hedging in both price and yield futures declines relative to hedging in price futures alone. They also concluded that hedging effectiveness depends critically on the price and yield bases.

Futures Options Contracts

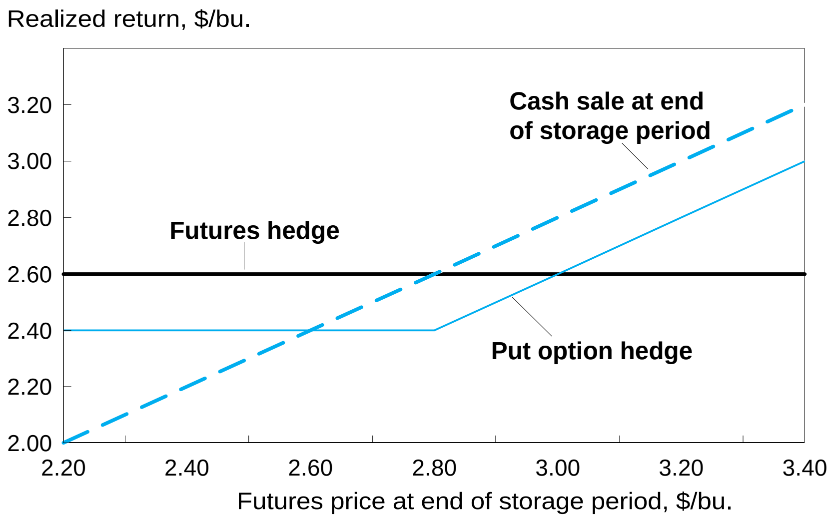
A commodity option gives the holder the right, but not the obligation, to take a futures position at a specified price before a specified date. The value of an option reflects the expected return from exercising this right before it expires and disposing of the futures position obtained. If the futures price changes in favor of the option holder, a profit may be realized either by exercising the option or selling the option at a price higher than paid. If prices move so that exercising the option is unfavorable, then the option may be allowed to expire. Options provide protection against adverse price movements, while allowing the option holder to gain from favorable movements in the cash price. In this sense, options provide protection against unfavorable events similar to that provided by insurance policies. To gain this protection, a hedger in an options contract must pay a premium, as one would pay for insurance.

Options provide protection against unfavorable events similar to that provided by insurance policies.

Options markets are closely tied to underlying futures markets. Options that give the right to sell a futures contract are known as "put" options, while options that give the right to buy a futures contract are known as "call" options. The price at which the futures contract underlying the option may be bought (for a call option) or sold (for a put option) is called the "exercise" or "strike" price. As an example, suppose a wheat producer purchases a put option having a strike price of $3.00 per bushel. If futures prices move to $2.80, the option may be exercised for a net profit of $0.20 ($3.00-$2.80), minus the premium paid for the option. If the harvest cash price is $2.70 per bushel, the farmer's return is $2.90 per bushel ($2.70 plus $0.20), minus the premium.

The effects on realized returns from hedging with futures and put options are compared for a range of possible futures price outcomes in figure 7. In this example, corn is stored in November and sold in May, output risk is absent, and the

Figure 7
Effects of futures and options hedging on exposure to price variation at marketing time, a storage example



Source: Hypothetical example developed by ERS.

hedge ratio is 1.0. The May futures price is $2.80 per bushel at the beginning of the storage period and the expected May basis is -$0.20. By hedging with futures, the farmer obtains an expected return for the corn in storage of $2.80 - 0.20, or $2.60. Alternatively, the farmer can buy an at-the-money put option with a $2.80 strike price for a $0.20 premium. The put guarantees a price equal to the strike price, minus the premium, minus the basis, or $2.80 - 0.20 - 0.20 = $2.40, while allowing the farmer to gain if the futures price rises above $3.00 in May. By not hedging, the farmer gets the futures price minus the basis. The figure shows that the range of possible prices is greatest with the cash sale and least with the futures hedge. Unlike futures hedging, the put does not limit the potential profits associated with increasing prices, but the price must rise more than the premium cost before a profit is realized.

The premium paid for an option typically consists of "intrinsic" value and "time" value. The intrinsic value reflects the difference between the underlying futures price and the strike price. If the price of the underlying futures contract is $2.90 per bushel, for example, and the strike price is $2.70, then the holder of a call option could gain $0.20 by exercising the option immediately. Consequently, the premium in this case must be at least $0.20 per bushel, and the option is "in the money." If the strike price is above the futures price, the intrinsic value of the call option is zero and the put is said to be "out of the money." When the strike price equals the futures price, the option is "at the money."

The time value of an option, in contrast, depends on several factors, including the volatility of the underlying futures contract, the time until the option expires, the interest rate, the strike price, and the underlying futures price. Time value refers to the money that buyers are willing to pay for the possibility that the intrinsic value of an option will increase over time. An option on a futures contract with very low volatility, for example, will have a small time value because traders do not expect the intrinsic value to change to a great extent over time. If the futures price is volatile, in contrast, the probability is high that the option's intrinsic value would increase and traders would be willing to pay more for the chance of such a gain (Sarris). In addition, intrinsic value depends on the time until the option's expiration. The greater the time horizon, the greater the intrinsic value because price uncertainty is greater. Observed options prices can be used to provide information about anticipated price variability (see box, p. 40).

Table 12 illustrates the situation for a central Illinois producer on March 15 who plans to produce 500 acres of corn and hedge with put options. The December futures price is $3.00 per bushel at planting time and the premium for at-the-money puts is $0.20 per bushel. His expected yield is 150 bushels per acre, and his production costs are estimated at $150,000. Because the farmer expects his production to fall no lower than 50,000 bushels, he buys 10 put contracts (5,000 bushels per contract * 10 contracts = 50,000 bushels), and selects a strike price of $3.00. The cost associated with this purchase is $10,000 in premiums (at an assumed cost of $0.20 per bushel), and $350 in commissions (10 contracts at $35 per contract).

As a simplifying assumption, suppose that the producer makes his decision on October 20 as to the sale of the option. If the futures price that day is $3.00 (equal to the strike price), the option has no

Unlike hedging in futures, put options (or call options) do not limit the potential profits associated with increasing (decreasing) prices.

Table 12—An illustration of net returns to a corn farmer who uses put options to protect against price risk

Item	Revenues, costs, and net returns	Dollars
1	Revenue from crop sale on October 20: (75,000 bushels * $2.50/bushel)	187,500
2	Total production costs	150,000
3	Net return from crop sale	37,500
4	Premium for put option paid on March 15: (10 put options * 5,000 bushels * $0.20 premium/bushel)	10,000
5	Return from put sale received on October 20: (10 put options * 5,000 bushels * $0.07/bushel)	3,500
6	Commissions on put purchase and sale: (2 * 10 put options * $35 commission)	700
7	Net return from put hedge (5 - 4 - 6)	-7,200
8	Net return from cash sale and put hedge (3 + 7)	30,300

Note: The put option has a $3.00 strike price and a $0.07 time value on October 20. Although net returns from the hedge in this example are negative, the example could as easily have been constructed to show a positive net return. (See discussions in the text regarding the expected return to forward pricing.)

Source: Hypothetical example developed by ERS.

Many studies have found options to be a potentially useful method for stabilizing returns.

intrinsic value (since the option is at the money), and an assumed time value of $0.07 per bushel (reflecting the probability that the futures price will decline before the option expires, raising the option's intrinsic value). Using this estimate, the producer's return to the purchase of the option is the time value on October 20 at $3,500 ($0.07 * 50,000 bushels), less the premium cost of $10,000, and the commission cost of $700 (10 contracts * $35 per trade * 2 trades), or -$7,200. If the producer had sold his crop at the harvest cash price, his return would have been $37,500, instead of the $30,300 ($37,500 - $7,200) earned in this hypothetical put option situation.

The farmer's return to buying options depends largely on the futures price at harvest. With a high futures price in October (say, $3.75), the producer's loss associated with the option is even higher, while a low futures price (say, $2.50) would result in a higher gain than in the cash-sale-at-harvest-only case. In an efficient market, the producer's return from buying put options over a series of many years is expected to equal the return to either hedging with futures or simply selling the crop at harvest, except for commissions. Although returns are approximately the same in all three cases, hedging with either put options or futures reduces uncertainty about return.

Several studies have explored the risk-return properties of options as they affect the farm firm. Many of these studies have found options to be a potentially useful method for stabilizing returns (Heifner and Plato; Curtis, Kahl, and McKinnell). Various surveys have also found that options are used to at least the same extent as futures, including a study of the Iowa cattle sector (Sapp). In addition, large-scale Corn Belt producers participating in Top Farmer Crop Workshops in 1994 and 1995 indicated that they used options as frequently, or more frequently, than hedging and to price a significant portion of their crops (Patrick, Musser, and Eckman). In a 1988 survey of Iowa producers, about 11 percent of the grain producers responding indicated that they used hedging and about 11 percent indicated that they used options

(Edelman, Schmiesing, and Olsen). Hog and fed cattle producers, however, were more likely to hedge than to use options.

The conclusions of the literature, however, are not definitive as to the effectiveness of options contracts in reducing risk, based on different underlying assumptions. One study, for example, analyzes production, hedging, and speculative decisions in futures and options markets given the presence of basis risk (Lapan, Moschini, and Hanson). These researchers, assuming no production risk, found that options are a redundant hedging tool when futures and options markets are unbiased and when cash prices are a linear function of futures prices. They indicate that the optimal hedging strategy involves using only futures contracts (the returns of which are linear in futures prices) because they dominate options contracts (the returns of which are nonlinear in futures prices). If futures prices or options premiums are biased, however, the results indicate that options, used along with futures, provide the optimal strategy for insuring against price risk. They conclude that options are more appealing as a speculative tool to exploit private information about price distributions than as a hedging tool.

Intrigued by a comparison of survey findings with the Lapan, Moschini, and Hanson research, Sakong, Hayes, and Hallam questioned the conditions under which producers find options useful for hedging. Introducing both output and price uncertainty, these authors found that it is almost always optimal for farmers to buy put options and to underhedge on the futures market. Their results lend support to the practice of hedging the minimum expected yield on the futures market, while hedging the remainder of expected output against downside price risk using put options. These researchers also found that their results are strengthened if the producer expects local production to influence national prices and if risk aversion is higher at low income levels.

Maintaining Financial Reserves and Leveraging

Leveraging refers to the producer's use of debt to finance the operation. Increasing the degree of leverage increases the likelihood that in a year of low farm returns the producer will be unable to meet his or her financial obligations, and heightens the potential for bankruptcy. Thus, in general, highly leveraged producers operate in an environment of greater financial risk than do producers who choose a less highly leveraged farm structure.[15]

Highly leveraged producers operate in an environment of greater financial risk than do producers who choose a less highly leveraged farm structure.

A producer's choice of debt (relative to equity) depends on many factors, including the farmer's risk aversion, the size and type of operation, the farmer's market relationships with input suppliers and output purchasers, lenders' willingness to provide loans, and the availability of government programs for managing risk. Increasing the farm's leverage (that is, borrowing) increases the capital available for production, allowing expansion of the business, but also entails incurring a repayment obligation and creates the risk of loan default because of the risks inherent in the farming operation. Because of these many factors, a farmer's use of debt to finance the operation interacts with both the production and marketing risks faced by the producer (Barry and Baker; Gabriel and Baker).

[15]An increase in leveraging means that the farmer is at increased risk. In contrast, farmers who increase their use of most other risk management tools covered in the accompanying sections—such as hedging and insurance—reduce their risk.