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DYNAMICS OF PRICE CHANGES: IMPLICATIONS FOR AGRICULTURAL FUTURES MARKETS

by

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DYNAMICS OF PRICE CHANGES: IMPLICATIONS FOR AGRICULTURAL FUTURES MARKETS

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I am pleased to participate in this symposium to recognize Thomas A. Hieronymus. He was a pioneer in the study of commodity futures markets and the author of an early textbook on futures markets. His career spans a period of remarkable growth in futures markets and in research on futures and related markets.

The evolution of existing markets, the development of new markets, and the study of these markets certainly has been dynamic. The focus of this paper, however, is limited to the dynamic behavior of agricultural prices and to the implications of this behavior for agricultural futures markets. Specifically, I explore how price and basis behavior may change and how such changes might influence the use of futures markets.

To provide a context, I start with some comments about the influence of contract specifications on hedging use. Then, I turn to the topics of price and basis behavior. This discussion raises some concerns about the continued benefits of existing contracts and about whether changes in contract design are warranted. The paper concludes with suggestions for research.

Contract Design and Hedging Use

Firms have alternatives to futures markets for pricing commodities and managing risk, and if a futures market is to have important economic benefits, it must be the least

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cost alternative for hedging for a large number of firms. A large volume of trading implies that a futures market is indeed the least cost hedging alternative for many firms.

The features of futures markets which can make them a low cost way to hedge include the margining system, marking to market, and the associated clearing arrangements. The standardized contract is an important component of the system. A futures contract contains relatively specific language about timing of delivery, quality to be delivered, and location of delivery (i.e., relative to the diversity of qualities and locations being traded in cash markets). Among other things, these features assure contract integrity and minimize ambiguity about the item being priced and therefore about the linkage of futures to cash prices (e.g., Peck).

A potential danger exists, however, that the contract specifies an uncommon commodity which bears a weak (or declining) relationship to most cash transactions. If the contract provisions are too narrow, the commodity defined by the contract is costly to deliver because the supply of the deliverable commodity is tiny, and the price of the deliverable commodity will not be closely related to the broader cash market. A delicate balance exists between having a clear, precisely defined contract and having a too narrowly drawn contract.

This is not just a problem for writing new contracts, but can become a problem for existing contracts. For example, the potato futures contract traded on the New York Mercantile Exchange called for the delivery of Maine-grown, round white potatoes, and the potatoes had to be delivered and pass inspection (meet grade standards) in New York City. Changes in the quantity and type of potatoes grown in Maine made it increasingly difficult to obtain potatoes that could meet the delivery conditions of the contract, particularly in April and May. The commodity defined by the contract became a rare item

whose price was detached from the prices of cash sales. It was possible to have an ample supply of potatoes, but few of deliverable grade in New York City. When this happened, cash and futures prices diverged. Thus, a market that worked well in the 1950s and 1960s started to work poorly in the 1970s and ultimately died (Paul, Kahl, and Tomek). The contract was not useful for hedging Maine-grown potatoes nor for cross hedging potatoes grown elsewhere.

A necessary condition for successful hedging is that basis risk be less than price-level risk. The potato market had (and still has) much price risk, but with relatively static contract specifications, a huge increase in basis risk developed. One attribute of a useful futures contract is that many hedgers, in a variety of circumstances, are able to forecast the particular basis relevant to their decisions with reasonable accuracy. A potential problem for agricultural futures is that basis relationships are becoming less predictable. Larger basis risk implies, other things being equal, larger costs of hedging. The remainder of the paper addresses this concern and related research issues.

Price Level Risk

Cash prices for commodities are autocorrelated, moving from high to low levels and back again. The variances of price changes also behave systematically moving from periods of relatively quiet to periods of great volatility. Distributions of prices for some commodities are occasionally truncated by the effects of government price support programs, but prices can also have sharp spikes of exceptionally large changes. The tails of the distributions of price changes are typically larger than those of the normal probability distribution (for references on these points, see Tomek and Myers).

In my judgment, this type price behavior and hence price risk will continue in the future much as in the past. I can point to factors that might increase volatility and others

that might reduce volatility, but it is difficult to say that one set of factors will dominate the other. Both the supply and demand for commodities will grow, but not always at the same rate. When supplies, including inventories, are small relative to demand, prices will be high. Small inventories and high prices result in large price changes for any given change in economic conditions. There will also be periods with ample supplies, low price levels, and little price variability (for a discussion of the role of inventories in price variability, see Williams and Wright).

In considering the future, I can think of two reasons why periods of high and variable prices might be somewhat ameliorated. First, more substitutes for commodities are appearing as inputs for final products. For example, a variety of sweeteners now exist as alternatives for traditional cane and beet sugar. This implies that the demand for sugar is less price inelastic, which presumably has a dampening effect on sugar prices. But, I note examples, such as wool, where prices are still highly variable notwithstanding the development of potential substitutes. The question of the true degree of substitutability and its effect on price variability must be answered empirically, commodity by commodity.

Second, processors are demanding variants of commodities that have attributes that make them less generic. Urban believes that 25 percent of U.S. corn production will be processed into consumer products, energy, sweeteners, starch, proteins, and oils by the year 2000 and that a large portion of this corn production will be "identity preserved." For example, specialized starches needed by food and paper industries can be genetically introduced into the grain, and starch processors presumably will want to contract with farmers for this particular (identity preserved) corn. Niches with less competition will develop within commodity markets, and while this means a more price inelastic demand

for the niche use, the development is nonetheless likely to reduce price variability, at least for the niche commodity. Firms will have a greater ability to match supply with demand assuming that, as noted above, they contract with farmers to produce the desired commodities at relatively stable prices.

A related development is the increase in niche products at the retail level. If these niches reduce price variability for final products, then the variability of the input prices also should be reduced. Thus, even if the input is a generic commodity, the effect of retail niches may be to reduce overall price variability. This effect on price variability, however, may be small; the commodity may be a relatively small part of the value of the final product.

The main argument favoring higher and more variable prices in the future is that a persistent shortage of food will develop in the world. Global warming, pressures to reduce farm-related pollution, and increased political instability are factors that could result in slower rates of growth in food supplies while population growth persists. But I am rather skeptical about a scenario of persistent high prices. Technological developments, including those from biotechnology, could result in large increases in supply. The capacity of the economy to find substitutes both for inputs and for final products tends to be underestimated by general observers, if not by economists. Historically, high prices have brought forth the technology and resources needed to increase food supplies and reduce prices.

To the extent that government price supports are eliminated or become ineffective, as support levels are lowered, prices could become more variable. Decreases in prices will not be truncated by support levels, and government-held inventories will not be available to offset high prices. For example, the prices of cheese and nonfat dry milk

have risen above support levels, and with more variable prices in recent years, futures markets have started for these commodities.

On balance, I cannot say with confidence that price behavior will change from that observed in recent years. Markets for generic commodities will remain important in an absolute sense (if not relative to the total economy), and they will have episodes of large price variability. Thus, prices will remain difficult to forecast, and price risk will continue to exist much as it has in the past. The implication is that hedging demand, based on price level risk, for agricultural futures is likely to change relatively little. There will be periods of large and small hedging demand, in so far as this demand is related to the volatility of prices for generic commodities.

Basis Risk

It is nonetheless possible that basis risk will increase--that our ability to forecast basis changes will decrease. Admittedly, little evidence exists for this hypothesis. Relatively little research has been done on **forecasting** bases, let alone analyzing whether forecasts are becoming less precise. But, I believe that reasons exist for concern. I discuss these reasons in two steps: those related to the factors determining the basis for the par (deliverable) commodity and those related to other factors which are specific to a particular local basis.

Theoretically, the only difference between the cash and futures prices of the par commodity is the time dimension; the two prices are identical at contract maturity. In practice, the par basis at maturity will depend on the economics of making delivery. Costs exist in arbitraging between cash and futures markets--in making and taking delivery (Paul). To the degree that the par commodity becomes less like the bulk of the cash market, the more likely it becomes that it will be costly to make delivery.

The CBOT grain markets are facing this problem, but it is a potential concern for other agricultural futures markets as well. For the CBOT grain contracts, Chicago (even Toledo) delivery has become economically "up hill" relative to most grain flows. Thus, inventories available in exchange-approved warehouses for making delivery can be small relative to the open interest in the nearby futures contract. Retendering of the same grain is required in some months to cover all of the deliveries, and "squeeze potential" exists in such markets.

This raises the key question, has the predictability of the par basis declined? Peck and William find that price spreads for the grains have become more variable in the 1980s, but find no clear evidence that hedging effectiveness has declined. At least for corn and soybeans, the predictability of convergence of cash and futures prices appears to remain unchanged. The recent period, however, requires a more complex model to achieve the same forecasting accuracy, and clearly the timing of convergence is variable. Thus, hedging effectiveness may have declined for some firms, and concern exists that it could decline in the future.

This brings me to the second question, is the local component of bases becoming more difficult to forecast? Individual transactions prices are like a swarm of insects clustered around a central tendency, but with the individual insects changing positions relative to the central tendency and each other. There are many cash prices, a futures price representing the central tendency, and hence many bases. These bases depend on the location, quality, timing, and other attributes unique to the particular cash transactions. Feeder cattle are a good example of the diversity of quality and locations that can influence spot prices (Rich and Leuthold), but most agricultural commodities have this problem.

Farm markets are becoming more complex in at least two senses. Commodities have increasingly diverse uses which depend on varying quality and location attributes, and they are being priced in a larger number of ways, often involving private treaties and little public information. There are more bases, and it is increasingly difficult to obtain data on relevant bases and their changes.

The development of niche uses, mentioned above, is an example of the growing complexity of commodity markets. Such developments imply greater basis risk and reduced use of futures markets. Even if niche markets remain relatively small, it is nonetheless true that individual prices are influenced importantly by local supply and demand conditions. Changing demands for particular outputs derived from commodities (say, changing demand for ethanol produced from corn) combined with the location of major processing plants can have important effects on local prices. A larger number of quality attributes appear to be influencing individual prices. These attributes include both the presence of desirable characteristics and the absence of undesirable characteristics.

Also, buyers may require that the commodity contain the relevant attributes within a rather narrow range (Barkema, Drabenstott, and Cook). In some cases, as noted above, these attributes are likely to be obtained by contracting with farmers to produce the desired product. In other instances, it may be that through time varying supplies of the desired attribute are produced and enter the market. The protein content of spring wheat, for example, is variable from year to year, and consequently the premium paid for high protein wheat is variable. When the supply of protein is small, price is in a highly inelastic portion of the demand function; when supply is large, price falls to a more elastic range of the demand function. It follows that the basis for particular lots of spring wheat can be dramatically influenced by the relative supplies of protein.

In sum, basis behavior is probably getting more difficult to forecast and certainly is not easier to forecast. Stated another way, the growing complexity of commodity markets means that the diversity of potential cross hedges is increasing. The problem for futures markets is the effectiveness of these potential hedges. In this context, futures exchanges should be concerned that contract design not exacerbate the problem of basis risk and should be asking whether contract design can accommodate the increasing diversity of cross hedges.

Changing Contract Specifications

Contracts should be designed to minimize basis risk for the largest volume of potential hedging. It appears, however, that changes in contract specifications evolve slowly and by trial and error in response to problems. Naturally, exchanges are reluctant to tamper with historically successful contracts, and even if the contract appears to have problems, short-run costs of change are a source of inertia. These costs include the risk that the revised contract will not be an improvement over the old. This risk is increased by the growing labyrinth of cash prices.

Changes in existing contract specifications include both revised delivery provisions and shifts to cash settlements. Each approach has potential problems. A single delivery point typically does not make economic sense, while multiple locations (or qualities) with fixed premia and discounts create ambiguity about what is being priced, i.e., about what quality will be delivered and where. But, one only has to think of the analogy with the swarm of insects to see the problem of developing a cash settlement contract for agricultural commodities. The diversity of cash prices means that a representative price series is costly to collect and maintain and that it is difficult to construct a series that is closely related to the wide range of cash prices.

These problems have led me to wonder whether futures markets must become more complex. Simplicity is a virtue, other factors being constant, but perhaps one must accept the necessity of representing increasingly intricate cash markets in a more meaningful way. The issue can be framed as, how to define the par, deliverable commodity? (Or, the cash settlement index?)

An answer is to define a contract so that a "large" number of basis relationships have a "high" degree of predictability. The criterion is to minimize basis risk over the maximum number of transactions (volume of trade). For example, basis risk could be defined in terms of the mean of the squared forecast errors, and then the question is, what contract specification minimizes the mean squared errors for the most economically important bases? Stating the question in this way emphasizes two points: (1) other factors constant, hedging volume is a function of basis risk relative to price risk, and (2) basis risk must be considered over the various bases faced by potential hedgers.

Unfortunately, the foregoing criterion is exceedingly difficult to use in practical applications to specific situations. How does one vary contract specifications and measure their effects on basis behavior over a wide range of potential hedging situations? A futures contract could be designed so that basis risk is zero for a single cash transaction. The problem of "optimal" contract design is difficult precisely because a large variety of potential uses must be considered. And, I have argued above that the diversity of cash transactions is increasing.

Perhaps contracts can be written to obtain the needed balance between specificity and inclusiveness, but an alternate approach is to increase the number of par contracts, letting the market determine the price relationships among the contracts. For example, separate contracts could be developed for different delivery points, using the same

delivery months, with all contracts trading in the same ring. This would permit low cost arbitrage among locations and maturities. Indeed, one location might be considered the base contract, and the other contracts traded at discounts or premiums to the base price. It may be sufficient for the "locational contracts" to trade only for the nearby maturity month, perhaps with the ability to roll over to the next maturity. The effect of having more par commodities should be to reduce basis risk over a wider range of transactions.

Given that three futures markets for wheat exist in the United States, the foregoing notion is not particularly radical, but if a proliferation of contracts is considered unrealistic, then perhaps spatial differentials in a contract could be made more flexible rather than being fixed constants. Spatial price differences are not fixed in reality, and a way needs to be found to assure that relatively low cost delivery on futures is feasible.

Quality specifications of contracts also may require revision. First, the economically meaningful attributes of the commodity need to be determined, and then, given the relevant attributes, it may again make sense to let the market determine the prices of these key characteristics rather than having constant premia in the contract. The role of futures markets in pricing attributes, however, is likely to be reduced to the degree that processors contract directly with farmers for the production of special attributes. It may not be possible to define futures contracts that are useful to participants in niche markets for identity-preserved commodities.

Theoretically, every competitive cash market should have a corresponding futures market, but in practice, not every commodity requires a futures market. New contracts increase costs, and if economical cross hedging is possible, each commodity (or commodity variant) does not require a separate contract. If, however, the ability to hedge

with existing contracts is declining, then the question of whether the benefits of contract proliferation (or revision) outweigh the costs must be addressed.

Unquestionably, the foregoing suggestions have potential operational problems, i.e., costs. The addition of new contracts can dilute volume per contract, and writing contracts with market-based premia would not be easy. At the same time, the agricultural economy is dynamic, and exchanges must be concerned when basis risk grows, because commodity futures markets will be in danger of failure. Thus, change may be necessary for the continuation of useful agricultural futures markets. Creative suggestions about possible changes and improvements in contracts are needed, and these suggestions should come from a variety of sources. Basically, I am asking what is the optimal number of futures contracts?

Conclusions--Needed Research

The research needs that follow from the foregoing discussion are perhaps obvious, but I elaborate a bit. First, we need to better understand basis behavior, and from this, our ability to forecast bases and to quantify basis risk can be appraised. Structural models for livestock commodities differ importantly from those for the grains, but a foundation exists for further research (e.g., Kahl and Curtis; Leuthold and Peterson). The research should include work, like that of Peck and Williams, on whether the predictability of convergence of bases has changed. A major problem for the foregoing type research is obtaining appropriate data for cash prices and for explanatory variables.

Explaining historical basis behavior may be a necessary, but certainly is not a sufficient, condition for accurate forecasts. Forecasts based on structural models require ancillary forecasts of the explanatory variables. The basis near maturity may depend, among other things, on the size of open interest relative to stocks in deliverable positions,

but if these explanatory variables can not be estimated accurately when a hedge is being placed, then the explanation has little value for forecasting. Thus, a distinction must be made between our ability to explain basis behavior ex post and our ability to use this information to forecast ex ante. Explaining basis behavior is difficult, and accurate forecasting even more difficult (e.g., Taylor and Tomek). It may be that time-series models or simple averages will forecast as well as structural models (e.g., Hauser, Garcia, and Tumblin).

A second, related area of research is on the relationship of contract design to the success of futures markets. What attributes must a cash market possess for a futures market to potentially be successful (useful)? What attributes must a futures contract have to realize the potential? The literature contains notions about these attributes (e.g., Telser and Higinbotham). Futures markets appear to work best for highly fungible commodities with large price risks, with good information about cash prices and the forces affecting them, and with a need for the integrity provided by the futures clearing system.

Many problems exist, however, in trying to estimate the probability of success of a new or a revised contract. Useful research must go from the conceptual to specific empirical models, and these models require data relevant to defining "fungibility," "price risk," and the other concepts in a particular model. One must try to estimate how alternative contract specification will influence hedging use, i.e, basis risk for various cross hedges. And so on. Like the basis, accurate forecasts of the success of new or revised contracts are also difficult to make. But, we need to try.

References

Barkema, A., M. Drabenstott, and M. L. Cook. "The Industrialization of the U.S. Food System," in Food and Agricultural Marketing Issues for the 21st Century, D. I. Padberg, editor. College Station: Texas A&M University, 1993. Pp. 3 - 19.

Hauser, R. J., P. Garcia, and A. D. Tumblin. "Basis Expectations and Soybean Hedging Effectiveness," North Central Journal of Agricultural Economics 12(January 1990): 125-136.

Hieronymus, T. A. Economics of Futures Trading. Commodity Research Bureau, 1977.

Kahl, K. H., and Charles E. Curtis, Jr. "A Comparative Analysis of the Corn Basis in Feed Grain Deficit and Surplus Areas," Review of Research in Futures Markets 5(No. 3, 1986): 220-232.

Leuthold, R. M., and P. E. Peterson. "The Cash-Futures Price Spread for Live Hogs," North Central Journal of Agricultural Economics 5(January 1983): 25-29.

Paul, A. B. Treatment of Hedging in Commodity Market Regulation. USDA Technical Bulletin No. 1538, April 1976.

Paul, A. B., K. H. Kahl, and W. G. Tomek. Performance of Futures Markets: The Case of Potatoes. USDA Technical Bulletin No. 1636, January 1981.

Peck, A. E. "The Economic Role of Traditional Commodity Futures Markets," in Futures Markets: Their Economic Role, A. E. Peck, editor. Washington, D. C.: American Enterprise Institute for Public Policy, 1985. Chapter 1.

Peck, A. E., and J. C. Williams. "Deliveries on Chicago Board of Trade Wheat, Corn, and Soybean Futures Contracts, 1964/65-1988/89," Food Research Institute Studies XXII(No. 2, 1991): 129-225.

Rich, D. R., and R. M. Leuthold. "Feeder Cattle Cash Settlement: Hedging Risk Reduction or Illusion?" Journal of Futures Markets 13(August 1993): 497-514.

Taylor, P. D., and W. G. Tomek. "Forecasting the Basis for Corn in Western New York," Journal of the Northeastern Agricultural Economics Council 13(April 1984): 97-102.

Telser, L. G., and H. N. Higinbotham. "Organized Futures Markets: Costs and Benefits," Journal of Political Economy 85(1977): 969-1000.

Tomek, W. G., and R. J. Myers. "Empirical Analysis of Agricultural Commodity Prices: A Viewpoint," Review of Agricultural Economics 15(January 1993): 181-202.

Urban, Thomas N., "Agricultural Industrialization: It's Inevitable," Choices, the Magazine of Food, Farm, and Resource Issues Fourth Quarter 1991, pp. 4-6.

Williams, J. C., and B. D. Wright. Storage and Commodity Markets. Cambridge University Press, 1991.

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