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EFFECTS OF FUTURES AND OPTIONS TRADING
ON FARM INCOMES

William G. Tomek

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Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

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This paper reviews and appraises the evidence about the effects of options and futures trading on the level and variability of farmers' incomes. Futures and options markets are vehicles for price discovery and hedging (Peck, 1985), but other market institutions can play the same roles (Telser). Thus, this paper is concerned not just with the returns from hedging, but with the question, what institution provides the least cost alternative for hedging? Futures markets typically are liquid and have a high degree of integrity. Therefore, for many firms, a futures contract provides the lowest cost hedge. But, these markets may not be the least cost alternative for the majority of farmers.

The theoretical and empirical evidence about the benefits of hedging is reviewed in the first section. This evidence suggests that hedging in futures (or options) should be beneficial, but that relatively few farmers use futures or options contracts for hedging. In this context, past analyses of the effects of hedging on farmer income are critiqued; in particular the costs of using futures and options markets are reviewed. The final section addresses the role of futures and options markets in influencing farm incomes including the facilitation of forward cash contracts between merchants and farmers.

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## Potential Benefits to Farmers

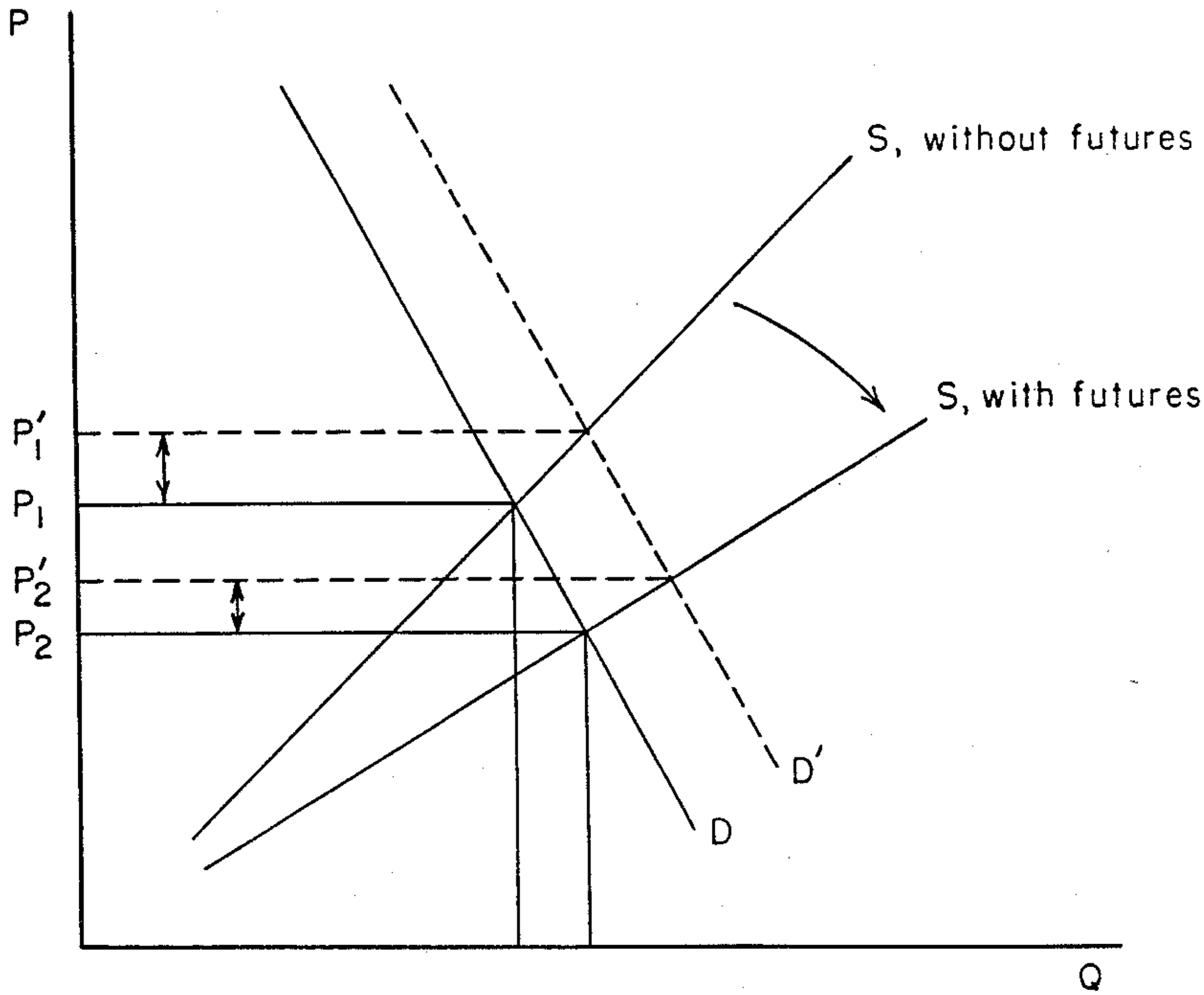
### Theory

It is convenient to divide the discussion of potential benefits into two categories: (a) the influence of hedging on the mean and variance of individual firm's incomes and (b) the influence of futures and options trading on the mean and variance of market prices and quantities. This paper is largely about point (a), but theoretical models suggest that the introduction of a futures market can influence market prices and quantities, thereby indirectly affecting all farmers (and consumers). These results are summarized briefly.

Market effects. In typical models (e.g., Stein; Turnovsky), the supply function shifts to the right and becomes flatter because producers are assumed to shift price risk at no cost with a futures market.[1] Thus, the mean price is lower and production larger than it would have been without an active futures market. Also, with a flatter slope, changes in demand will result in smaller price changes than under a supply regime without a futures market (figure 1). However, this model treats producers as the only hedgers.

A more complete model (e.g., based on Anderson and Danthine) would allow buyers of farm commodities to hedge as well. In such a model, both the demand and supply functions presumably would be affected by the introduction of a futures market, since it is again assumed to permit costless hedging. Firms therefore hedge, and a new futures market should have unambiguous positive effects on welfare (shifting both supply and demand to the right). In reality, hedging in futures is not costless, but the existence of active markets for many farm commodities implies that they have economic benefits.

FIGURE 1. AN EFFECT OF INTRODUCING A FUTURES MARKET



Intrayear prices may be affected as well. The introduction of a futures market should reduce the seasonal variability of spot prices around the annual average, because the constellation of spot and futures prices helps guide the allocation of inventories (Working, 1960). Moreover, operational hedging by processors and exporters of farm commodities should reduce marketing margins. Futures often serve as a temporary, but important, substitute for cash purchases which merchants must make to meet contracted obligations and also provide for shifting price risk (Peck, 1985, pp. 17-19). Without futures, procurement costs would be larger, and hence a good case can be made that farm prices would be lower and retail prices higher (Brorsen, et al.; Thompson and Dziura).

Finally, the conceptual literature is more ambiguous about the potential effects of futures on short-term price behavior, but the empirical evidence suggests that the introduction of a futures market does not increase and perhaps may decrease the variability of daily or weekly price changes (Tomek). On balance, the aggregate market effects of futures trading seem to be beneficial to farmers, raising and stabilizing incomes, or at least are not harmful.

Individual firm effects. Conditional on whatever market effects the introduction of organized futures trading may have, economic conditions determine prices. Returns to individual farmers from transactions in cash markets will be distributed around market averages. Moreover, since futures trading provides zero additional returns in the aggregate, such trading could raise returns to farmers only if farmers as a group could consistently extract revenues from other traders. This would require farmers to be better forecasters than other traders. Although individuals can develop superior forecasting skills, no theoretical justification exists for arguing that farmers as a group can raise average returns through futures transactions themselves.

Similar arguments apply to farmers' use of options markets. For example, purchase of a put option places a floor under the sales price, and the purchaser can pick among floor (exercise) prices thereby providing different risk-return alternatives (see Hauser and Andersen). But, the price (premium) of the put reflects both expected price variability and the exercise price. Thus, if the farmer wishes to purchase a put with an exercise price above the current equilibrium level, this will be reflected in a relatively large premium. Even if the farmer purchases a put with an exercise price equal to the current equilibrium price each year, the expected value of the premium should essentially equal the expected benefit from holding the put (assuming, of course, that these values are determined in competitive markets). Whether or not the potential buyer of an option judges the premium to be "large" or "small" depends on the buyer's judgment about the future variability of prices relative to the market's judgment. The buyer can obtain an underpriced option only if his/her forecast of price volatility is better than the market's. In general, there is no free lunch.

Hedging, however, can have beneficial effects on farmer returns. The variability of returns can be reduced.[2] Moreover, if the constellation of prices indicates that an opportunity for profitable storage or production exists, these returns can be "locked in" through a hedge. But, the existence of futures and options markets does not guarantee that profitable opportunities will exist on a continuous basis; in competitive markets, prices can be below the cost of production. Forward markets do provide the flexibility to take advantage of profitable price relationships when they exist and to develop a variety of portfolios. These portfolios can include speculative positions, and in principle, the level and riskiness of returns can be altered to suit the individual's preferences.

Empirical Evidence

Research on farmer hedging has considered the effect of taking positions in futures on the variance of returns, on the mean of returns, and on the ability of hedges to assure the returns implied by relative prices. Early research simulated alternative marketing strategies, comparing various hedging programs with not hedging. Typically, futures positions were assumed to be 100 percent (but be opposite in sign) of the cash position. Both routine and selective hedge programs were considered, where selective hedges involved some type of decision rule about whether or not to hedge. Such research usually showed that routine hedges could reduce the variance of farmers' returns and that selective hedges increase average returns in some cases. A typical result is shown in table 1.

Table 1. Net prices for corn in Western New York, under simulated alternative marketing programs, 1975-1980

| Program | Mean | St. Dev. |
|---|---|---|
| | ----------$ per bu. | ----------- |
| Cash sale | 2.31 | 0.40 |
| Routine hedge | 2.27 | 0.16 |
| Selective hedge | 2.37 | 0.27 |

Source: Querin and Tomek, Table 2.

Subsequent research has emphasized the use of optimal hedges in the context of portfolio concepts. Optima have been estimated for a variety of commodities and for different specifications of the riskiness of prices and yields (e.g., Peck, 1975 (eggs); Heifner, 1973 (grain and livestock); Heifner, 1978 (soybeans); Wilson (wheat), and Leuthold and Peterson (cattle)). Such studies suggest that the optimal futures position is often a large percent--say, 75 to 100--of the expected cash position.[3] Thus, the implications for farmers' returns of optimal hedge positions are not much different than those studies that had assumed 100 percent hedges: namely, routine anticipatory hedges of production decisions will reduce the variability of income with little effect on average income.

The use of an objective function that involves explicit profit maximization, subject to a risk constraint, does imply, however, that the optimal futures position depends on expected price changes over the hedge interval. Thus, considerable research has considered whether price forecasts, through either technical or fundamental analysis, could improve hedging decisions (e.g., Franzmann and Sronce). Research of this type often implies that farmers' incomes can be increased by selective hedges based on forecast price changes. It seems doubtful, however, that most individual farmers can <u>consistently</u> make profitable forecasts, thereby increasing incomes through futures transactions.

Producers of storable crops have a variety of marketing choices, and futures can assist in making these choices. The concept of arbitrage hedging emphasizes the use of futures to take advantage of expected (forecast) changes in <u>relative</u> prices rather than expected changes in price levels. Specifically, the change in the cash price relative to the futures price over a storage interval can be forecast from the level of the initial basis (Working, 1953; Heifner, 1966).[4] This change in basis is a return to storage, and is assured through hedging. If a position in futures is taken when the initial basis (and the corresponding forecast of the return to storage) indicates that storage would be profitable, then a low risk, competitive profit is assured whether or not price levels rise or fall.

In table 2, these principles are applied to the storage of corn in western New York for the eight crop years, 1978-85. If a farmer had routinely stored corn at harvest each year and held the corn 24 weeks, the average gross return--the average seasonal rise in cash prices--would have been about 30 cents per bushel. However, these returns were highly variable. Routine hedging of the inventory would have reduced the variability of returns. But, more important, the harvest-time basis could have been used to forecast whether hedged storage would have been profitable or not. In two of the eight years, this basis was small, indicating that corn should have been sold at harvest and not stored. If corn had been stored <u>and hedged</u> in the six years in which the initial basis seemed consistent with profitable storage, returns to storage would have been raised 11 cents per bushel relative to routine, unhedged storage. Moreover, the standard deviation of returns would have been reduced.

An analogous concept exists for livestock: the producer can assure a return to "feedlot services" through the use of futures, when profitable relative prices occur (Paul and Wesson). Of course, relative prices may not always permit profitable hedges; the returns to feedlot services (or to processing or storage) can be small or negative. But, profitable feeding of cattle or hogs often can be assured via the use of futures (Hayenga et al;

Kenyon and Clay), and the existence of futures markets for feeder cattle and corn as well as for fed cattle means that a profit margin could be established even before cattle are placed on feed (Leuthold and Molker).

Table 2. Gross returns to storing corn, Western New York, 1978-85 crop years

| Marketing strategy | Returns Mean | St. Dev. |
|---|---|---|
| | ------cents per bu.----- | |
| Unhedged stocks | 29.5 | 36.0 |
| Routinely hedged stocks[a] | 32.1 | 21.6 |
| Selective hedge[b] | 40.7 | 16.4 |

[a] Hedge placed about November 1 each year; corn is sold 24 weeks later (late April) and position in May futures removed; return to storage is change in basis. The return without hedging is based on the seasonal change in cash prices over the same interval.

[b] Returns from carrying inventory and futures positions in six of eight years. In the other two years, the harvest-time basis was judged too small for hedging. The "zero" return from not carrying stocks in these years is not reflected in the calculations, but presumably the revenue from the harvest-time sale of corn would have earned a market rate of return in an alternative investment.

Source: Author.

Much less empirical research has been done on the impacts of hedging in options on farmer incomes. But options contracts should be a useful hedging tool, especially where the underlying risk itself has the characteristic of an option (Stoll and Whaley, p. 227). In particular, at the beginning of a production period, farmers face both yield and price risk. Selling futures, of course, provides a hedge against price declines, but it exposes the hedger to a risk if the crop fails and prices rise. In contrast, the purchase of a put option provides a hedge against a price decline, and if prices rise, the option will expire worthless. The farmer obtains the benefit of the higher price for whatever crop has been raised. An analysis of pricing soybeans through put options shows, for example, that options can place a secure floor under prices while having little effect on the net realized price (Eberle, et al).

In addition to simple hedges, options can be used for many, more complex transactions and portfolios that involve varying risks and returns (see Hauser and Eales and references therein). The introduction of options expands the choice set, and advisory services often refer to all of the strategies as "hedges." But clearly varying levels of speculation are involved, and as returns increase, risk increases. The precise levels of risk and return are constrained by the existing price distribution (Hauser and Eales).

In sum, the use of futures or options can help shift risk. Moreover, arbitrage hedges can assure (approximately) competitive returns on storage and production decisions when such returns are reflected in market prices (not just when the farmer has a crop to sell). It is doubtful that farmers, as a group, can raise incomes via hedging. However, in principle, producers can tailor portfolios from spot, futures, and options positions to achieve risk-return objectives suited to their individual situations.

<u>Actual Farmer Hedging</u>

The limited evidence available suggests that few farmers use futures or options markets and that many take speculative positions when they do (Helmuth; Leuthold). In contrast, commercial, nonfarm firms often make active hedging use of futures. It is well-documented that short open interest in the grains is highly correlated with inventory levels. Likewise, long hedging in the grains grew as exports (and the contemporaneous procurement risk) grew. Short and long positions in potatoes futures also were related to stock holding, on the one hand, and forward commitments of processors and seed merchants, on the other (Paul et al, 1981). Even though Peck and Nahamias found that optimal hedge models were poor forecasts of actual hedge levels of flour millers, their hedge levels were large.

Thus, one is led to ask, are farmers ignoring large potential benefits relative to the cost of hedging? Or, are there deterrents to hedging uses of organized markets not suggested by past research? The answers may be, to some degree, "yes" to both questions. Farmers perhaps are not well-informed about the use of futures and options markets. I shall also argue, however, that the objective functions specified for farmers have not fully characterized the costs of using futures and options markets. Thus, for many farmers, especially those of small or medium size, the direct use of futures and/or options markets may not be the low cost way to hedge.

## Appraisal of Benefits

### Objective Functions

Farmers' expected utility is commonly made a function of expected returns and risk; i.e., hedging is appraised in a mean and variance framework based on a measure of returns, not profit. I will not review the issue about whether a mean-variance framework is an adequate characterization of farmers' utility, but I will argue that the usual measures of returns omit important costs of hedging. Moreover, the parameters of the objective function are treated as constants over the entire sample period, while they undoubtedly should be viewed as changing from decision period to decision period.

Both theory and empirical evidence imply that the parameters of the distributions of prices are not constants, either within years or across years (e.g., Anderson; Gordon; Kenyon, et al.), while the conventional estimation of these parameters assumes that they are constants over the entire sample period. Using a model that allows the estimates of parameters of optimal hedge equations to vary from decision period to decision period can reduce the size of the optimal hedge (e.g., Harwood).

The main reason for overestimating the size of optimal hedges, however, is probably related to the omission of important costs from most specifications of farmers' objective functions. These costs include yield risk, transactions costs including those associated with margin calls, costs of managing a position in futures, and the lumpiness of contracts. While options may help avoid margin calls and yield risk, they are probably viewed as even more sophisticated instruments than futures by the uninitiated. The options are, of course, on positions in futures, and thus are also lumpy (for general discussion of forward commitments, see Paul et al, 1985).

<u>Costs of Using Futures</u>

The liquidity and integrity of futures markets are especially important to large commercial users, while transactions costs and the lumpiness of contracts are relatively unimportant to such users. Thus, the discussion of costs and risks, which follows, is from the viewpoint of the small or medium-sized farmer.

Heifner (1978) in a pioneering study demonstrated that yield risks can be relatively important in determining optimal hedges. His work used county yield data for soybeans. A subsequent analysis of three Illinois corn growers by Greenhall, et al indicated that the minimum risk anticipatory hedge on May 1 was only eight to 20 percent of expected production.[5] While one must be careful in generalizing from an analysis of three farms, such calculations suggest that optimal hedges for individual farms can be small indeed. If, in addition, other costs are considered, one might conclude that the optimal anticipatory hedge for many farmers is zero.

The cost of initial margin and the possible risk of margin calls are potentially important.[6] The correct treatment of the cost of initial margin is unclear. For large traders, treasury bills can be used for the initial margin deposit if arrangements are made for payment daily of variation margin. But a small trader, even a small hedger, is unlikely to be permitted to use treasury bills in this way and, moreover, the minimum size bill is $10,000, which is likely to be larger than the minimum margin requirement. In any case, there is an opportunity cost of using a bill for margin, and in my view, one simply cannot assume that the cost of the initial margin is zero.

If changes in futures prices are approximately a random walk, then the income or costs associated with changes in the value of the contract are about zero on average. Thus, it perhaps is not surprising that the few studies that have included margin costs have found them to be a small component of hedging costs (Nelson; Alexander, et al.). Nonetheless, large margin calls can occur in particular years. For example, if the standard deviation of daily price changes for soybeans were 10 cents per day, a hedger would need a line of credit of about $14,000 per contract to have a 99 percent probability of meeting the cumulative sum of margin calls that could occur over a 100 day hedge interval. This amount contrasts with an initial margin of $2500 or less per contract.

A prudent hedger would want to establish a line of credit for the major part of the margin risk exposure, not just for the initial margin, but will bankers typically extend such a line of credit? And, at what cost? Margin calls on anticipatory hedges are most likely to occur as yield expectations decline (and prices rise), and the appreciation in the spot price is meaningless if the farmer does not have a crop to sell. Thus, a lender has a good reason (lack of collateral) for not extending credit for margin calls. In such a situation, the farmer may want to offset the futures position. But that is related to my point: what is the optimal size of the futures position, what is the cost of maintaining that position, and how should the position be managed?

Research by Nelson indicates that the lumpiness of futures (or options) contracts can significantly influence the per bushel returns. In a simulation of a California wheat grower wishing to hedge 7,600 bushels, he found the difference in returns between a 7,000 and an 8,000 bushel position in futures ranged from less than 0.1 cent to 15 cents per bushel over an eight year period.

Costs of Using Options

If the farmer is buying (rather than writing) options contracts, then no margin is required, but a premium must be paid. An option's premium depends on the option's intrinsic value and its time value. The intrinsic value is determined by the size of the exercise price relative to the market price. The right to sell at above the market price can be obtained only by paying a large premium. For example, in early April 1987, when cash corn in

Illinois was $1.42 per bushel and July futures $1.62, the price of a put option on July futures with an exercise price of $1.80 was 20 cents per bushel. That is, the right to a short position in July futures at a $1.80 per bushel could have been obtained even though that futures was trading at only $1.62. But this right cost more than the difference in the two prices. The time value of the option depends on the length of time to maturity and the expected volatility of prices (as well as interest rates).

As indicated earlier, options are advantageous for anticipatory hedges because they need not be exercised and hence are a way to deal with yield risk. But options still have basis risk. Changes in option premia are not perfectly correlated with changes in the price of the underlying futures contract, and since the option is on the futures contract, one still has the basis risk between the futures and cash markets.

There are also costs and perhaps unforeseen risks in taking advantage of the numerous alternatives provided by options markets. For example, this past winter a respected farm magazine recommended that farmers create a synthetic call option in corn, by buying July futures and by buying a July put, rather than buying a July call directly (Fraedrich). The underlying assumptions of the advice were that corn prices were at a bottom and that a synthetic call was cheaper and less risky than buying a call or carrying inventory. Thus, the advice related to a way to speculate on a possible increase in corn prices and not to a way to hedge inventory.[7] Unfortunately, although corn prices were low in December, they declined still further over the next four months. The long position in July futures lost 24-1/4 cents by April 6; this was partly offset by a 12-3/4 cents gain in the premium of the July 180 put. Ultimately, if prices remain low, the call can be exercised, and the major cost limited to the premium. But, as the example suggests, costs an be incurred while the positions are held, and in this case, the long position in futures was taken at a price somewhat above the strike price, thereby causing an additional loss from a price decline.

As it turned out, the premium on the call declined from 10 to 1-1/4 cents over the same period. Thus, the loss from speculating in the call through early April 1987 would have been less than the loss on the artificial call. My main point is, however, that the potential benefits of diverse portfolios provided by options have associated, potentially important management costs. These costs might be appraised in terms of professional management fees or in terms of opportunity cost of a farmer's time.

Since the option is on a futures contract, lumpiness of contract size remains an issue. Also, to date, the volume of trading in most agricultural options, especially those with distant expiration dates, has been low. Thus, some markets may be sufficiently thin that individual transactions could have unexpected price effects. In sum, I suspect that there are major barriers to farmers use of options, including the size of the premiums and the seeming complexity of using the instrument.

## Conclusions

Hedging in organized futures or options markets has clear benefits in terms of shifting risk and of assuring competitive returns identified by existing price relationships. Forward markets, however, cannot provide above average returns for farmers as a whole. To imply, for example, that hedging in futures or options can provide above equilibrium prices is to engage in a fiction.

The benefits of using organized markets come at some cost, and these costs may be relatively large for individual farmers. Yield and basis risk are important issues at the farm level; transactions costs, including margins, can be large; the lumpiness of the contracts may affect the returns from the hedge; and farmers may perceive futures and options as complex instruments, which have high costs in terms of a scarce management resource.

In my opinion, these costs conspire against the direct use of futures and options contracts by many individual farmers. If this is true, then the benefits of futures and options markets for most farmers will come from their indirect use. As Philip McBride Johnson has argued, opportunities exist for "wholesalers" to develop a wide range of services, contracts, and products, based on underlying futures markets, that can be "retailed" to a larger public.

For example, forward contracts and basis contracts are widely available to farmers from their local merchants with the merchant then undertaking the requisite transactions in futures. Options markets permit additional forward arrangements. Grain buyers can offer minimum price contracts to farmers, with prices based on those offered in the organized options markets (McDonald). The minimum price contract provides the farmer with the benefit of the option--the establishment of a minimum sale price with the potential for taking advantage of price increases if they occur. The farmer also must pay the transactions costs, the option premium. But the farmer may see the contract as having a lower management cost and no basis risk and thus find it more attractive than the direct use of the options market.

In sum, for many farmers, the benefits of organized futures and options markets are most likely to come from their indirect, rather than direct, use, and of course these indirect uses can occur only if active, healthy futures and options markets exist.

## Footnotes

1 The models typically assume that hedgers are risk averse and that they "pay" speculators to take the price risk through a risk premium. The market, however, does not have transactions costs.

2 In the optimal hedge framework, the effect of the futures position on the variance of returns depends, in part, on the covariance between futures and cash prices (or price changes). Measures of the parameters should pertain to the hedge interval. Thus, if a cattle producer held a hedge over a five month period, then the optimal hedge depends on variance and covariance parameters for this period. The variance of returns is reduced if the relevant covariance is not zero.

3 This result occurs because basis risk is often small relative to price-level risk and because these are the only risks considered in the analysis. For example, using harvest-time prices for soybeans in Decatur Illinois, the standard deviation of the price level was $2.12 per bushel in the 1965-1985 period, while the standard deviation of the basis was only $0.12.

4 Using the spot price and the current quote of a distant futures price relevant to the decision, the local basis (B) is defined. For example, at harvest, the difference between the current futures price for May corn and the local cash price defines a price of storage from harvest time until May. The regression $dB = a + bB + e$ can then be fitted to historical data, where B is the basis at the beginning of the storage period and dB is the change in the basis over the intended storage interval. (The definition of dB depends on the storage interval being appraised.) The equation provides an estimate of the narrowing of the basis over the interval defined by dB, and dB can be forecast from B. This is a classic forecasting problem, since B is observable, and the standard deviation of forecast error is a measure of the basis risk.

5 As time passes, yield risk declines, and the size of the optimal hedge increases.

6 Adding storage costs to the objective function can alter the optimal hedge when storage and futures positions are jointly determined (Bond and Thompson). Adding transactions costs to the objective function also will alter the optimal hedge.

7 An alternative piece of advice would have been to hold inventories and hedge these inventories in futures, a classic arbitrage hedge. The carrying charge reflected in market prices in the Fall of 1986 was quite large, and a hedge in futures could have "locked in" this return.

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