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HEDGING AND JOINT PRODUCTION: THEORY AND ILLUSTRATIONS

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The principal results of Anderson and Danthine can be summarized as follows:

1. In general, cash and future positions should be determined simultaneously.

2. The optimal hedge should be viewed as a sum of risk-minimizing position and a speculative position; hence, the traditional "routine hedge" in general is suboptimal.

3. The conventional portfolio framework involving the application of the mean variance formulation can be generalized to the case of multiple cash goods and multiple futures.

4. Basis risk is not only important for physical goods which are equivalent to goods defined by prespecified futures contracts but as well for those goods for which no futures market exists. Obviously, the magnitude of the basis risk for the latter case should exceed the basis risk for the former case; but, in any event, the resulting "cross-hedges" can be computed in exactly the same fashion as the conventional hedge.

5. Finally, the allocation signal to be used by hedger in selecting among alternative production levels is a linear combination of his spot market price expectations and the relevant futures prices.

These results, aside from the clarifications needed to incorporate basis risk, follow immediately from conventional portfolio theory. If the routine hedge defined by Hieronymus represented conventional wisdom, the paper by

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Anderson and Danthine (A-D) would be a significant contribution. However, as A-D recognize, this is clearly not the case.

To be sure, the paper's distinguishing feature is the explicit recognition of basis risk in the context of conventional portfolio theory. This recognition provides one of the more interesting implications of the A-D analysis. Specifically, in the absence of basis risk, the risk premium disappears; and the relevant price signal to be used by the hedger does not include the spot price expectations component. The hedger need only equate marginal cost to the current futures price less next period's basis. This result has been noted recently by Holthausen and Feder et al., as well as previous work of A-D. These authors demonstrate, under the special assumptions imposed, that all risk-averse firms in the market will key their production decisions to the futures price; and, thus, there is a separation of the real production decision and the futures market position decision. The incorporation of basis risk, however, even under the special assumptions, eliminates this separation.[1]

Given the above observations, what is the ultimate value of the analysis advanced in this paper? Two possible purposes for the analysis can be distinguished. First, the framework could be advanced as a market-based theory or as a prescriptive paradigm of choice for various types of hedgers and speculators. In what follows, I shall focus on each of these two purposes.[2]

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[1]Note that, if the relevant covariance matrix among the multiple cash and futures prices is singular, we have an equivalence to the absence of basis risk; and, once again, we have a separation of physical and futures market position decisions.

[2]A technical problem exists in the analysis provided by A-D which should be noted. They implicitly assume that their optimal conditions provide an interior solution. This is not insured and, in fact, one would expect that, in the context of multiple cash goods and multiple futures, that corner solutions would arise. This problem can be easily corrected by restating the necessary conditions via the Kuhn-Tucker formulation and thus admitting non-interior solutions.

Market-Based Theory

Although A-D do not advance their formulation in the context of a market equilibrium formulation, the spirit of their analysis could be used for this purpose. Unfortunately, such an extension of their analysis would provide a market-based theory which is inadequate. Available empirical evidence, knowledge of existing institutions, and advancements in theoretical formulation suggest that a framework for futures market behavior must admit (1) several groups of market participants, both rational and irrational and informed and uninformed; (2) risk aversion; (3) wealth limitations and imperfect capital markets; (4) indivisible capital and choice selections; and (5) transaction and information costs. Transaction and information costs are particularly important in a futures markets' attempt to form the relevant information set composed of exogenous influences such as planning intentions, yields, consumption, export demand, and the like. Given this information base, which reflects the aggregate judgmental views of all participants, the market must also perform a second function, namely, transmit this information into a futures price. The efficiency with which this transmission is accomplished depends upon the influence of irrational market participants, uninformed market participants, risk aversion, wealth limitations, imperfect capital markets, and alternative transaction and information costs. The A-D formulation explicitly admits only risk aversion and, thus, cannot capture those price transmission errors which emanate from the remaining influences.

Progress has been made in the context of futures market behavior on isolating the potential influences of irrational market participants by Stein, uninformed market participants by Grossman, and heterogeneous information expectations and the importance of wealth by Figlewski. However, no one has yet dealt squarely with the influence of imperfect capital markets and

indivisible choice selections or, for that matter, related all of the various possible sources of errors in a single comprehensive model.

Prescriptive Paradigm-Based Theory

It is difficult to imagine a situation in which a decision-maker evaluating positions in futures markets would find the formulation advanced by A-D useful. At best, the A-D analysis represents only a first cut at an operational empirical formulation. The simplifying assumptions that are imposed in the development of their framework for most behavioral units are unacceptable. These simplifying assumptions include:

1. A two-period formulation. In the context of portfolio theory, the A-D framework could be generalized along the lines of Samuelson, Merton, and Stein's previous work. The A-D formulation does not admit the possibility of changing future positions many times during a particular period of holding an open cash position and, thus, is unrealistic. The authors might benefit from consulting a recent article by Tesfatsion who has investigated the use of myopic decision rules in approximating the outcome of dynamic optimization problems.[1]

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[1]Tesfatsion shows that the degree of approximation is improved the smaller the uncertainty in a system and the higher the correlation among the gains of different periods. Moreover, he finds the bound for the approximation error which is expressed in terms of absolute risk aversion, variance of the stochastic element, and the marginal gain.

2. The mean-variance framework utilized by A-D is, indeed, restrictive. The relevant statistical distributions for most agricultural commodities are not two-parameter distributions and are most certainly not Gaussian (see the empirical evidence summarized by Day). Given the failure to satisfy this condition for the mean-variance formulation, the remaining condition of quadratic utility function implies well-known absurdities. Hence, it can be rejected largely because of its anomalous properties in the large (Arrow and Pratt).
3. The formulation does not include production uncertainty or uncertain input prices. Given the mean-variance formulation employed by A-D, their results will not be seriously altered by this omission. However, a more general formulation which allowed for skewed distributions and decreasing absolute and relative risk aversion, production uncertainty would indeed modify the A-D results.
4. The framework employed by A-D assumes no wealth constraints and perfect capital markets. No hedger or speculator with whom I am aware is faced with such a perfect world or any set of circumstances even remotely resembling such a perfect world. These factors strongly influence the optimal behavior of any particular market participant and place into proper focus the important concept of "gamblers ruin."
5. The A-D framework utilizes available statistical information to estimate the price relationships between futures and spot in order to capture the appropriate cross-hedging strategy. Unfortunately, these price relationships are viewed as totally

> random and thus neglect the causal mechanisms that exist between futures and spot markets. A number of systematic influences or causal variables--such as transport costs, interest rates, energy prices, and the like--directly influence these price relationships and cause them to change over the life of a particular futures contract. A-D completely neglect such causal factors, the seasonality of price relationships, and the inherent instability in such relationships.[1]

The implications of the above observations can be briefly illustrated in terms of two types of futures markets' hedging participants. First, for producers, the implications of 2 and 3 should be obvious. Moreover, explicit recognition of 4 requires a formulation to admit the notion of liquidity risk. Such risk, given empirical evidence on fixed credit lines available from bankers, has an important effect on farmers' hedging activities.

Another group of hedging participants--food processors--deal not only in spot and futures markets but as well in "actuals" or "forward contracting markets" (FCM). Forward contracting markets are particularly important in the context of a number of agricultural commodities, e.g., cocoa, coffee, sugar, corn; and quantity availablity is often secured through futures market activities. The existence of FCMs and their relative importance, vis-a-vis spot and futures markets, implies that food processors are concerned not only with price risk but as well with quantity (availability) risk and quality risk.

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[1]They are certainly subject to change. Fortunately, econometric techniques are available for effectively capturing such changes (Mundlak and Rausser).

In addition, many food processors employ the futures market to price the product that they have contracted for in FCMs. This insitutional arrangement can obviously not be dealt with by the A-D formulation. In addition to the price and basis risk recognized in the A-D framework, food processors also face liquidity risk, as suggested by 4, and still another risk associated with their competitor's hedging behavior. That is, for those elements of the food manufacturing sector that closely approximate monopolistic competition, food processors are especially concerned with their competitor's futures market actions. If a particular food processor does not hedge and his major competitor does and raw product prices increase significantly, the outcome of the game on consumer market shares can be altered drastically. Hence, a prescriptive paradigm for such behavioral participants must explicitly recognize this sort of "competitive risk."

Empirical Applications

Although A-D's investigation of two illustrative examples is commendable, for the above reasons, these treatments leave much to be desired. The estimated random price relationships, the neglect of the life remaining on futures contracts, the neglect of seasonality, and what appears to be the disregard for existing institutions in these applications is bothersome. For the grain storage example, A-D fail to recognize that a futures markets for barley exists in Winnipeg. The specified static cost function is ludicrous; and the static price expectations that are assumed make this example artificial. Certainly the authors did not need to advance this example to demonstrate "how the stochastic nature of output prices introduces an important jointness into the production decision, even though the production technology is separable."

The debt portfolio interest rate futures example also suffers from the same limitations. Here we are informed that many agents have a satisfactory way of selecting positions in the cash markets; and, thus, a risk-minimizing formulation can be employed. Unfortunately, they provide no evidence to justify this observation. They also argue that high liquidity and low transaction costs of organized futures markets lead such agents to revise future positions more frequently than cash positions. As noted above, their framework has nothing whatsoever to say about such influences. The additional observation that the term structure interest rates obeys a degree of regularity suggests that they have not closely examined recent data on yield curves. Here, again, their framework sweeps under the rug many important causal factors which influence the relationship between cash and futures market prices. Perhaps more importantly, they provide us with no information on the robustness of their results to the arbitrary assumptions imposed. To add insult to injury, they violate existing institutional knowledge by assuming only two futures markets are available for hedging cash positions in 2, 5, and 10-year treasury bonds.[1]

Summary

I have attempted to provide here only a thumbnail sketch of the limitations of the A-D analysis. In the spirit of the snail's pace at which the economic and finance professions seem to be addressing the behavior of futures

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[1]Another technical problem arises in the A-D analysis. They use R^2 to confirm the intuitive notion that, for a 2-year bond, the T-bill futures are preferable if only one future is to be employed, whereas, for the 10-year bond, the T-bond futures are preferable. This application of R^2 completely neglects the literature on the simultaneous determination of futures and spot prices. For such simultaneous determination, the R^2 provides no evidence whatsoever and may, in fact, be misleading.

markets, the contribution offered by A-D in terms of a conceptual formulation for basis risk and cross-heding has some value. In fact, from a prescriptive standpoint, it is one of the more interesting pieces that is currently available. Nevertheless, the economics and finance professions should not be satisfied with such routine applications. Instead, incentives must be found for bright and obviously competent research analysts, such as Anderson and Danthine, to examine the real challenges and issues.

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