain quantity of a commodity within certain quality limits and in one or more prescribed locations. What we have to explain is why at given prices traders (i.e., all those in the market) are willing to hold or owe certain quantities of those securities; this will at the same time lead us to consider to what extent traders are prepared to hold stocks of the commodity itself.

The particular significance of the spreads in this context arises from the empirical observation that over relatively short periods (within a crop year) the spreads show much less variation than the absolute price level of the commodity concerned. Both theoretical reasons, which we can only briefly discuss in this outline, and statistical results suggest that this is due to absolute prices being much influenced by naturally volatile expectations, while spreads depend mainly on such stable factors as the level and distribution of stocks. Another reason for concentrating on the spreads is the fact that the two prices from which each spread is derived refer to the same "contract" quality.

We shall denote the commodity concerned, taking all varieties together, as x and the contract grade, assumed to be the only one deliverable on, futures contracts, as x_o. We consider two futures f_1 and f_2, expiring at times t_1 and t_2 respectively.

It is almost a tautology to say that at any time the price ratio between f_1 and f_2 must equal the marginal rate of substitution between them for the market as a whole, though not necessarily for each individual trader. In order to give some significance to this proposition we must look into the nature of the substitution. The possession of one unit of either f_1 or f_2 entitles a trader to the receipt of a certain amount of x_o, but at different times. An upper limit to any premium of f_2 over f_1 is therefore given by the marginal cost of carrying forward a unit of x_o from t_1 to t_2, for any trader whose carrying charge (storage cost plus interest) is less than the premium will buy f_1 and sell f_2 up to the limit of his financial resources. By accepting delivery at t_1 and making delivery at t_2 he will then enjoy a certain profit. This is in fact one of the purposes for which operators of storage facilities use the futures market.

On the other hand no trader will be prepared to hold x_o from t_1 to t_2 if the spread is less than his carrying charge minus freight to and from the delivery point, for he could achieve the same result more cheaply by selling f_1 and buying f_2. The intervention of freight charges reduces the effectiveness of this condition as a lower bound on the spread. Only if there are considerable stocks of x_o in deliverable positions will the spread therefore equal the marginal carrying charge, which itself will be an increasing function of total stocks. This condition is most likely to arise in the early futures of the crop year.

It is also possible to sell non-contract grades against futures if the carrying charge minus freight exceeds the spread, but the trader who does so assumes a "basis risk" in that the relative prices of the different grades may change between t_1 and t_2. Towards the end of the crop year the commercial supply of some grades may even run out altogether. The willingness to take this risk will evidently increase as the prospective reward, measured mainly by the spread, becomes smaller algebraically. This phenomenon puts an effective lower limit on the spread: as the discount on the more distant future becomes larger traders will be increasingly inclined to hold futures rather than stocks. If stocks are small only traders with strong preferences for particular grades, or at considerable distances from delivery points, will be found to be holding them. As a general rule stocks and spreads will move in the same direction.

This conclusion still needs more elaborate demonstration and qualification but we have to leave this to a proposed comprehensive survey of the theory of forward trading.[1] For the moment we note that the above argument does not involve decisions whether to have a long or short interest in x at all; we think that for the present problem this is an essentially secondary complication. We did not think it necessary either at this stage to refer explicitly to hedging, although this neglect is more apparent than real. One reason for not discussing the important phenomenon of hedging is the insufficiency of the available empirical evidence. Any theories we offered on that subject would therefore be difficult to test, but there is hope that with new material it may be possible to make our approach more explicit.

Having now discussed our reasons for relating stocks and spreads we proceed to discuss some confrontations of our theory with statistical observations on the wheat and corn markets in Chicago and the cotton market

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1. For related discussions cf. Holbrook Working, "Theory of the Inverse Carrying Charge in Futures Markets," Journal of Farm Economics, 30 (1948), pp. 1-28 and the literature there quoted.

in New York. Our material consisted of monthly averages of daily closing futures prices, derived almost entirely from published and unpublished figures of the Commodity Exchange Authority and its predecessors, and of official figures on stocks[2] and Commodity Credit Corporation holdings and pledgings.

In these correlation analyses, which were made by classical least-squares methods, the average spread between two futures during a month was correlated with stocks at some immediately previous date. The pairs of futures consisted either of an old-crop and the following new-crop future or of two late futures within the same crop year; both the statistics and the above theory show that spreads between early futures are given primarily by carrying charges.

It soon became evident--and theoretical considerations show this too--that stocks had to be subdivided in different classes which affect the spread in different ways. The subdivisions used were prescribed by the basic data and are not quite identical for all three commodities.

After various experiments the following type of equation was found to give the best fit:

$$x_0 = a + b_1 \log x_1 + b_2 \log x_2 + b_3 x_3$$

where x_0 is a spread, x_1 is the stock in terminal markets, x_2 the stock elsewhere corrected for pledgings to the Commodity Credit Corporation and x_3 the stock owned by the CCC; more detailed descriptions will be

2. For wheat and corn: "Feed Statistics, including Wheat, Rye, Rice," U.S.D.A. Statistical Bulletin, No. 111 (April 1952) and for cotton: "Statistics on Cotton and Related Data," U.S.D.A. Statistical Bulletin, No. 99 (June 1951).

given for each commodity separately. The reason why no logarithm of x_3 was taken is that this variable was zero in several years.

Although the influence of the CCC clearly had to be taken into account the manner in which this was done is to some extent arbitrary. Not only is there room for theoretical clarification, but the statistics also leave much to be desired, particularly as regards the location of CCC stocks. The underlying assumption of the approximations used is that stocks pledged to or held by the CCC do not affect the choice between futures and free stocks for the market as a whole, but it is conceivable that these approximations are still valid if this assumption is not fulfilled.

Of the several different spreads investigated we shall discuss here one each for wheat, corn and cotton. For the period 1927-51 (excluding 1943-46 when futures trading was suspended) we obtained the following equation for wheat

$$x_0 = 28.3\ (\pm\ 6.6)\ \log x_1 + 10.6\ (\pm\ 6.5)\ \log x_2 - .050\ (\pm\ .025)\ x_3 - 78.4$$

where x_0 = May-September spread during April, in percent.

x_1 = stocks in U.S. terminal markets, April 1, millions of bushels.

x_2 = stocks on farms, April 1, less part of stocks pledged to CCC. This part was estimated by assuming that CCC pledgings were stored on farms and in country elevators in proportion to total stocks in these locations, 10^6 bu.

x_3 = Stocks owned by CCC, April 1, 10^6 bu. (intended as a correction on x_1).

The multiple correlation coefficient was only .73, indicating that some important variables may have been left out. These are probably stocks in

Canada and in locations other than terminals and farms, for which no information over the whole period is available. Various improvements will be attempted. The largest discrepancy occurred in 1931 when the Federal Farm Board cornered May wheat and the discount reached the unprecedented figure of nearly 26 percent. Although during the activity of the Federal Farm Board its holdings were subtracted from terminal stocks this correction was apparently not sufficient for that year.

The result for corn was somewhat more satisfactory. For the period 1926-51 (excl. 1943-46) we found

$$x_0 = 18.8\ (\pm\ 3.5)\ \log x_1 + 15.8\ (\pm\ 5.8)\ \log x_2 - .028\ (\pm\ .010)\ x_3 - 69.3$$

where x_0 = September-December spread during July, in percent.

x_1 = stocks in U.S. terminal markets, July 1, 10^6 bu.

x_2 = stocks on farms less all pledgings to CCC, July 1, 10^6 bu.

x_3 = stocks owned by CCC, July 1, 10^6 bu.

The correlation coefficient was .86. The decision to subtract stocks pledged as collateral for price-support loans from farm stocks was made on the basis of an earlier analysis with a linear formula where these two variables were entered separately; it was found that the regression coefficients were of opposite sign but very close in absolute magnitude.

In the case of cotton the regression equation for the full period 1924-50 turned out to be

$$x_0 = 20.67\ (\pm\ 2.94)\ \log t_1 + .27\ (\pm\ .14)\ t_3 - 17.7$$

where x_0 = July-October spread during April, in percent.

x_1 = all stocks in U.S. except those in consuming establishments or held by or pledged to CCC, April 1, millions of bales.

x_3 = Stocks owned by CCC, 10^6 bales.

with a correlation coefficient of .82 . Another variable x_2 (stocks in consuming establishments) was found to exercise no significant effect. The correlation would be greatly improved if the years before 1930 were omitted, as before that year Southern delivery on New York contracts was not possible. It appears that before 1930 the spreads were closely related to the relatively small stocks in New York itself. Further work on this problem is still in progress.

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