A NOTE ON ALTERNATIVE MARKET AND GOVERNMENTAL RISK TRANSFERENCE MECHANISMS

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Abstract

The major mechanisms for the transference of price and output risk by crop producers are examined. These include the use of futures and options contracts, government price-support and deficiency-payments programs, and crop insurance. Iso-revenue curves are used to highlight the distinctions between these alternatives.

Key words: futures contracts, options contracts, price-support programs, deficiency-payment programs, crop insurance, agricultural policy.

There has been considerable discussion recently about the alternatives to current commodity programs. The term "market orientation" has become popular in describing the direction in which agriculture should move. A key aspect of the current discussion concerns the use of market mechanisms to substitute for the risk transference role now performed by government commodity programs. While commodity programs clearly have had multiple goals, including income support, the risk transference role commonly is used for program justification. It has been argued that the risk agricultural producers face, especially crop producers, is greater than in other sectors because of uncertainties in both output levels and price.

Currently U.S. government programs that address output risk are the crop insurance and disaster relief programs, which essentially transfer risk from producers to taxpayers. Commodity price-support programs are the primary public mechanism to address price risk. Depending on the specific form of the program, risk is transferred from the producer to the consumer or to the taxpayer.

Private mechanisms for addressing output risk are minimal, although some specific peril insurance such as hail insurance does exist. The main market mechanisms for addressing price risk are forward, futures, and options contracts. The potential use of options, in particular, has gained considerable attention. Gardner pointed out that price supports act like put options, implying that the availability of options may reduce the need for government programs. The similarities between options and price supports in terms of their risk implications for individual producers has been noted in subsequent studies (Petzel). Marcus and Modest pointed out, however, that when output is random a governmental price guarantee on all output is not equivalent to a simple option, which guarantees a price on a specified, fixed quantity.

The purpose of this note is to provide a simple means to illustrate how various programs and market mechanisms differ in terms of their effects on an individual producer's gross revenue when both output and price are random. A graphical approach is used that offers a fresh perspective on this aspect of the decision problem facing agricultural producers. This approach helps clarify some of the differences in the strategies that producers can use to manage risk. It may also prove to be a useful pedagogical tool for instructors of agricultural policy and marketing.

METHODOLOGY

Crop producers can use a number of alternatives to address the problem of revenue risk. Most of the major alternatives and their associated revenue implications are examined in this paper. Included are the exclusive use of the cash market, the use of futures and forward contracts, the use of option and minimum price contracts or participation in a deficiency-payment program (the equivalence of these two alternatives is discussed below), partici-

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pation in a price-guarantee program, participation in a price-guarantee program on an allotment, and participation in the crop insurance program.

In this paper, the management decisions of a crop producer are simplified using a stylized, two-period model. For expository convenience, and at the risk of some imprecision, the two periods are denoted planting and harvest time. The producer is assumed to make planting, marketing, and program participation decisions simultaneously. Furthermore, all fixed and variable costs are known with certainty at this time. At harvest all output is sold, all futures and options positions are liquidated, and revenues from government programs are received. The outcome of any decision made prior to harvest will depend on the harvested output and the realized harvest time cash price (denoted Q and P, respectively), both of which are random at planting time. The random gross revenues received at harvest time (denoted R) will also depend on which, if any, risk transference mechanism is utilized. Each of the alternatives examined (except the cash market) will specify what are termed, generically, a contract quantity and contract price; these are non-random and denoted q and p, respectively. For example, with a short position in futures, q refers to the number of futures contracts times the trading unit per contract, while p refers to the futures price at planting time.

In the following sections, each of the alternatives listed above is examined in detail. Formulas for the revenues generated for the alternatives are summarized in Table 1. Each formula corresponds to an iso-revenue diagram (Figure 1), which shows the price/output combinations that produce a given level of revenue. These diagrams provide a graphical means of assessing the nature of the differences between the alternate mechanisms, as well as insight into the nature of the incentives that these mechanisms provide to an individual producer. In these diagrams, iso-revenue curves are shown over the price range [0.5,2.5] and the output range [0,4], with arrows indicating the direction of increasing revenue. For each of the alternatives, the contract quantity and price levels are set at q=2 and p=1.5. Note that, in each case, R=3 for (P,Q)=(1.5,2) and that the levels shown are in 1/2 unit intervals.[1]

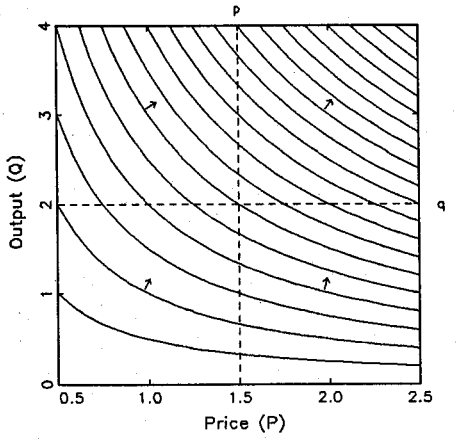
Only the gross revenues associated with the various alternatives are examined graphically. To assess their relative desirability to a producer, it would be necessary to consider all the associated costs. All costs, however, are assumed to be known at planting time. Cost considerations thus have no effect on the shape of the iso-revenue lines displayed in Figure 1, whether these are interpreted as gross or net revenue curves. Costs will, however, affect the level of net, but not gross, revenue associated with each curve.

TABLE 1. REVENUE AND EFFECTIVE PRICE FORMULAS FOR ALTERNATIVE RISK TRANSFERENCE MECHANISMS

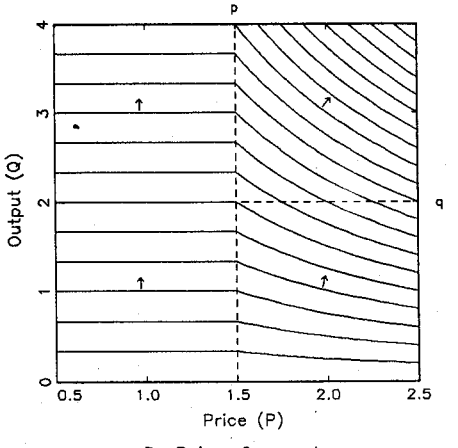
Cash Market	
$R = QP$	
Futures Contract	
$R = QP + q(p-P)$	
Options Contract or Deficiency Payment	
$R = QP + \max(0,q(p-P))$	
Price Guarantee	
$R = Q\max(p,P)$	
Price Guarantee on an Allotment	
$R=\begin{cases} Q\max(p,P) \\ QP + \max(0,q(p-P)) \end{cases}$	$Q<q$ $Q>q$
Crop Insurance	
$R = QP + \max(0,p(q-Q))$	

R = Gross revenue
P = Harvest time cash price
Q = Output
q = Contract quantity
p = Contract price

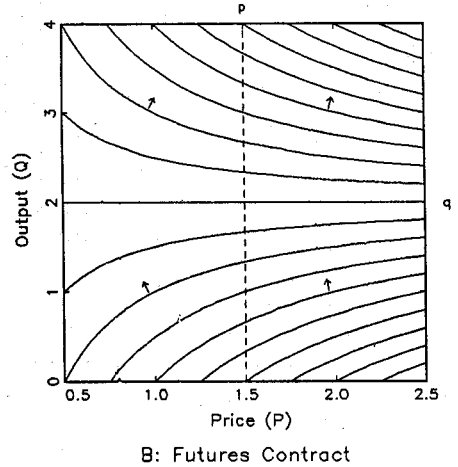
[1]The output, price, and revenue levels are arbitrary and do not correspond to any particular commodity. It is the shape of the revenue surface, which is invariant to scale, that is of primary concern.



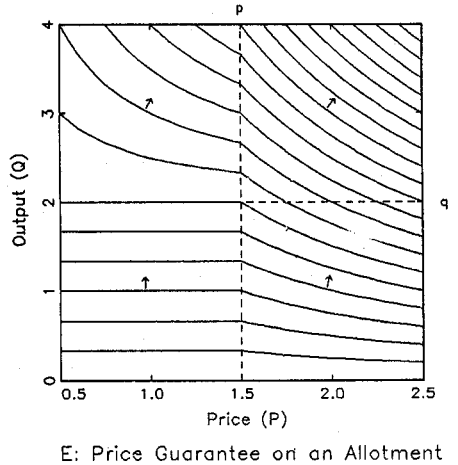
A: Cash Market



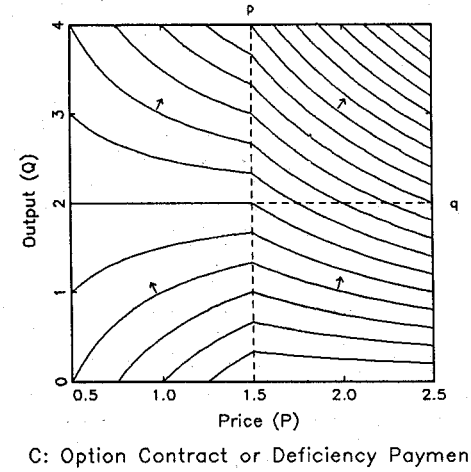
D: Price Guarantee



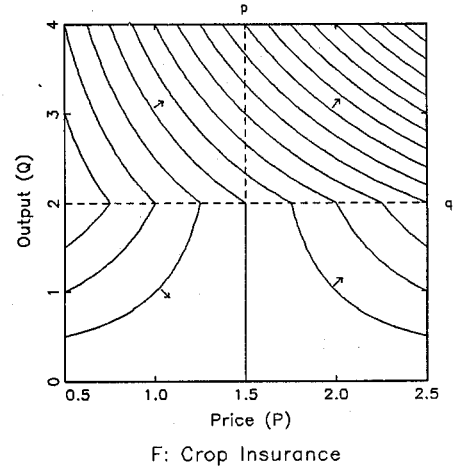
B: Futures Contract



E: Price Guarantee on an Allotment



C: Option Contract or Deficiency Payment



F: Crop Insurance

Figure 1. Iso-Revenue Curves for Alternative Risk Transference Mechanisms.

It is also important to note that alternatives with similar gross revenues may have different costs to a producer. For example, the government now subsidizes crop insurance, and there is discussion of a subsidized options program (Glauber and Miranda; Heifner and Wright). While gross revenues under such programs would be the same as with market crop insurance and market option contracts, the net revenue generated would differ. This paper focuses on understanding the differences in gross revenue implications of the alternatives, largely ignoring the question of precisely how an alternative is implemented and, therefore, what it will cost a producer to use.

A complete analysis of the relative desirability of the alternatives would also account for the probabilities associated with price/output combinations. These probabilities would change with the introduction or elimination of any one of these alternatives because of aggregate supply effects. Furthermore, acreage set-aside or other requirements for government program participation change the probability that any given output level will be realized. The analysis of these factors, however, is beyond the scope of this paper.

CASH MARKET

If all output is sold on the cash market, then gross revenue is simply equal to output times the harvest time cash price: $R=QP$. Iso-revenue curves are shown in Figure 1A. As indicated by the arrows, an increase in either P or Q will always result in an increase in R.

FUTURES AND FORWARD CONTRACTS

A short position in the futures market or a forward sales contract commits the producer to sell a given amount (q) at the planting time futures price (p). A futures position can be entered into at minimal cost, though it does require payment of brokerage fees, the deposit of margin, and, possibly, the deposit of additional margin. Furthermore, the use of futures contracts involves basis risk, which adds a third dimension of uncertainty to the framework presented here. These are ignored for simplicity of exposition, thus eliminating the distinction between futures and forward contracts; the term futures applies here to either type of contract.

The gross revenue obtained using a strategy based on futures is equal to what would be obtained by selling all output on the cash market plus the profits realized from the short futures position (which may be negative): $R=QP+q(p-P)$ (Figure 1B). Whether this generates greater revenues than the cash market case clearly depends on the sign of p-P.

It is instructive to examine the producer's attitude toward price, given alternative signs of Q-q. In the situation in which Q=q, the harvest time cash price, P, does not affect gross revenue because all output is sold at p. In general, a horizontal iso-revenue curve represents an insensitivity of revenue to price for a given output, while a vertical curve represents an insensitivity to output for a given price. The arrows in the Figure 1B indicate that when $Q>q$ revenue is increasing in P and hence a high price is desirable. When $Q<q$, however, an increase in P will lead to lower revenue. Thus, a producer who takes a large short position actually may end up desiring the price to decrease. This seemingly perverse result is due to the fact that when output cannot cover the futures position, the output shortfall can be viewed as a short speculative position, and short positions benefit from price declines. By extension, if a high probability is associated with the area below the Q=q line, this alternative is consistent with the speculative position that the harvest time cash (futures) price, P, will be lower than the planting time futures price, p. On the other hand, if a high probability is associated with the area above the Q=q line, the position is consistent with the speculative position that price will increase between planting and harvest.

OPTIONS CONTRACTS

Options markets provide another market tool with which a producer can transfer risk. The simplest strategy, examined here, involves buying put options. Put options give the purchaser the right to sell an amount (q) of a commodity at a specified exercise price (p) on or before a given date. If the harvest time cash price is above the exercise price ($P>p$), the purchaser allows the option to expire and sells all output in the cash market. Market-traded options require the buyer to pay a premium for this right, the size of which will affect the desirability of this alternative.[2]

[2]The discussion here makes no distinction among options on the physical commodity, options on a futures contract, and minimum price contracts. These distinctions are relevant mainly in the presence of basis risk and when brokerage or processing fees differ among the alternatives.

The gross revenues from such a strategy are R=QP if P>p and R=QP+q(p-P) if P<p. Alternatively, this can be written as R=QP+max(0,q(p-P)) (Figure 1C). For P>p, this alternative generates the same gross revenue as the cash market case, while for P<p, the gross revenue generated is the same as in the futures market case (recall that gross revenues exclude transactions costs, premiums, etc.). When P<p and Q<q, a producer holding an options contract is acting as a speculator in the same sense as in the futures case and will, therefore, benefit from a price decrease.

DEFICIENCY PAYMENTS

Of the government programs designed to alter agricultural producers' risk environment, the first to be considered is a deficiency-payment program. In such a program, a producer receives a base allotment (q) times the positive difference between a guaranteed (target) price (p) and the harvest time cash price. The actual output, all of which is sold at harvest time cash price, does not alter the deficiency payment received. Thus R=QP if P>p, and R=QP+q(p-P) if P<p. Combining these gives R=PQ+max(0,q(p-P)), which is the same as the formula for the options case. Therefore, the options contract and the deficiency-payment program iso-revenue diagrams are identical (Figure 1C) when the target price equals the strike price and the base output equals the size of the options contract.

In practice there are important differences between using an options contract and a deficiency-payment program that must be accounted for. In particular, different costs are associated with these two alternatives. Using an option contract may require payment of a premium unless it is fully subsidized by the government. On the other hand, program participation may involve acreage reductions or other requirements that either have a direct cost or alter the probability distribution of output. Furthermore, a deficiency-payment program may lead to attempts by producers to alter their base acreage and base yields to obtain more favorable payments in the future. Nonetheless, the basic shape of iso-revenue curves for the two alternatives will remain the same.

MINIMUM PRICE GUARANTEE

A minimum-price-guarantee program ensures that a producer receives a minimum price on all output produced. Such a program can be implemented through government purchases, through direct payments to producers, or, if the good is traded, through either export subsidies or import restrictions. Regardless of what method is used to implement the program, a given price/quantity combination will in principle yield identical revenues of R=QP if P>p and R=Qp if P<p, where p is the guaranteed minimum price (in this case there is no contract quantity q). Combining these results in the formula R=Qmax(p,P) (Figure 1D). This makes revenue independent of the harvest time cash price as long as that price is below the minimum, indicated diagrammatically by the horizontal portions of the iso-revenue curves. This type of program is similar to the current CCC loan programs (though there are sometimes acreage reductions tied to program participation, these affect the level of output not the revenue contingent on that output level).

It is sometimes argued that a price-guarantee program is like the provision of a put option with an exercise price equal to the guaranteed minimum price. A comparison of the iso-revenue lines for these two cases (Figures 1C and 1D) reveals that this is not true when output is uncertain.The reason for the difference is that a price guarantee applies to all output, while an option contract applies to a fixed amount. This means that any excess output beyond that covered by the option will be sold at the market rate, resulting in lower returns than those obtained under the price-guarantee program (when P<p). On the other hand, when there is an output shortfall with an options position (Q<q), the producer essentially is acting as a speculator because the output does not cover the commitment in the options contract. This means that a low price/low output situation provides additional revenue from the speculative gains of the options position.[3]

MINIMUM PRICE GUARANTEE ON AN ALLOTMENT

An alternative price-guarantee program covers only a fixed amount, q, of the output produced. Such an allotment or quota provision eliminates the differences between a price guarantee and an options position when output ends up being higher than the contract

[3]If a deficiency payment is combined with a price guarantee, as is currently the case for a number of commodities (e.g., wheat and corn), then a hybrid situation occurs. These programs involve both a loan rate or guarantee price (p_l) and a target price (p_g). Revenue is the same as with a pure deficiency payment for $P>p_l$, while for $P<p_l$ it is the same as with a price guarantee.

quantity (Q>q). With such a program, if output is greater than the allotment, the excess production is priced at the harvest time cash price. However, if production falls below the allotment, then all output is priced at the guaranteed price. Thus R=QP when P>p, but when P<p, revenues will depend on whether realized output is greater or less than the production allotment: R=Qp if Q<q, and R=(Q-q)P+qp if Q>q (Figure 1E).[4] In a low output/low price situation, this program generates less gross revenue for any given price/output pair than an option contract or deficiency-payment program (compare Figures 1C and 1E). However, when P>p or Q>q, these alternatives generate identical gross revenues. A price guarantee on an allotment must, therefore, be less valuable than a subsidized option or a deficiency-payment program (assuming similar participation costs).

CROP INSURANCE

The final government program considered is the crop insurance program. The current program has the following features. A producer can elect a certain yield coverage and price. If yield, and therefore output, falls below the insured level, the producer receives a payment equal to the elected price times the output shortfall. Actual output is sold at the cash price. Thus, R=QP if Q>q, and R=QP+p(q-Q) if Q<q, where q is the insured output level and p is the elected price. Combining these yields, R=QP+max(0,p(q-Q)) (Figure 1F). The notable feature about the iso-revenue curves in the crop insurance case is that the producer is better off with less output in the low price/low output situation (P<p, Q<q). This occurs because any output produced receives a lower price than that obtained on the insured output shortfall. This can be interpreted as a graphical representation of a moral hazard problem, since it implies that, when prices are low, a producer with crop insurance who realizes that yields will also be low has an incentive to strive for even lower yields. Notice also that the iso-revenue curves have the same shape as those for an option, if the axes are reversed. This is because an option is, in essence, a price insurance policy.

DISCUSSION

It is clear from the iso-revenue diagrams that the alternatives discussed result in different patterns of revenue when producers face both output and price risk. These diagrams of the institutional impacts on producers' risk environment provide a pedagogical tool as well as additional insight into the nature of these institutions. The use of the diagrams makes it easy to identify quickly any unique features of a given alternative. In particular, the arrows indicating the direction of increasing revenue identify areas in which price declines are preferred with the futures and options alternatives, a phenomena that can be given a speculative interpretation. Also, in the crop insurance case, the area in which lower output is preferred is easily identified and provides an illustration of the moral hazard problem.

The diagrams also make clear that the use of market mechanisms, particularly agricultural options, to reproduce the random returns offered by governmental price guarantees and insurance programs is not as simple as it first appears. A subsidized option program that covers the cost of purchasing an option with a strike price equal to the target price and covering the base allotment provides the same risk environment as a pure deficiency payment scheme but differs from price-guarantee programs. There is, therefore, a need for careful consideration of the alternative random returns when analyzing the effects of substituting market mechanism for current government programs. While a complete analysis of the desirability of alternative strategies must account for cost differences and the probabilities associated with the price/quantity combinations, the gross revenue implications of alternatives can be easily compared using the simple graphical tool presented here.

[4]Such a program is similar to the current peanut program under the assumption that the price support on any non-allotment output (additionals) is non-binding.

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